Forest bird population trends at Martins Bay, Hollyford Valley, Fiordland

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Objective

Forest birds were monitored at Martins Bay to determine their response to an intensive predator control programme carried out by the Hollyford Conservation Trust. Initial bird monitoring was conducted in September 2014, before any management was undertaken. Counts were repeated annually. We report on changes in bird population trends between 2014 and 2017.

Methods

Sampling techniques

To report on the response of a wide range of forest bird species, bird counts were conducted using two methods: (1) line-transect based distance sampling (Buckland et al. 2001; Buckland 2006) to estimate population densities and monitor density trends of five key forest bird species, and (2) encounter rates (mean number of detections per km) to monitor gross changes in population size and composition for all forest bird species.

Study species

Bellbird (*Anthornis melanura*), kereru (*Hemiphaga novaeseelandiae*), South Island rifleman (*Acanthisitta chloris chloris*), South Island tomtit (*Petroica macrocephala macrocephala*) and tui (*Prosthemadera novaeseelandiae*) were monitored more intensively because these species represent several important guilds for the healthy functioning of forest ecosystems and are vulnerable to predation by possums, rats and stoats. Other forest bird species were also monitored, although less intensively, to reveal gross changes in population size and composition resulting from management.

Transect establishment

Monitoring was undertaken using line-transects. Thirty-six transects; eighteen on the true right and eighteen on the true left of Lake McKerrow and the Hollyford River, 450 m in length and at least 200 m apart were sampled (Fig. 1). Transects on the true right were established in 2014; using a random design, transects on the true left were established in 2015; using a systematic sampling design with a random start point.

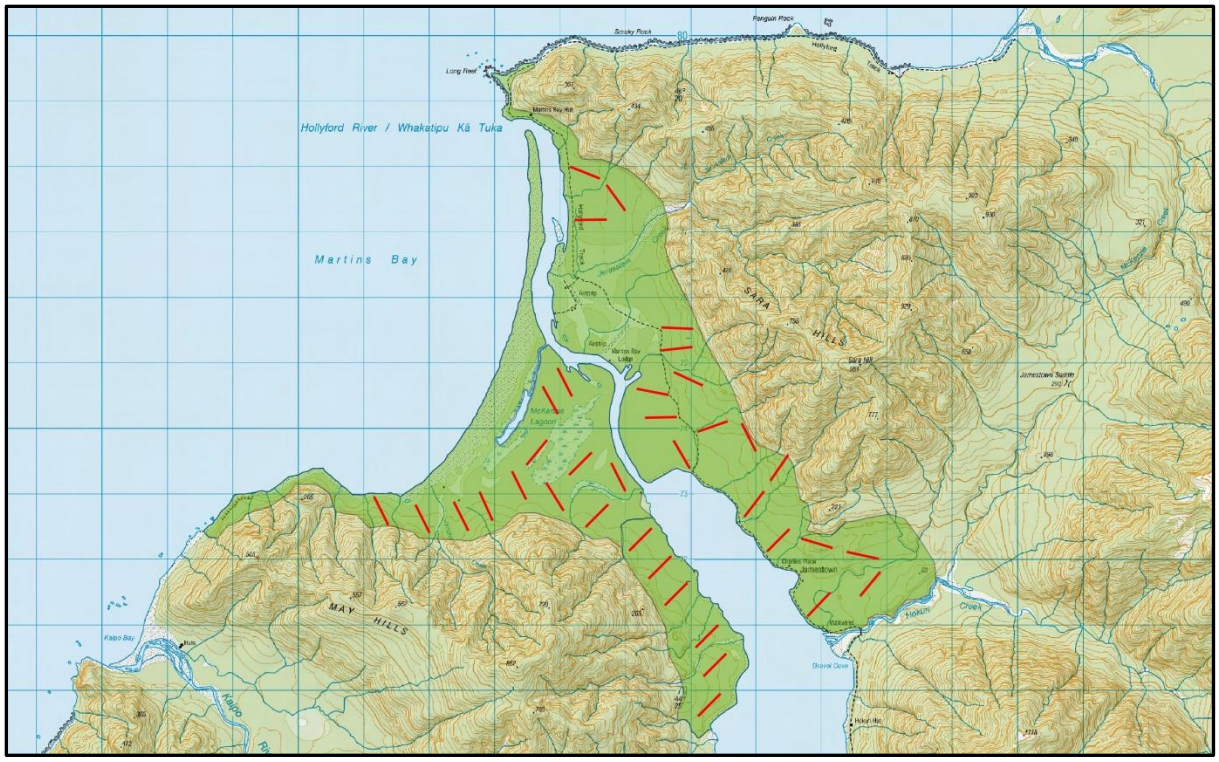

Figure 1. Distribution of bird monitoring transects (red) at Martins Bay. The green shaded area is managed by the Hollyford Conservation Trust

Data collection

Data was collected annually in September during fine weather only (no rain or strong winds). During the 2014 survey, only transects on the true right (18) were monitored. All transects (36) were monitored during subsequent surveys between 2014 and 2017.

Data was collected by the same observer each year between 0800 hours and 1800 hours. The observer approached each transect with caution to avoid flushing undetected birds at or near the transect start point. Transects were walked at a slow and constant speed. Each time a transect was walked, a selection of weather variables including temperature, rain, wind and cloud cover were recorded at the end of the transect according to guidelines outlined in Dawson and Bull (1975).

Horizontal distances perpendicular from the transect line to each bellbird, kereru, rifleman, tomtit and tui were recorded to the nearest meter within 30 m of either side of the defined line, using a laser rangefinder with built-in inclinometer. Distances less than 5 m (minimum focal distance for a rangefinder) were estimated visually. Distances to those birds only heard, or not clearly seen, were estimated by measuring the distance to vegetation at an equivalent distance to the estimated position of the bird. The observer did not move away from the transect for more than a few meters to locate a heard bird. This was to ensure that birds on or near the transect were not missed. To prevent estimating distances to the same birds more than once, the observer paid attention to the movements of the birds seen. Particular attention was paid to ensure that distance estimates were made to their first position of detection. Birds that flew into, or over the transect area, were ignored to avoid overestimating densities.

All other forest bird species seen or heard from the transect were counted regardless of their distance from the transect. If a bellbird, kereru, rifleman, tomtit or tui was seen or heard beyond 30 m of either side of the transect, this was also recorded.

Data analysis

Distance sampling data was analysed in the software Distance 6.2 (Thomas et al. 2009) using Conventional Distance Sampling (CDS). Data collected on bellbird and tomtit was analysed using independent detection functions for each survey. Data collected on kereru, rifleman and tui was first pooled across surveys to increase the sample size and then post stratified by survey to estimate the population density for each species and survey, based on a global detection function.

No distinction was made between male or female birds or birds detected by sight or their call during data analysis. Data were not truncated more than the limit set in the field (30 m) as further truncation did not improve model fit. Data were not grouped into interval classes for analysis. Detection probability histograms were constructed for each species and survey. Robust detection functions were fitted to the histograms based on guidelines in Buckland et al. (2001), and population density estimates were derived.

The following details were compared for each analytical approach: Akaike's Information Criterion (AIC), visual inspection of the detection probability histograms, Q-Q plots, accuracy of calculated density estimates and corresponding confidence intervals and Cramer-von Mises (CvM) GoF statistics, from which a preferred model was selected, and density estimates were derived.

Simple indices of relative abundance were estimated for all species by calculating the mean number of birds counted per km per survey using the software R version 3.1.2 (R Core Team, 2013).

A linear regression model was fitted to the distance sampling and encounter rate data for each species to determine the population trend over the monitoring period. R^2 were calculated for each species to show how close the data are to the fitted regression line, the higher the R^2 value, the better the model explained the data; an R^2 value of 1 means that the regression line perfectly fits the data. R^2 values less than 0.05 were considered to show no statistically significant change in the population trend for that species.

Results

Density estimates

Estimated bellbird, kereru and rifleman densities increased in 2015 compared to pre-operational levels (2014), and further increased in 2016 (Table 1, Fig. 2). Their densities decreased in 2017 to levels similar to those measured in 2015 (Table 1, Fig. 2). A linear regression model fitted to the data showed a positive population trend (R^2>0.05) for all three species over the monitoring period (Fig. 2).

Tomtit density estimates increased in 2015 compared to pre-operational levels, and further increased in 2016 (Table 1, Fig. 2). Their densities decreased slightly in 2017, but

remained higher than those measured in 2015. The population trend over the monitoring period was positive (Fig. 2).

Tui densities were very low between 2014 and 2016, but showed a big increase in 2017 (Table 1, Fig. 2). The population trend over the monitoring period was positive (Fig. 2).

Table 1. Population density estimates ($\hat{D}$) for bellbird, kereru, rifleman, tomtit and tui at Martins Bay between September 2014 and September 2017.

Species	Year	Samples	Total transect length	n	Model[1] (key+adjust)	$\hat{D}$	$\hat{D}$ 95% lower CI	$\hat{D}$ 95% upper CI
Bellbird	2014	18	8.1	31	Unif+cos	1.23	0.71	2.11
	2015	36	24.3	233	Unif+cos	2.65	1.88	3.73
	2016	36	16.2	199	Hnorm+cos	5.27	4.01	6.93
	2017	36	16.2	158	Hrate+cos	2.80	1.93	4.05
Kereru	2014	18	8.1	8	Unif+cos	0.26	0.11	0.6
	2015	36	24.3	43	Unif+cos	0.46	0.29	0.72
	2016	36	16.2	42	Unif+cos	0.67	0.34	1.31
	2017	36	16.2	26	Unif+cos	0.41	0.24	0.7
Rifleman	2014	18	8.1	7	Unif+cos	0.32	0.11	0.96
	2015	36	24.3	22	Unif+cos	0.33	0.14	0.82
	2016	36	16.2	31	Unif+cos	0.71	0.29	1.73
	2017	36	16.2	18	Unif+cos	0.41	0.15	1.15
Tomtit	2014	18	8.1	42	Hnorm+cos	1.23	0.85	1.78
	2015	36	24.3	251	Unif+cos	2.39	1.90	3.02
	2016	36	16.2	230	Unif+cos	3.75	3.14	4.48
	2017	36	16.2	251	Hrate+cos	3.26	2.76	3.85
Tui	2014	18	8.1	10	Hnorm+cos	0.22	0.08	0.59
	2015	36	24.3	17	Hnorm+cos	0.15	0.06	0.26
	2016	36	16.2	6	Hnorm+cos	0.07	0.02	0.19
	2017	36	16.2	94	Hnorm+cos	1.03	0.65	1.64

[1] Model consisting of a key function (half-normal, uniform or hazard rate) with a cosine adjustment term.

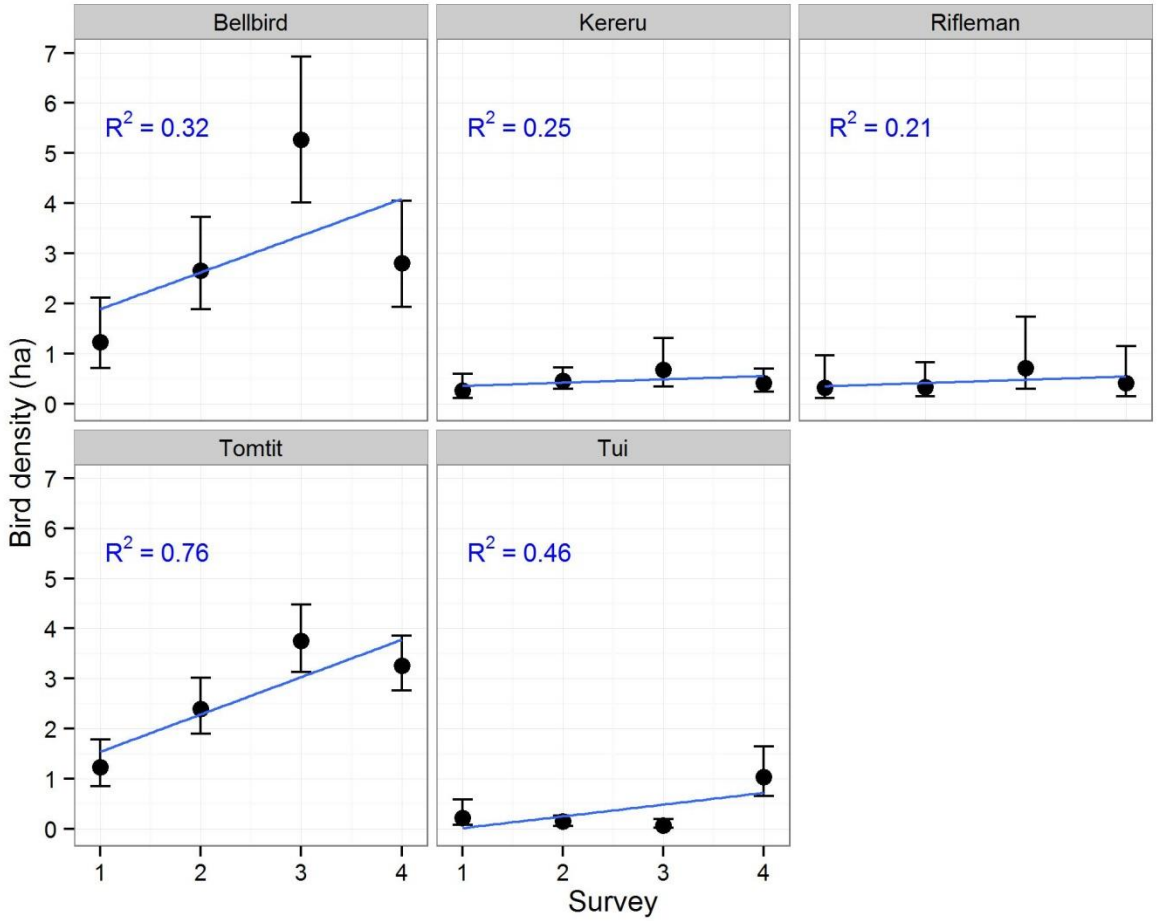

Figure 2. Population density estimates and population trend for bellbird, kereru, rifleman, tomtit and tui (birds/ha ± 95% CI) at Martins Bay between September 2014 (survey 1) and September 2017 (survey 4). A linear regression model fitted to the data (blue) shows the population trend for each species over the monitoring period. R^2 values show how close the data are to the fitted regression line.

Encounter rates

A positive population trend was seen for 12 species: bellbird, blackbird (*Turdus merula*), New Zealand falcon (*Falco novaeseelandiae*), fantail (*Rhipidura fuliginosa*), fernbird (*Bowdleria punctata*), greenfinch (*Carduelis chloris*), kereru, yellow-crowned parakeet (*Cyanoramphus auriceps*), rifleman, shining cuckoo (*Chrysococcyx lucidas*), tomtit and tui (Fig. 3).

Five species showed a negative population trend: brown creeper (*Mohoua novaeseelandiae*), chaffinch (*Fringilla coelebs*), grey warbler (*Gerygone igata*), silvereye (*Zosterops lateralis*) and song thrush (*Turdus philomelos*) (Fig. 3).

Three species: South Island kaka (*Nestor meridionalis meridionalis*), kea (*Nestor notabilis*) and redpoll (*Carduelis flammea*) did not show either a positive or a negative population trend (R^2<0.05).

An additional eight species were encountered from the transects, including: Australasian bittern (Botaurus poiciloptilus), Canada goose (Branta canadensis), kingfisher (*Halcyon sancta vagans*), morepork (Nixon novaeseelandiae), New Zealand scaup (Aythya novaeseelandiae), oystercatcher (Haematopodidae sp.), paradise shelduck (Tadorna variegate), and skylark (*Alauda arvenis*). These species were not included in analysis because they were either very rare (only encountered during one of the four surveys), nocturnal, or non-forest birds.

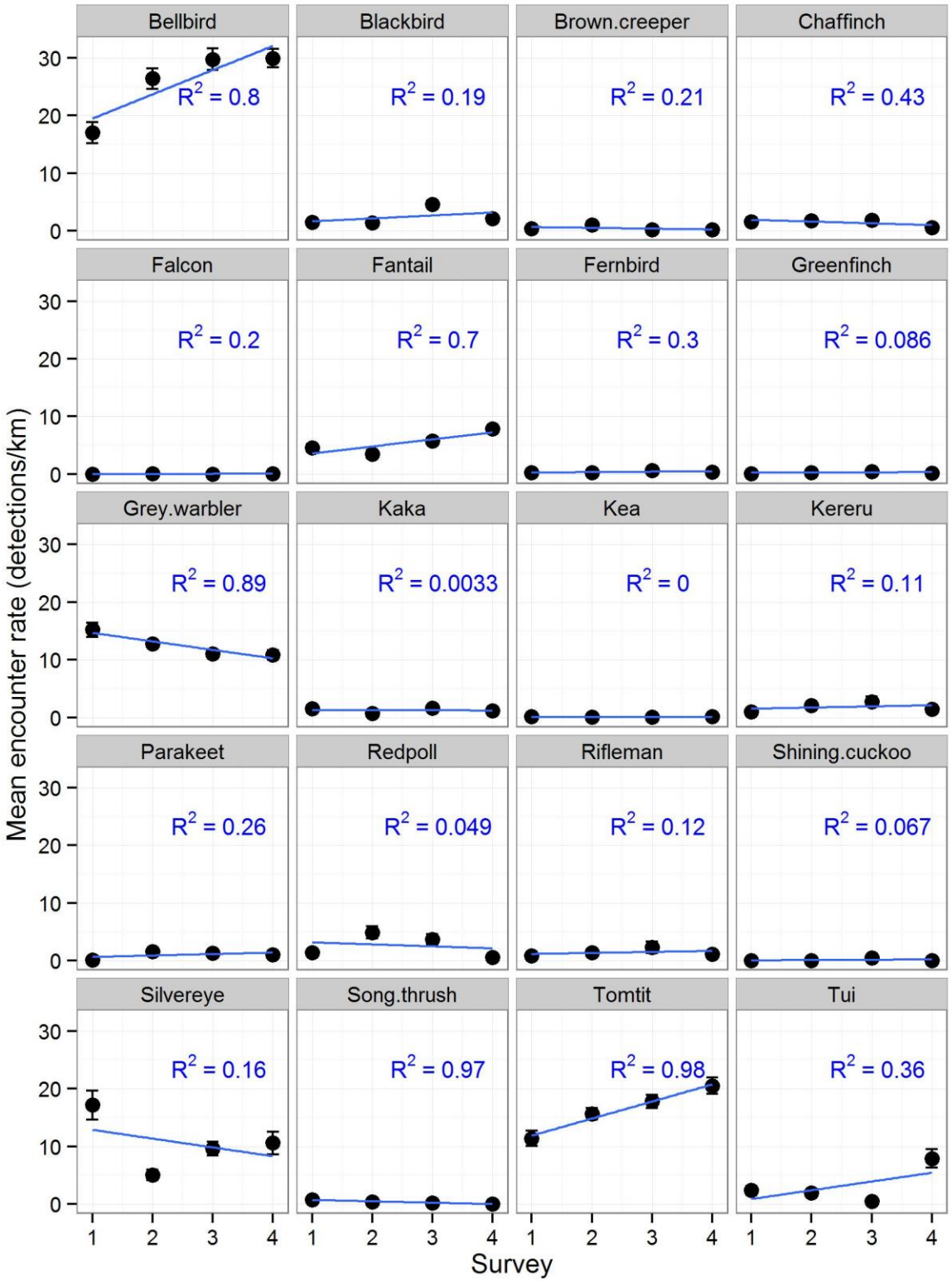

Figure 3. Mean encounter rates for forest bird species detected from transects at Martins Bay between September 2014 (survey 1) and September 2017 (survey 4). Encounter rates are presented as the mean number of birds detected per kilometre and include all birds seen or heard regardless of their proximity from the transects. A linear regression model fitted to the data (blue) shows the population trend for each species over the monitoring period. R^2 values show how close the data are to the fitted regression line.

Discussion

The 2016 beech mast resulted in high rodent and stoat numbers in the Hollyford. Stoat capture (using traps) in the area managed by the Hollyford Conservation Trust was high between May 2016 and May 2017; a total of 189 stoats were caught. In unmanaged areas, adjacent to the area managed by the Trust, including the Eastern and Western side of Lake McKerrow, upper Hollyford, Kaipo and Pyke, stoat numbers reached high levels; a stoat survey conducted in February 2017 resulted in 53% tracking. Stoat tracking in the area managed by the Trust was 3% at that time. Rodent numbers inside the area managed by the Trust were high in July 2016, prior to the bird breeding season (65% tracking), but were successfully reduced by November 2016 (8% tracking).

Changes in estimated densities for 4 of the 5 species monitored in detail (bellbird, kereru, rifleman and tomtit) showed similar patterns; densities increased between 2014 and 2015 following initial management, and further increased in 2016, following another season of low predator numbers. Estimated densities for all four species declined in 2017 compared to 2016. The decline was greatest for bellbirds. Despite stoats being controlled to reasonably low levels, they could have done some damage to the bird population before getting caught in the traps. Their impact was however likely to be much greater if the site was unmanaged. Rodents could also have done some damage to the bird population at the start of the bird breeding season (August), before their numbers were reduced. Although densities of 4 of the 5 species had declined, the decline measured between 2016 and 2017 was not greater than the growth that was measured between 2015 and 2016, and an increasing population trend over the monitoring period (2014-2017) was retained.

Tui numbers increased markedly in 2017 compared to previous year. The increase of these nectar eating birds that are often drawn to flowering food sources is likely the result of increased forest health and increased food availability following three years (2015-2017) of low predator numbers. The decrease in bellbirds between 2016 and 2017 could also partly be related to the increasing number of the more dominant tui.

Fifteen native forest bird species were encountered from the transects at Martins Bay. Ten species (bellbird, falcon, fantail, fernbird, kereru, parakeet, rifleman, shining cuckoo, tomtit and tui) showed an increasing population trend over the monitoring period. Three species (brown creeper, grey warbler and silvereye showed a decreasing trend and 2 species (kaka and kea) showed no trend. Population trends, derived from changes in encounter (detection) rates are likely to be more reliably determined over a longer monitoring period (5-10 years).

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