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

Report prepared by Mainly Fauna Limited for the Hollyford Conservation Trust

Iris Broekema
Mainly Fauna Limited
231K Ramparts Road
RD1
Te Anau, 9679
Email: mainlyfauna@gmail.com

Summary

Forest birds were monitored at Martins Bay, Hollyford Valley, Fiordland, to determine their response to an intensive long term predator control programme managed by the Hollyford Conservation Trust using two methods: (1) line-transect based distance sampling to estimate population densities and long term density trends for bellbird (*Anthornis melanura*), South Island kaka (*Nestor meridionalis meridionalis*), kereru (*Hemiphaga novaeseelandiae*), rifleman (*Acanthisitta chloris*), South Island tomtit (*Petroica macrocephala*) and tui (*Prosthemadera novaeseelandiae*), and (2) recording encounter rates for all forest bird species seen or heard from transects to reveal gross changes in population size and composition. Bird counts were conducted annually in September between 2014 and 2016.

Density estimates for bellbird, kereru, rifleman and tomtit increased between 2014 and 2015, following an aerial 1080 operation conducted by the Department of Conservation, and further increased in 2016, following additional ground control managed by the Hollyford Conservation Trust. The numbers of detections for kaka and tui were too low to reliably estimate their population densities.

Interim results (population trends derived from 3 years of encounter rate data) also showed a positive population trend for fantail, fernbird, and yellow-crowned parakeet. Grey warbler, silvereye and tui showed a negative population trend, while no trend was seen for other native species encountered during the surveys. Introduced species that showed a positive population trend were blackbird, greenfinch and redpoll. Population trends, derived from changes in encounter rates are likely to be more reliably determined over a longer monitoring period (5-10 years).

Ongoing annual monitoring of forest birds is important to help determine if the control methods used at Martins Bay are sufficient to suppress and maintain predator numbers to low enough levels to achieve positive population growth and population trends for forest bird species.

Introduction

The lower part of the Hollyford Valley/Whakatipu Kā Tuka, consists of a series of unique ecosystems, ranging from dune systems and wetlands to podocarp forests. The flora and fauna in the valley is threatened by introduced species such as possums (*Trichosurus vulpecula*), rats (*Rattus rattus*) and stoats (*Mustela erminea*) through predation and competition. To protect this area, a predator control operation was carried out in November 2014 by the Department of Conservation, using an aerial application of 1080 across 19,617 ha. Following the aerial operation, The Hollyford Conservation Trust started an intensive long term predator control programme to restore and protect 2,500 ha of land surrounding Martins Bay though a network of traps and bait stations.

To determine the response of forest birds to the predator control programme at Martins Bay, and the effectiveness of the chosen management tools, a forest bird monitoring programme was initiated. 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 six key forest bird species; bellbird (*Anthornis melanura*), South Island kaka (*Nestor meridionalis meridionalis*), kereru (*Hemiphaga novaeseelandiae*), South Island rifleman (*Acanthisitta chloris chloris*), South Island tomtit (*Petroica macrocephala macrocephala*) and tui (*Prosthemadera novaeseelandiae*), and (2) encounter rates (mean number of detections per km) to monitor gross changes in population size and composition for all forest bird species.

The distance sampling methodology (Buckland et al. 2001) was chosen as the primary monitoring tool in this study as it has major advantages over other simple count methods such as five-minute bird counts (Dawson & Bull 1975). Distance sampling can reliably estimate densities for selected forest bird species during a multi-species survey (Broekema and Overdyck 2012). Robust density estimates enable us to comment on short term changes in bird densities as well as on long term population trends for each selected species. This allows us to report on species response to management and the effectiveness of predator control techniques. Encounter rate data is used to report on gross changes in population size and composition only, preferably over a longer period (5 to 10 years). The advantage of this method is that it allows us to comment on population changes and composition for all forest bird species.

Initial bird monitoring was conducted in September 2014, prior to the application of the aerial 1080 operation. Counts were repeated in September 2015 and 2016.

Methods

Study species

Bellbird, kaka, kereru, rifleman, tomtit and tui 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. Some of the selected species such as rifleman and tomtit have high fecundity and are therefore likely to show a

rapid response to predator control. Others including kaka and kereru are expected to respond once pest numbers have been suppressed for significant periods of time and once habitat improves. Other forest bird species were also monitored, although less intensively, to reveal gross changes in population size and composition resulting from management.

Study site

The study site (2,500 ha) encompasses mostly flat land on the true right and true left of the Hollyford River, between the Hokuri Creek and the sea. The vegetation is predominantly lowland podocarp hardwood forest with patches of mixed native shrub and scattered silver beech (*Lophozonia menziesii*).

On the true right the majority of the vegetation is taken up by a mixture of rimu (*Dacrydium cupressinum*), Southern rata (*Metrosideros umbellate*), mahoe (*Melicytus ramiflorus*), kamahi (*Weinmannia racemose*), rough tree fern (*Dicksonia squarrosa*) and supplejack (*Ripogonum scandens*). Kiekie (*Freycinetia banksia*) becomes more common towards the Northern end of the study site, while tanekaha (*Phyllocladus trichomanoides*) is dominant between Hokuri Creek and Jamestown, mixed with emergent rimu trees and dense patches of *Neomyrtus pedunculata*.

On the true left, the Southern end consists of old podocarps such as rimu and Southern rata, mixed with mahoe, rough tree fern, with an open, mainly supplejack, understory. The area around the lagoons and wetlands is mostly taken up by kahikatea (*Dacrycarpus dacrydioides*) and rimu with a dense kiekie understory mixed with grasses. The Western strip along the coast consist of open and dry forest, with kamahi and supplejack. The lakeshore on both sides is lined with South Island kowhai (*Sophora microphylla*).

Predator control

The 2,500 ha study site is managed by the Hollyford Conservation Trust using a combination of bait stations and traps. This area lies within the larger lower Hollyford predator control area (19,617 ha) which encompasses the lower half of the Hollyford Valley from the Pyke Junction to the Coast, between the Kaipo River and Big Bay. Aerially distributed 1080 was applied to the management area on November 5, 2014. Some private properties surrounding Martins Bay and Lake McKerrow/Whakatipu Waitai area were excluded from aerial control; 1080 baits were hand laid on these properties, which was completed by December 4, 2014. The operation resulted in a reduction of possums, rats, stoats and mice (*Mus musculus*) (Department of Conservation, 2015).

Following the aerial operation, the Hollyford Conservation Trust installed a network of Philproof rodent bait stations on a 100m x 100m grid and double set DOC 200 stoat traps on a 200m x 400m grid, across 900 ha comprising the northern half of the area on the true right. This bait station and trapping network was expanded over the entire 2,500 ha site in March 2016. In addition, Good Nature R24 (rat and stoat) traps were installed on a 100m x 100m grid on the true right between the northern end of Lake McKerrow and the Hollyford River mouth at Martins Bay during August and September 2016. Possum, stoat and rodent numbers were maintained between low to moderate levels throughout the year (data not presented).

Transect establishment

Monitoring was undertaken using line-transects. Thirty-six transects; eighteen on the true right and eighteen on the true left, 450 m in length and at least 200 m apart were sampled (Fig. 1). Transects on the true right were established in 2014; ten transects were located along existing monitoring lines between Jamestown and Jerusalem Creek. Five additional bird count transects were established between Jamestown and Hokuri Creek, and three additional transects were established between Jerusalem Creek and the Hollyford river mouth at Martins Bay. Transects on the true left were established in 2015, using a systematic sampling design with a random start point. Transects were marked with pink flagging tape and start and end points of transects were permanently marked with a white plastic triangle.

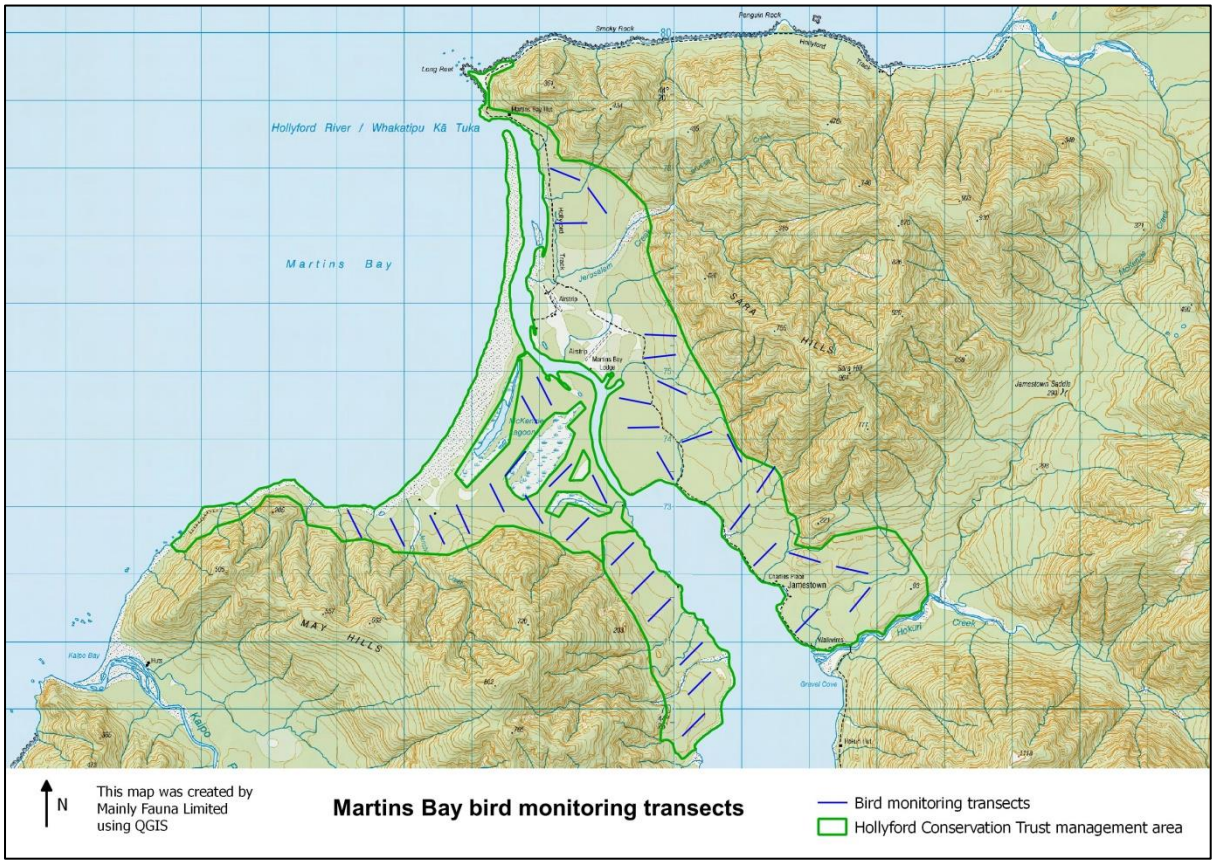

Figure 1. Distribution of bird monitoring transects at Martins Bay.

Data collection

Data was collected annually in September during fine weather only (no rain or strong winds). During the 2015 survey, only transects on the true right (18) were monitored. All transects (36) were monitored during subsequent surveys in 2015 and 2016.

Data was collected by one observer 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, kaka, 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, kaka, 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). Limited detections make estimation of a useful detection function difficult and may bias density estimates; for this reason, distance sampling data collected for tui and kaka was not analysed. Data collected on bellbird and tomtit was analysed using independent detection functions for each survey. Data collected on kereru and rifleman was first pooled across surveys to increase the sample size and then post stratified by survey to estimate the population density for each species for each survey.

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). For each method, a linear regression model was fitted to the data to determine the population trend over the monitoring period.

Results

Density estimates

Estimated densities for bellbird, kereru, rifleman and tomtit increased in 2015 compared to 2014 and further increased in 2016 (Table 1, Fig. 2). A linear regression model fitted to the data showed a positive population trend for all four species over the monitoring period (Fig. 2).

Table 1. Population density estimates ($\hat{D}$) for bellbird, kereru, rifleman and tomtit at Martins Bay between September 2014 and September 2016.

Species	Year	Samples	Total transect length (km)	n	Model[1] (key+adjust)	GoF CvM (cos) P	$\hat{D}$	$\hat{D}$ 95% lower CI	$\hat{D}$ 95% upper CI
Bellbird	2014	18	8.1	31	Unif+cos	0.8	1.23	0.71	2.11
	2015	36	24.3	233	Unif+cos	0.15	2.65	1.88	3.73
	2016	36	16.2	199	Hazrate+cos	0.1	6.07	4.22	8.74
Kereru	2014	18	8.1	8	Hnorm+cos	0.6	0.24	0.10	0.56
	2015	36	24.3	43	Hnorm+cos	0.6	0.43	0.27	0.68
	2016	36	16.2	42	Hnorm+cos	0.6	0.62	0.32	1.23
Rifleman	2014	18	8.1	7	Unif+cos	0.4	0.31	0.10	0.92
	2015	36	24.3	22	Unif+cos	0.4	0.32	0.13	0.79
	2016	36	16.2	31	Unif+cos	0.4	0.68	0.28	1.66
Tomtit	2014	18	8.1	42	Hnorm+cos	0.8	1.23	0.85	1.78
	2015	36	24.3	251	Unif+cos	0.6	2.39	1.9	3.02
	2016	36	16.2	230	Unif+cos	0.15	3.75	3.14	4.48

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

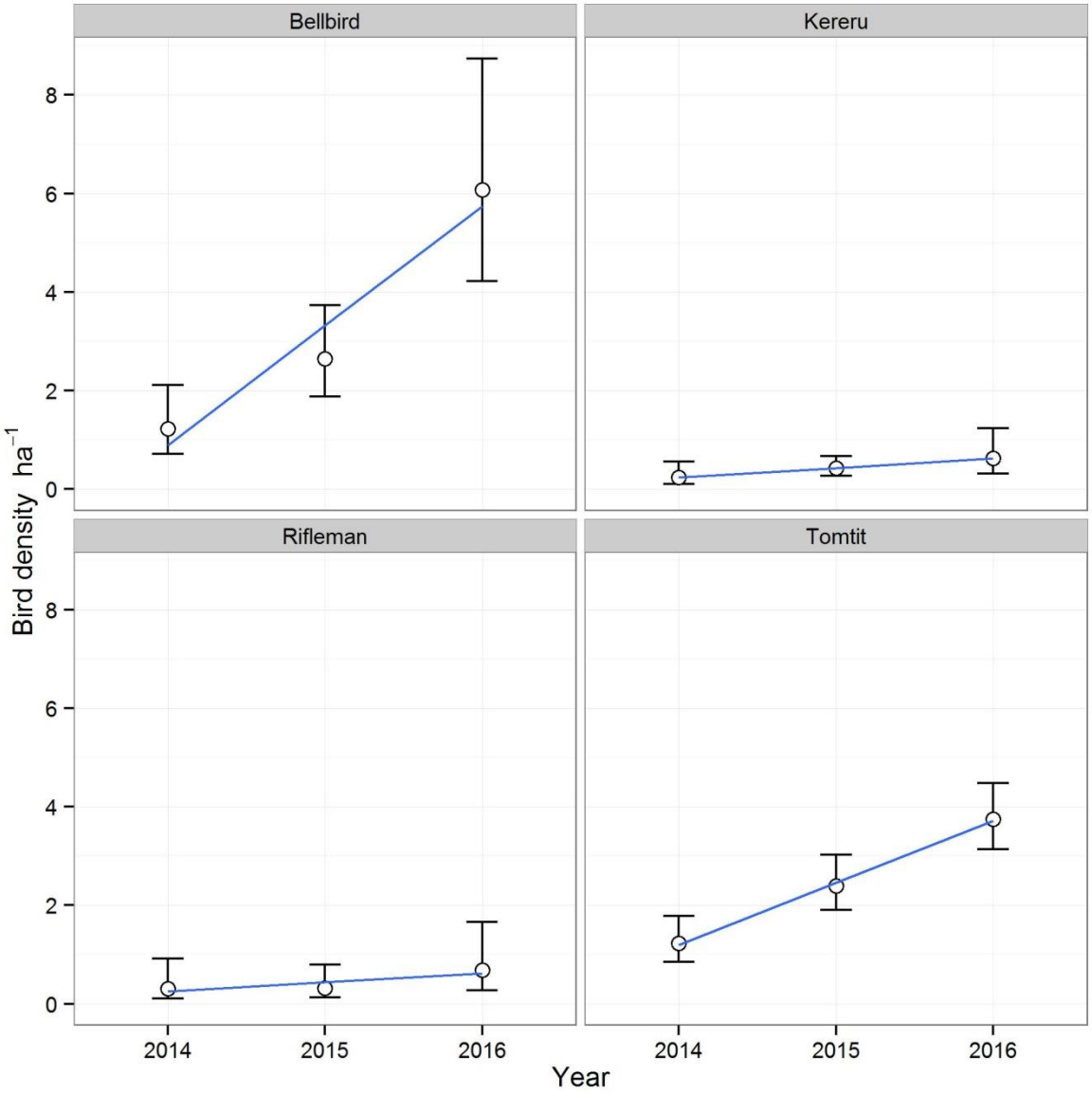

Figure 2. Population density estimates for bellbird, kereru, rifleman and tomtit (birds ha–1 ± 95% CI) at Martins Bay between September 2014 and September 2016.

Encounter rates

Twenty-two (22) forest bird species were encountered at Martins Bay over the period monitored (2014 - 2016). A positive population trend was seen for ten (10) species: bellbird, blackbird (*Turdus merula*), fantail (*Rhipidura fuliginosa*), fernbird (*Bowdleria punctata*), greenfinch (*Carduelis chloris*), kereru, yellow-crowned parakeet (*Cyanoramphus auriceps*), redpoll (*Carduelis flammea*), rifleman and tomtit (Table 2, Fig. 3). Four (4) species including grey warbler (*Gerygone igata*), silvereye (*Zosterops lateralis*), song thrush (*Turdus philomelos*) and tui showed a negative population trend (Table 2, Fig. 3). Four (4) species showed no obvious positive or negative population trend; brown creeper (*Mohoua novaeseelandiae*), chaffinch (*Fringilla coelebs*), kaka and kea (*Nestor notabilis*) (Table 2, Fig. 3). Four (4) species including New Zealand falcon (*Falco novaeseelandiae*), kingfisher

(*Halcyon sancta vagans*), shining cuckoo (*Chrysococcyx lucidas*) and skylark (*Alauda arvenis*) were rare as they were only encountered during one of the three surveys (Table 2).

Table 2. Mean encounter rates (detections/km ± SE) for forest bird species detected from transects at Martins Bay between September 2014 and September 2016. 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.

	2014			2015			2016		
Species	n	Mean encounter rates (detections/km)	SE	n	Mean encounter rates (detections/km)	SE	n	Mean encounter rates (detections/km)	SE
Bellbird	18	17.04	1.82	36	26.42	1.78	36	29.75	1.89
Blackbird	18	1.48	0.44	36	1.39	0.31	36	4.63	0.58
Brown_Creeper	18	0.37	0.37	36	0.99	0.63	36	0.19	0.14
Chaffinch	18	1.60	0.71	36	1.76	0.47	36	1.85	0.55
NZ_Falcon	18	0.00	0.00	36	0.06	0.06	36	0.00	0.00
Fantail	18	4.57	0.63	36	3.49	0.73	36	5.74	0.55
Fernbird	18	0.25	0.25	36	0.25	0.15	36	0.62	0.37
Greenfinch	18	0.12	0.12	36	0.31	0.31	36	0.49	0.33
Grey_Warbler	18	15.19	1.27	36	12.78	0.56	36	10.99	0.78
Kaka	18	1.48	0.57	36	0.68	0.21	36	1.60	0.43
Kea	18	0.12	0.12	36	0.06	0.06	36	0.06	0.06
Kereru	18	0.99	0.41	36	2.06	0.41	36	2.72	0.87
Kingfisher	18	0.00	0.00	36	0.00	0.00	36	0.06	0.06
YC_Parakeet	18	0.12	0.12	36	1.57	0.43	36	1.30	0.38
Redpoll	18	1.36	0.41	36	4.91	1.05	36	3.70	0.94
Rifleman	18	0.86	0.48	36	1.36	0.60	36	2.35	1.01
Shining_Cuckoo	18	0.00	0.00	36	0.00	0.00	36	0.49	0.18
Silvereye	18	17.16	2.50	36	5.03	0.90	36	9.57	1.18
Skylark	18	0.00	0.00	36	0.00	0.00	36	0.12	0.12
Song_Thrush	18	0.74	0.44	36	0.37	0.17	36	0.19	0.10
Tomtit	18	11.36	1.31	36	15.62	0.97	36	17.78	1.11
Tui	18	2.35	0.79	36	1.91	0.55	36	0.43	0.21

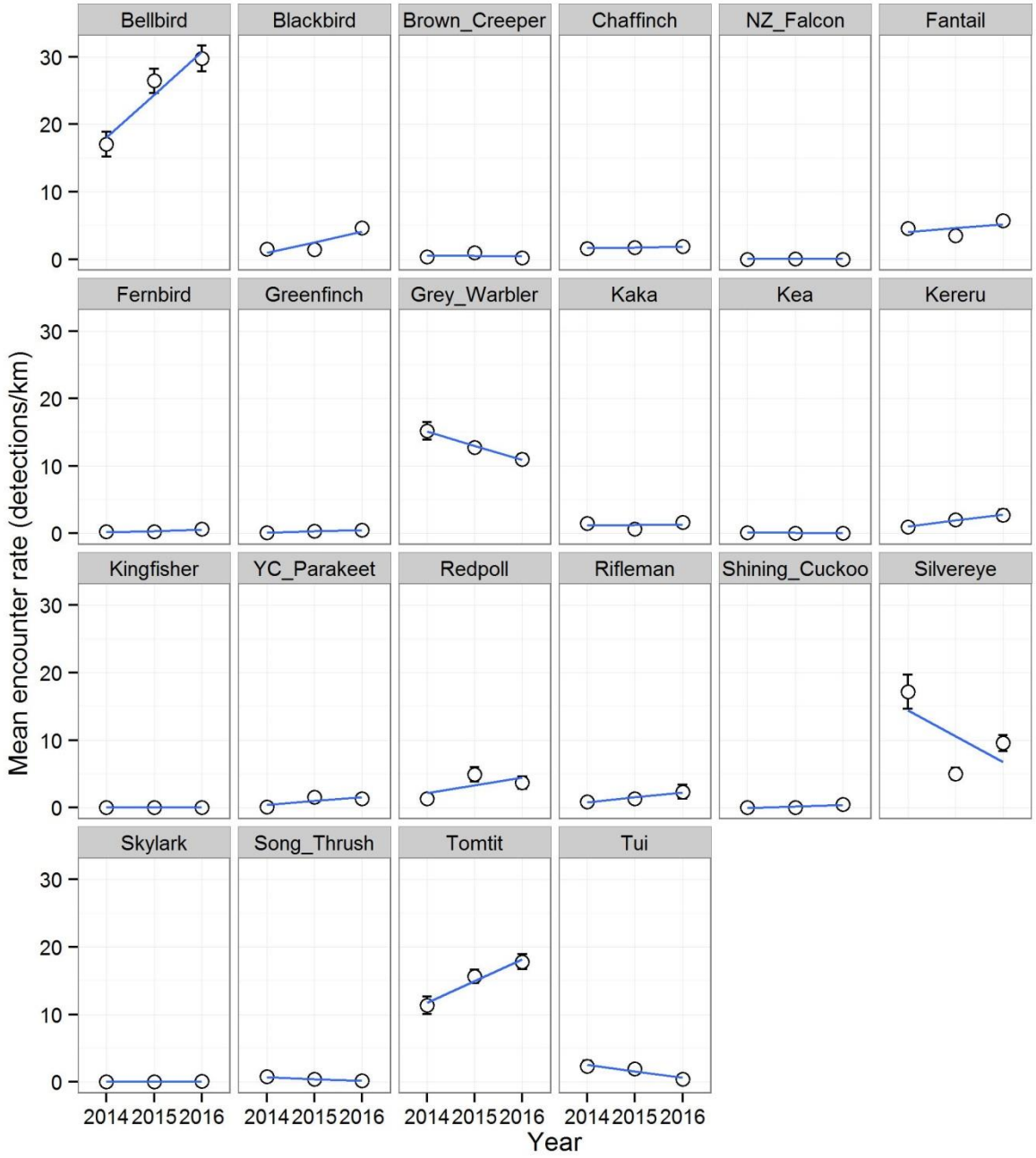

Figure 3. Mean encounter rates for forest bird species detected from transects at Martins Bay between September 2014 and September 2016. Encounter rates are presented as the mean number of birds detected per kilometre and include all birds seen or heard regardless of their proximity from the transects. A linear regression model fitted to the data (blue) shows the population trend for each species over the monitoring period.

Discussion

Bellbird, kereru, rifleman and tomtit were monitored in most detail by using distance sampling to compare their estimated densities and population trends. Density estimates for all four species increased between 2014 and 2015, following an aerial 1080 operation conducted by the Department of Conservation, and further increased in 2016, following additional ground control managed by the Hollyford Conservation Trust.

Other forest bird species were monitored in less detail by determining their population trend based on encounter (detection) rates. This method is significantly less robust than the distance sampling method, as encounter rates depend on real bird abundance, and the detectability of the species of interest, which is often influenced by variations in the environment, and species behaviour. This method is best used to determine gross changes in species population size over a longer period of time (5 to 10 years). Here, we present interim results, based on a comparison of detection rates for each species over the first 3 years of monitoring.

Native species (other than the species already monitored in detail) that showed a positive population trend over the monitoring period are fantail, fernbird, and yellow-crowned parakeet. Grey warbler, silvereye and tui showed a negative population trend, while no trend was seen for other native species encountered during the surveys. Silvereye and tui show a considerable amount of local movement, mainly seeking fruit or nectar (Heather & Robertson 1996) and the decline in detections for these species may be related to seasonal movements. The decline seen in grey warbler detections could be related to changes in singing frequencies as a result of different behaviour associated with breeding and defending territories. Population trends, derived from changes in encounter (detection) rates are likely to be more reliably determined over a longer monitoring period (5-10 years).

Introduced species that might have also benefited from management in the area are blackbird, greenfinch and redpoll; their detections increased over the monitoring period. Song-thrush detections declined slightly. Monitoring of introduced species is an important aspect of forest bird monitoring, as introduced species can potentially compete with native species over habitat and food.

Fernbirds were found in shrub surrounding the various wetlands and lagoons at Martins Bay. However they are not a forest bird, they have been included in this study as they were detected frequently from transects that bordered or intersected wetland habitat. This study was however not designed to sample wetlands, and monitoring lines in this habitat are underrepresented. Ideally, annual fernbird counts should be undertaken along the edges of wetlands and lagoons and in areas of low shrub. Fernbirds are vulnerable to predation, mainly by mustelids, and as such, may be used as an indicator species for (successful) management.

Ongoing annual forest bird monitoring is important to help determine if the control methods used at Martins Bay are sufficient to suppress and maintain predator numbers to low enough levels to achieve positive population growth and population trends. However kaka and tui numbers are currently too low to reliably estimate their densities, their numbers may increase in the future, making meaningful distance sampling analysis possible.

Acknowledgements

We thank Les Scown, PC Taylor and Simon Torr for assisting with the establishment of the bird monitoring transects, and Terry Greene from the Department of Conservation for advice on study design and analysis. We thank Hollyford Guided Walks and the community of Martins Bay for assisting with boat transport across the lake and river, and Michael Pullar from the Hollyford Conservation Trust, and Lindsay Wilson from the Department of Conservation for providing logistical support.

References

Broekema I, Overdyck O 2012. Distance sampling to estimate densities of four native forest bird species during multi-species surveys. New Zealand Journal of Ecology 36: 353-364.

Buckland ST 2006. Point-transect surveys for songbirds: robust methodologies. The Auk 123: 345–357.

Buckland ST, Anderson DR, Burnham KP, Laake JL, Borchers DL, Thomas L 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press.

Dawson DG, Bull PC 1975. Counting birds in New Zealand forests. Notornis 22: 101–109.

Department of Conservation 2015. Battle for our Birds in the Lower Hollyford/Whakatipu Kā Tuka area. http://www.doc.govt.nz/our-work/battle-for-our-birds/pest-control-operations/lower-hollyford-area/

Heather BD, Robertson HA 1996. The field guide to the birds of New Zealand. Auckland, Viking. 400 p.

R Core Team 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/.

Thomas L, Laake JL, Rexstad E, Strindberg S, Marques FFC, Buckland ST, Borchers DL, Anderson DR, Burnham KP, Burt ML, Hedley SL, Pollard JH, Bishop JRB, Marques TA 2009. Distance 6.2. Release 1. St Andrews, Scotland, Research Unit for Wildlife Population Assessment, University of St Andrews. http://www.ruwpa.stand.ac.uk/distance/.