Halo Project Robin Survey 2018-2019

Photo credit: Nick Beckwith

Prepared for the Halo Project

Georgina Pickerell, May 2020

The HALO PROJECT
Beyond Orokonui

Lottery Grants Board
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Contents

Summary

Background

The Halo Project, part of PFD, has rolled out community trapping programmes around Orokonui Ecosanctuary since 2017. Biodiversity outcome monitoring is essential to inform how well predator control operations are performing. South Island robins, reintroduced into Orokonui in 2010-2011, are dispersing into the Halo area. Robins are vulnerable to mammalian predation, which makes them a good species to monitor to assess the effectiveness of predator control.

Objectives

Successful predator control should allow robins to colonise new locations outside Orokonui Ecosanctuary; permanently establish populations in these locations; and increase in number over time. Specifically, indications that the Halo predator control programme is benefiting SI robins include:

1. Robins are present at sites from year-to-year
2. The number of robins and/or territories within a site increases from one year to the next
3. New sites are colonised from one year to the next

Methods

- Twelve sites in the Halo area were surveyed for the presence of robins twice a year between 1 Aug and 31 October using standardised methods.
- Five sites were surveyed in 2018 and 2019; 7 sites were surveyed only in 2019.
- Surveys consisted of 2-minutes of looking and listening at survey points systematically placed at 100 m intervals along a transect.
- The location of robins detected from survey points was recorded and mapped.
- Robin records from both surveys in a year were combined to obtain the total number of robins and robin territories recorded at each site.
- Two measures of relative abundance were calculated for those sites where robins were recorded: (1) the average number of individual robins seen or heard per survey point each year; (2) The frequency of survey points with robins nearby.
- In addition to the 2-minute surveys, other records of robin presence were obtained from Halo staff and volunteers and members of the public from 2018-2020.
- As a result of collaboration with Birds NZ, information on nesting success is available for a small robin population within the Halo area.

Results

- Robins were recorded at 3 of the 5 sites surveyed in 2018 and 2019 but were not detected at any of the 7 sites surveyed in 2019 only.
- All 3 sites with robins in 2018 also contained robins in 2019.

- Generally, territories occupied in 2018 were also occupied in 2019.
- The average number of robins recorded per survey point increased at each of the 3 sites between 2018 and 2019.
- The frequency of survey points with robins nearby increased at each of the 3 sites.
- The increases were not statistically significant.
- Surveys provided no evidence that new sites were colonised between 2018 and 2019.
- Robins were reported from a further 13 sites within the Halo area by volunteers, staff, Birds NZ and members of the public. These sightings were widely spread and in all directions around Orokonui Ecosanctuary.
- Since 2017, the number of pairs and nesting attempts at the Birds NZ study site has increased. Promisingly, at least 3 nests have fledged young, although nest success remains relatively low. Nests mostly failed from unknown causes.

Conclusions

- Survey results indicate that SI robins are persisting and increasing in numbers at sites from year to year. These outcomes suggest that the current mammalian predator control regime is proving effective at suppressing predators to low enough levels for biodiversity gains. It is not possible to establish causality, however, as comparisons could not be made with sites without predator control.
- All available robin records point to the main areas populations have established as being along Mt Cargill Road (a km either side of Green Rd), to the east of Orokonui Ecosanctuary towards Osborne, at locations through Doctors Point, and north of Orokonui towards White Road.
- A Birds NZ study provides evidence that robins are breeding successfully in the Halo area; however, breeding success is relatively low and is based on a small sample of nests. Nest cameras would help ascertain nest outcomes.
- Possible reasons robins have not established at sites include a lack of food; a lack of conspecifics; and high numbers of predators - especially rats, stoats and feral cats.

Recommendations

- The 12 sites should be resurveyed in 2-4 years' time for comparison with 2019 surveys.
- Occupancy modelling should be considered in addition to assessing changes in relative abundance.
- Predator control activities should be reviewed in the main areas where robin populations have established to ensure they are as effective as possible. Mammalian predator monitoring for rats, stoats and feral cats should be considered in these areas also.
- Members of the public and volunteers should be encouraged to continue to report sightings of robins to Halo staff or via eBird or iNaturalistNZ.
- The Halo Project should loan cameras to Birds NZ to help determine nest outcomes.
- Nest monitoring and banding should be considered for other sites within the Halo area.

Background

The Halo Project

The Halo Project, established by the Landscape Connections Trust (LCT), covers a 55,000 ha area around Orokonui Ecosanctuary, 20km north of Dunedin (Fig. 1). Its main objectives are to connect people to their local environment, enhance the health of ecosystems, protect and restore indigenous biodiversity, and support the local economy. Community-delivered mammalian predator trapping networks have been rolled out since 2017, initially focussing on the 3,900 ha Inner Halo area. In October 2018, the Halo Project became one of the delivery partners for Predator Free Dunedin (PFD) and community trapping initiatives have since spread to other residential areas such as Port Chalmers and Aramoana (Fig. 2). Eventually they will reach north Dunedin.

In February 2018, 15 Community trapping groups were operating 307 traps in two thirds of the Inner Halo area and had caught 270 predators[1]. By November 2019, trapping networks covered the Inner Halo area and beyond, there were 790 active traps on the ground and 1807 pests had been caught[2]. Trapping is designed for best practice stoat (*Mustela erminea*) and possum (*Trichosurus vulpecula*) control. However, other mammalian predator species are also caught in the traps; rats (mainly ship rats, *Rattus rattus*), hedgehogs (*Erinaceus europaeus*), possums and stoats are the most frequently caught[3].

Although increasing numbers of predators are being caught, the effectiveness of the predator control for creating gains for indigenous biodiversity is best measured by monitoring outcomes of native species.

[1] The Halo Project newsletter: February 2018. Available from: https://www.haloproject.org.nz/resources
[2] The Halo Project newsletter: November 2019. Available from: https://www.haloproject.org.nz/resources
[3] Unpubl. data from Trap.NZ (1 March 2017 – 1 November 2019; accessed 19 April 2020)

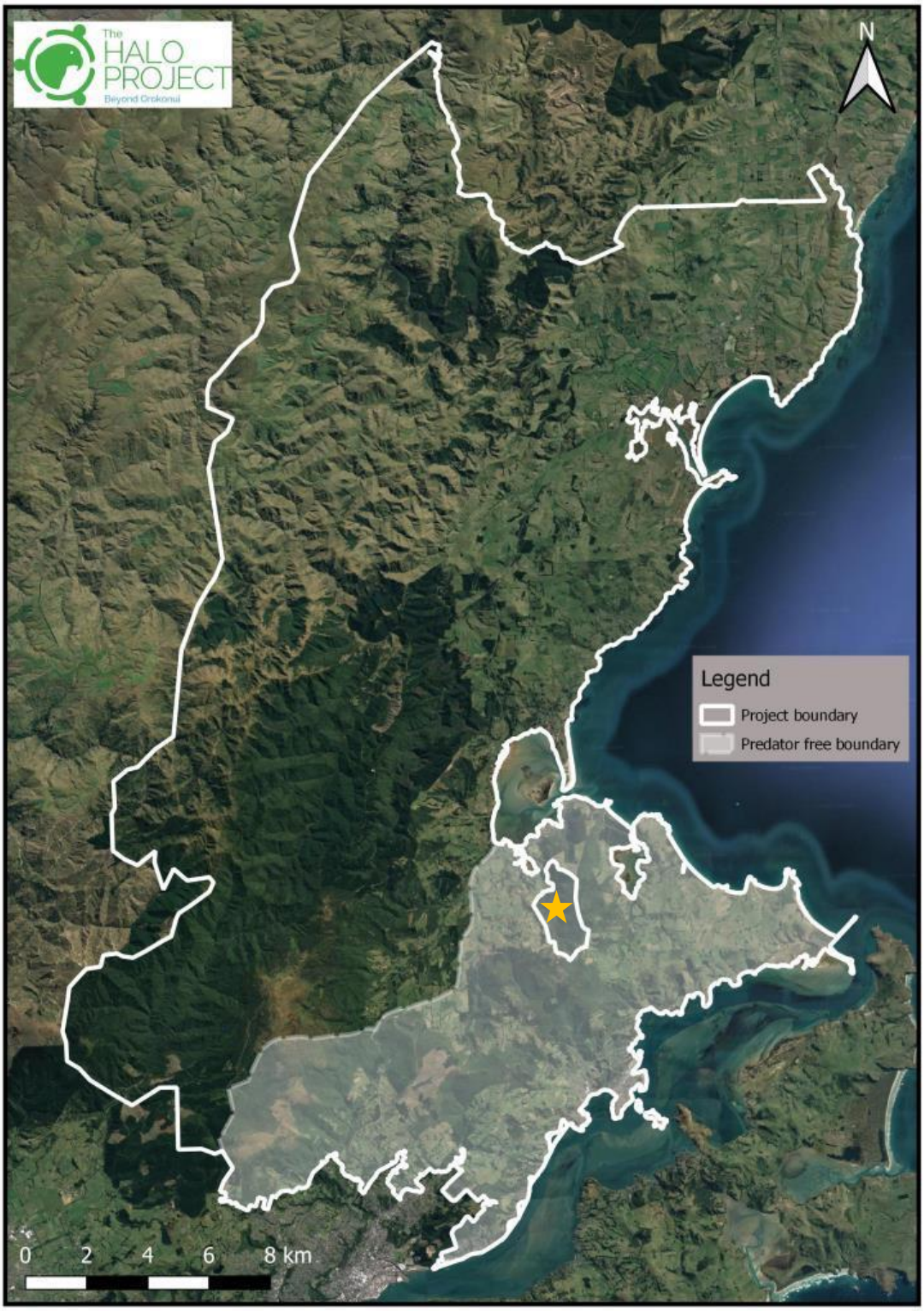

Fig. 1: Map showing the extent of the 55,000ha Halo Project and Predator Free area around Orokonui Ecosanctuary (marked with an orange star), north of Dunedin.

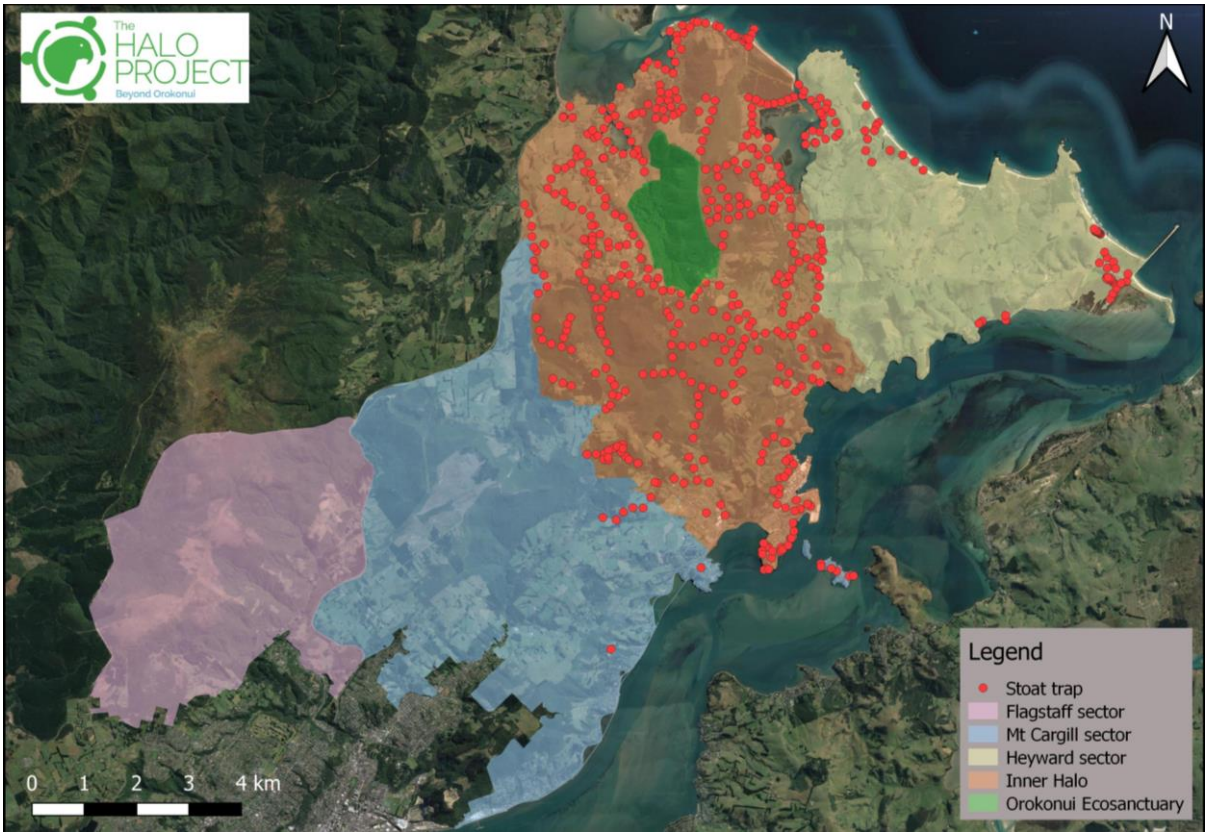

Fig 2: Locations of stoat traps in the Inner Halo Project area, June 2019. At present, mammalian predator trapping is focussed in the 3,900 ha Inner Halo.

South Island robins

South Island robins (*Petroica australis australis*) are a small endemic songbird found in forest and scrub areas, where they spend a lot of their time foraging on the ground. They were once widely distributed on the mainland but, mainly because of habitat loss and mammalian predation, in 2016 their threat status was upgraded from Not Threatened to At Risk-Declining[4]. Nowadays, populations of SI robins are concentrated in areas at the top and down the west of the South Island, but we have been fortunate in Dunedin because two small populations managed to persist in the Silverstream and Silver Peaks areas.

In 2010 and 2011, 45 robins were introduced into Orokonui Ecosanctuary from the Silver Peaks and Silverstream. Since then, a breeding population (about 80 pairs in 2018[5]) has established successfully within the ecosanctuary, resulting in an annual dispersal of juvenile birds into the Halo area. Since 2015, robins have been reported by members of the public from areas up to 3.3km from Orokonui, including at Mopanui, Waitati, Doctors Point,

[4] Robertson HA et al. 2017. Conservation status of New Zealand birds, 2016. NZ Threat Classification Series 19. Department of Conservation, Wellington. Available from: https://www.doc.govt.nz/Documents/science-and-technical/nztcs19entire.pdf

[5] Easton L. 2018. South Island robin (*Petroica australis australis*) August 2018 survey, Orokonui Ecosanctuary. Unpublished Orokonui report.

Deborah Bay and Grahams Bush[6]. SI robins are easily recognisable by sight and sound and, because they are vulnerable to mammalian predation, they are a good species to monitor to measure the benefits of pest control programmes for native biodiversity[7].

Annual breeding cycle

From July – December, males are very vocal, advertising their territory with a distinctive song, which can be heard over quite a distance. Nests are usually initiated from September. From November-December, the juveniles begin to disperse from their natal territory and young robins can begin to turn up at new sites as they search for a place to settle.

Behaviour and calls

Robins are territorial and pairs tend to stay in the same territory over successive years. They are relatively long-lived birds in areas without predators, with birds recorded living for up to 16 years[8]. Their territory size depends on the density of robins in the area and the food resources available. Fewer robins in an area means a pair can have a territory of a few hectares. However, at sites where there is a high concentration of robins (e.g. Orokonui Ecosanctuary), territory size can be less than 1 hectare. As well as a distinctive territorial song, robins make alarm calls consisting of a single 'chuck', and, especially outside the breeding season, they make a 'downscale' – a series of chucks that decreases in pitch.

Objectives

The aim was to survey for South Island robin presence and persistence in the Halo area following initiation of mammalian predator control operations.

Successful predator control should allow robins to colonise new locations outside Orokonui Ecosanctuary; permanently establish populations in these locations; and increase in number over time. Specifically, indications that the Halo predator control programme is benefiting SI robins include:

1. Robins are present at sites from year-to-year
2. The number of robins and/or territories within a site increases from one year to the next
3. New sites are colonised from one year to the next

Repeat surveys for robin presence/absence were undertaken at as many locations as available resources allowed and had two aims: (1) to examine changes in robin distribution between 2018 and 2019; (2) to provide baseline data for robin presence within the Halo area for comparison with future surveys. An additional benefit of the surveys was to provide

[6] Information from anecdotal reports to the author and reports from eBird (https://ebird.org/newzealand/)
[7] Jones MAT. 2016. Predation as a primary limiting factor: a comparison of the effects of three predator control regimes on South Island robins (*Petroica australis*) in Dunedin, NZ. MSc. Thesis, University of Otago.
[8] Powlesland RG. 2013 [updated 2017]. South Island robin. *In* Miskelly CM (ed.) NZ Birds Online. www.nzbirdsonline.org.nz

Halo staff with a clearer picture of where robins were located in the Halo, to help target predator control efforts.

Surveys initially focussed on 5 sites within the Inner Halo, and were carried out in 2018 and 2019. In 2019, surveys of an additional 7 sites were undertaken, including in areas outside the Inner Halo.

A point to note here is that all but one of the 12 survey sites were in areas with mammalian predator control, and all the sites which had robins were in the Inner Halo. Without comparisons with sites without predator control, it is not possible to establish causality.

Birds NZ collaboration: Breeding success

Colonisation and persistence of robins at new sites is one way of measuring the health of the Halo robin population. Measures of survival rates and breeding status of individuals, and breeding success were outside the scope of this study; however, these metrics also provide valuable information to assess the effectiveness of predator control operations. Otago Birds NZ has been monitoring a small population of robins in the Inner Halo since 2016, and in 2019 initiated a 5-year banding study to investigate survival rates. Otago Birds NZ is collaborating with the Halo Project by sharing details of their study, and a summary of their ongoing work is presented in this report.

Methods

Identifying survey sites

GIS maps and local knowledge were used to identify suitable robin habitat within the Halo area, with a focus on publically-accessible areas within the Inner Halo as the trapping programme was concentrated there. Suitable habitat included native and exotic forest and scrub areas[9]. Areas dominated by open habitat were not considered suitable. Survey sites were also selected so they were of varying distance and direction from Orokonui Ecosanctuary. The assumption was that robins would be more likely to have dispersed to sites closer to the ecosanctuary, but reports received from members of the public since 2015 indicated that robins could have established territories more than 3km from the ecosanctuary. Suitable habitat within 100m of the ecosanctuary was excluded from the site selection process as it would be uncertain if any robin found there were resident or temporary visitors from within the sanctuary. One area, adjacent to the eastern side of Orokonui, was not selected for surveys because robins at that site are comprehensively monitored by members of Birds NZ. Data on robins at that site are available in this report.

Surveys

Overview

In total, 12 sites in the Halo area were surveyed for the presence of robins (Fig. 3; Table 1). Each site was surveyed twice a year between 1 Aug and 31 October, the main robin breeding season before juvenile birds disperse from their natal territories. Surveys were standardised to be undertaken between 09:00 – 14:00 hours in fine, mild, non-windy weather by experienced observers. Five sites were surveyed in 2018 and 2019 by one observer, and 7 sites were surveyed only in 2019 by two other observers.

Sampling methodology

Each site was surveyed using a type of point sampling, where the location of robins detected from survey points along a transect was recorded. This method was chosen because it is a simple procedure suitable for monitoring a single, easily identifiable, species and has proved to be more efficient than traditional point sampling methods[10]. Distance sampling was not considered suitable because it can overestimate the number of robins in an area[11]. Line transect sampling can be problematic if the transects pass through rugged terrain and can lead to double counting of individual birds if birds follow the observer[12].

[9] Powlesland RG. 2013 [updated 2017]. South Island robin. *In* Miskelly CM (ed.) NZ Birds Online. www.nzbirdsonline.org.nz

[10] Buckland ST. 2006. Point-transect surveys for songbirds: robust methodologies. The Auk. 123(2):345-357.

[11] Greene T & Pryde MA. 2012. Three population estimation methods compared for a known South Island robin population in Fiordland, New Zealand. NZ Journal of Ecology, 36: 340-352.

[12] Greene T. 2002. Birds: incomplete counts – line transect counts: version 1.0. Department of Conservation report DOCDM-580459. Available from: https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/birds/

To be useful for comparisons, point sampling assumes there is a relationship between the number of the target species recorded and the number present at a site and that detectability of the target species is constant over time. Survey points should also be randomly or systematically positioned in the study site, and birds should not be double counted[13]. Point sampling methods lead to an index of robin abundance rather than an absolute density estimate. There will be an unknown number of robins at each site that remained undetected. But by using a standardised methodology each year, differences in detectability can be minimised.

One transect was surveyed per site, consisting of survey points placed systematically at 100m intervals along transects that followed roads, footpaths and tracks; this was considered suitable because the surveys were to assess robin presence along the transect over time and did not take comparisons with other factors such as habitat type into consideration. If a survey point was adjacent to noise (e.g. a stream), the observer moved a short way from the point until the noise no longer interfered with the survey. Observers walked at a steady pace along each transect (c. 3 km / hour) and stopped at each survey point to listen and look for robins for 2 minutes exactly. No attractants, such as playback of calls, clapping or squeakers, were used. All robins heard or seen from each survey point during the 2 minutes were recorded and their location pinpointed as accurately as possible. This included taking a general or compass bearing and estimating distance the bird was from the observer. If needed, extra time was allowed after the 2 minutes to help ascertain the location of a detected robin. It is acknowledged that mapping the locations of more distant robins would be less accurate; however, robins detected within 50m of the observer could be located on a map with reasonable precision. Robins were only identified as a different individual if the observer was confident it had not already been recorded on that visit. On rare occasions, this was difficult to assess, which led to a minimum and maximum count of robins for those surveys. Robins were also looked and listened for whilst the observer walked between the survey points, and recorded separately if detected only at this time.

[13] Hartley L & Greene T. 2012. . Birds: incomplete counts – five-minute bird counts: version 1.0. Department of Conservation report DOCDM-534972. Available from: https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/birds/

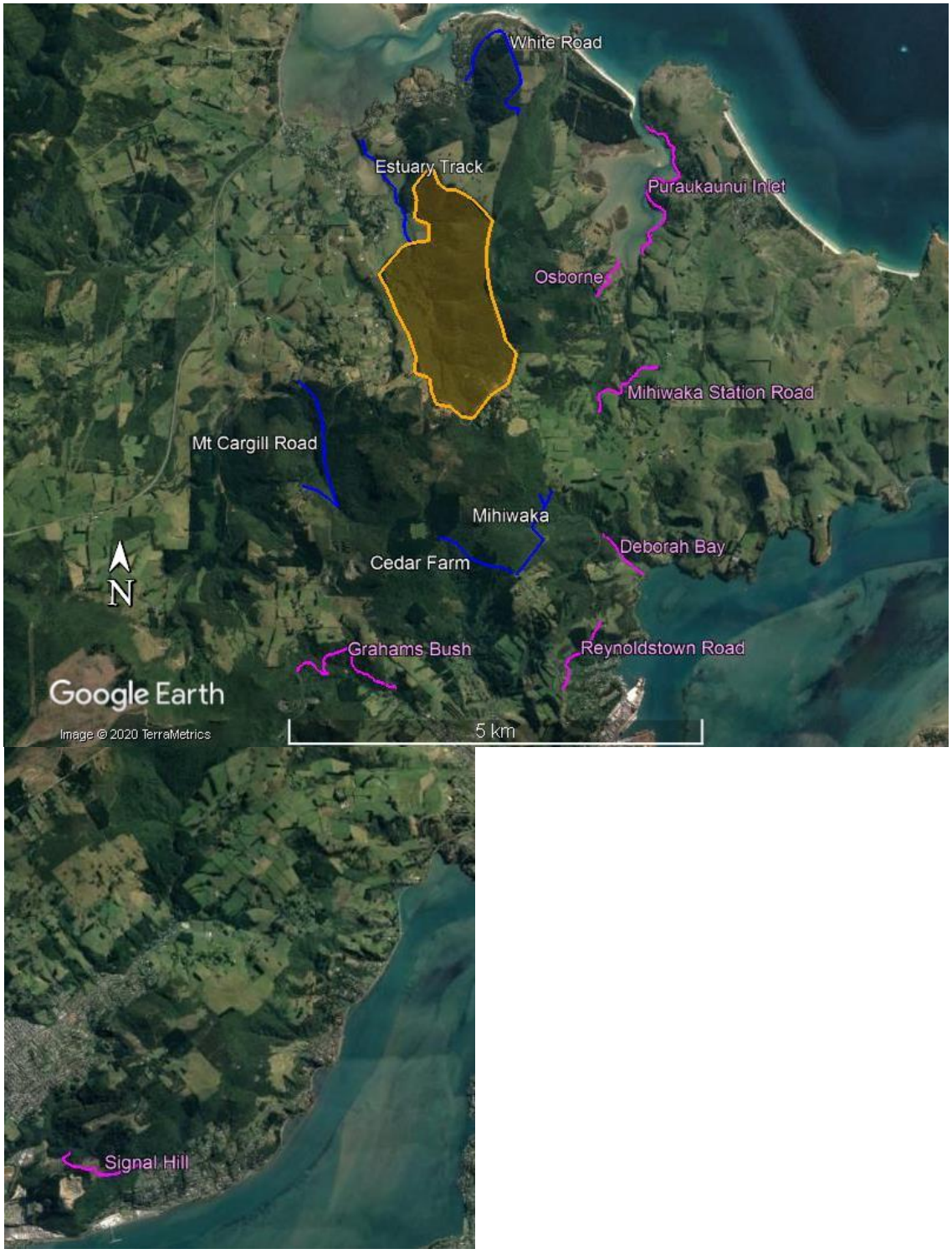

Fig.3: Map showing the location of the Halo robin survey sites in relation to Orokonui Ecosanctuary (shaded orange). Sites were surveyed either in 2018 and 2019 (blue lines) or 2019 only (pink lines).

Analyses

Robins detected from each survey point using 2-minute surveys were located on maps using Google Earth Pro software. This helped ascertain if 2 robin detections were possibly the same or different individuals. Robin records from both surveys in a year were combined to obtain the total number of robins/robin territories recorded at a site.

Point sampling assumes that differences in robin presence are correlated with a change in occupancy or abundance. Two measures of relative abundance were calculated for those sites where robins were recorded: (1) the average number of individual robins seen or heard per survey point each year. Confidence intervals (CI) for the means were calculated by multiplying the standard error of the mean by the t-statistic (degrees of freedom = n-1) at p=0.05. CI intervals were also calculated for the *difference* between the 2018 and 2019 means for each site. If these CI contain 0 it indicates that differences between the means are not statistically significant; conversely, CI that do not contain 0 imply that there is a statistically significant difference between the means. (2) The frequency of survey points with robins nearby. Robin densities were not high at any sites in 2018 and 2019, so each survey point only had one robin associated with it. (This will be not be the case when robins are seen in pairs or with young, or are present at high densities as then territory sizes can be less than 1ha.) Therefore, at White Road for example, robins were identified at 1 out of 21 survey points in 2018 and at 5 out of 21 in 2019 as 1 and 5 individual birds were recorded from that site in those years, respectively. Fishers Exact tests were used to compare frequencies of survey points with robins in 2018 and 2019.

Assessing reliability

Robins are very territorial and are likely to respond to robin calls played in their territory. To assess the reliability of the 2-minute point-sampling for detecting robin presence at a site, playback was used at 5 sites following completion of surveys in 2018 and 2019. Playback was used at every other survey point (i.e. at 200m intervals) 10 – 120 minutes after the initial 2-minute survey. The playback used was a 40-second clip of a robin's territorial song downloaded from NZ Birds Online[14], played through a portable speaker at the loudest volume, followed by 2 minutes observation for a response. The locations of robins detected following playback were marked on maps but were not included in any analyses. The five sites were: White Road, the Estuary track, Mt Cargill Road, Mihiwaka (Blueskin Road), Cedar Farm Forest.

[14] http://nzbirdsonline.org.nz/

Other records

In addition to the 2-minute point-sample surveys, other records of robin presence were obtained from Halo staff and volunteers and members of the public from 2018-2020. Halo staff and volunteers who regularly walked mammalian predator trap and monitoring lines were asked to record robin presence and absence as they undertook work along the lines (Fig. 4). Other information such as weather conditions, start and finish times, route taken and robin behaviour were also recorded. Observers submitted these data via an online Google form. Members of the public reported robin observations to GP or Halo staff on an ad hoc basis. Robin records were obtained also from iNaturalistNZ[15] and eBird[16].

Fig. 4: Ten lines (yellow) in the Inner Halo area where robin presence and absence was monitored on a casual basis by Halo staff and volunteers between 2018 and 2020.

Birds NZ robin monitoring

Since 2016, members of Otago Birds NZ have surveyed for robins during the breeding season in a privately-owned, c.40ha area of regenerating native and exotic-forest block on the eastern side of Orokonui. Possum and low level rat control has been carried out at the site for many years and DOC200 traps were deployed by the Halo Project in 2018. Feral cats (*Felis catus*) are also present at the site. As well as identifying the location of robin territories, Birds NZ also monitors breeding attempts. This has been achieved by visiting the site once every two weeks between August and December (2016: site visited in November

[15] https://inaturalist.nz/ [Accessed: 25/4/2020]
[16] https://ebird.org/newzealand/ [Accessed: 25/4/2020]

only), and finding all robins in the vicinity of the 2 main walking tracks through the site. Playback is used to help locate robin presence in the area. Once robins have been located, observers attempt to train them to feed on mealworms so that breeding attempts can be monitored. Breeding success is not monitored for all robins and not all nests are found. In 2019, Birds NZ initiated an additional 5-year project to band robins at the site with unique colour combinations in order to help ascertain the number of robins at the site and to collect data on bird survival. It is too early for any data on survival rates to be available.

Results

Surveys

Robins were recorded from three sites in both 2018 and 2019: White Road, the Estuary track and Mt Cargill Road (Table 1; Appendix A). In nearly all cases, birds were identified from male territorial calls. No pairs or juvenile birds were recorded and no additional robins were detected whilst walking between survey points (i.e. any robin heard whilst walking between survey points was also recorded during a 2-minute survey from a survey point). Robins were not recorded at any other site. Sites where robins were found were within 1,300 m of Orokonui Ecosanctuary at their closest point, but robins were not found at other survey sites a similar distance away. Robins were found in a range of habitat types, including areas dominated by scrub, patches of eucalypts, plantation blocks and native forest.

Robins are present at sites from year-to-year

Robins were present at the same three sites in 2018 and 2019. Within these three sites, locations where robins were mapped in 2018 tended to also have robins in 2019 (Figs. 5 – 7). There were two exceptions: at the Estuary track, no robins were recorded from survey point E1 in 2019, but they were recorded from a new point, E12. In addition, two-minute surveys did not record robins from survey point MC19 along Mt Cargill Rd in 2019 (however, use of playback that year confirmed that a bird was still present at that point).

Number of robins and/or territories increase from year-to-year

In total, 6 robins were recorded during 2-minute surveys in 2018 compared with 12-13 birds in 2019 (Table 1). The average number of robins recorded per survey point ranged from 0.05 to 0.24 and increased between 2018 and 2019 at each of the 3 sites where robins were present (Fig. 8). At all sites, the 95% CI of the differences between the yearly means overlapped 0, indicating that the increases were not statistically significant.

The frequency of survey points with robins nearby increased at each of the 3 sites with robins between 2018 and 2019; however, the increases were not statistically significant (Fisher Exact Test: White Rd, $p = 0.18$; Estuary, $p = 1$; Mt Cargill Rd, $p = 1$).

New sites are colonised from one year to the next

There were only 2 sites where robins were not recorded in 2018 and these sites did not contain robins in 2019 either.

Table 1: Number of robins recorded from 12 sites in the Halo area using 2-minute surveys at points 100 m apart along a transect. Surveys were undertaken twice a year between August and October. Distance from Orokonui measured as a straight line to the closest point. Observers: GP = George Pickerell; ST = Sanjay Thakur; KT = Kate Tanner; NA = no surveys undertaken. 95%CI calculated for the differences between the yearly means for a site; * calculated for 4 robins in 2019.

Site	**Distance (m) from Orokonui**	**Habitat type**	**# of survey points**	**Observer**	**Min – max # robins**		**Mean (± SE) robins/survey point**		**95%CI diff means**
					2018	**2019**	**2018**	**2019**	
White Road	1,200	Fragmented mixed exotic and native forest and scrub	21	GP	1 – 1	5 – 5	0.05 (0.02)	0.24 (0.03)	-0.41 – 0.03
Estuary Track	110	Fragmented native and plantation forest	15	GP	2 – 2	3 – 3	0.13 (0.04)	0.20 (0.04)	-0.37 – 0.23
Mt Cargill Rd	1,300	Extensive native and plantation forest	22	GP	3 – 3	4 – 5	0.14 (0.03)	0.18 - 0.23 (0.03)	-0.28 – 0.19*
Cedar Farm	1,400	Extensive plantation forest	11	GP	0	0	0	0	-
Mihiwaka (Blueskin Rd)	1,300	Extensive native forest	15	GP	0	0	0	0	-
Purakaunui Inlet	2,000	Fragmented native and exotic forest and scrub	25	ST	NA	0	NA	0	-
Osborne	1,400	Fragmented native forest and scrub	6	ST	NA	0	NA	0	-
Mihiwaka Station Road	1,100	Fragmented native forest	11	ST	NA	0	NA	0	-
Deborah Bay	2,100	Extensive native forest; some exotic	7	ST	NA	0	NA	0	-
Reynoldstown Road	3,000	Fragmented native and exotic forest and scrub	11	ST	NA	0	NA	0	-
Grahams Bush	3,000	Extensive native forest	19	ST	NA	0	NA	0	-
Signal Hill	10,000	Extensive native and plantation forest and scrub	10	KT	NA	0	NA	0	-

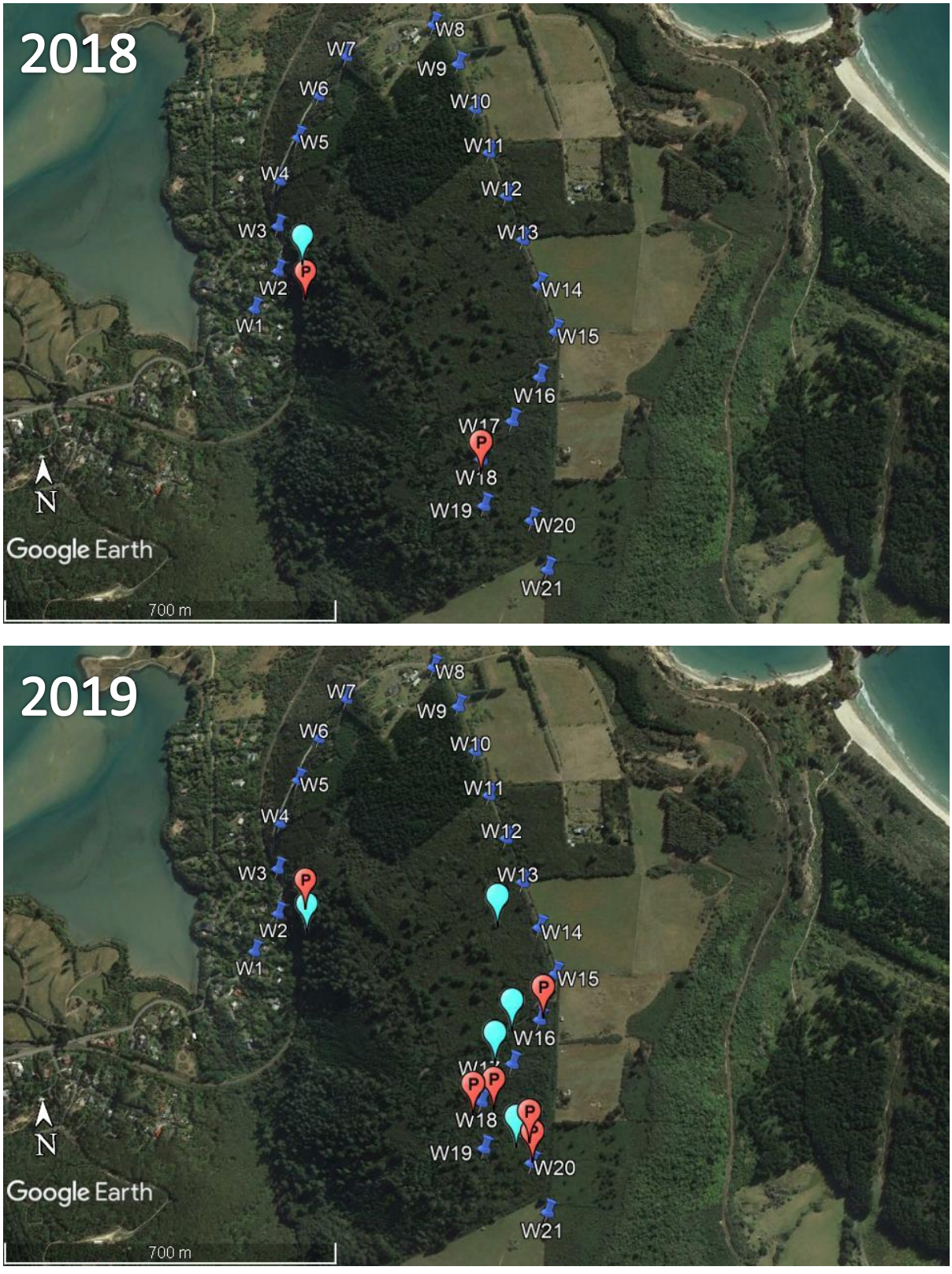

Fig. 5: Maps showing presence of robins recorded from White Road in 2018 and 2019 following 2 surveys in September-October. Labelled dark blue pins = survey points 100m apart; cyan pins = robins identified from 2-minute surveys at each survey point; red 'P' pins = robins identified following use of playback at every other survey point.

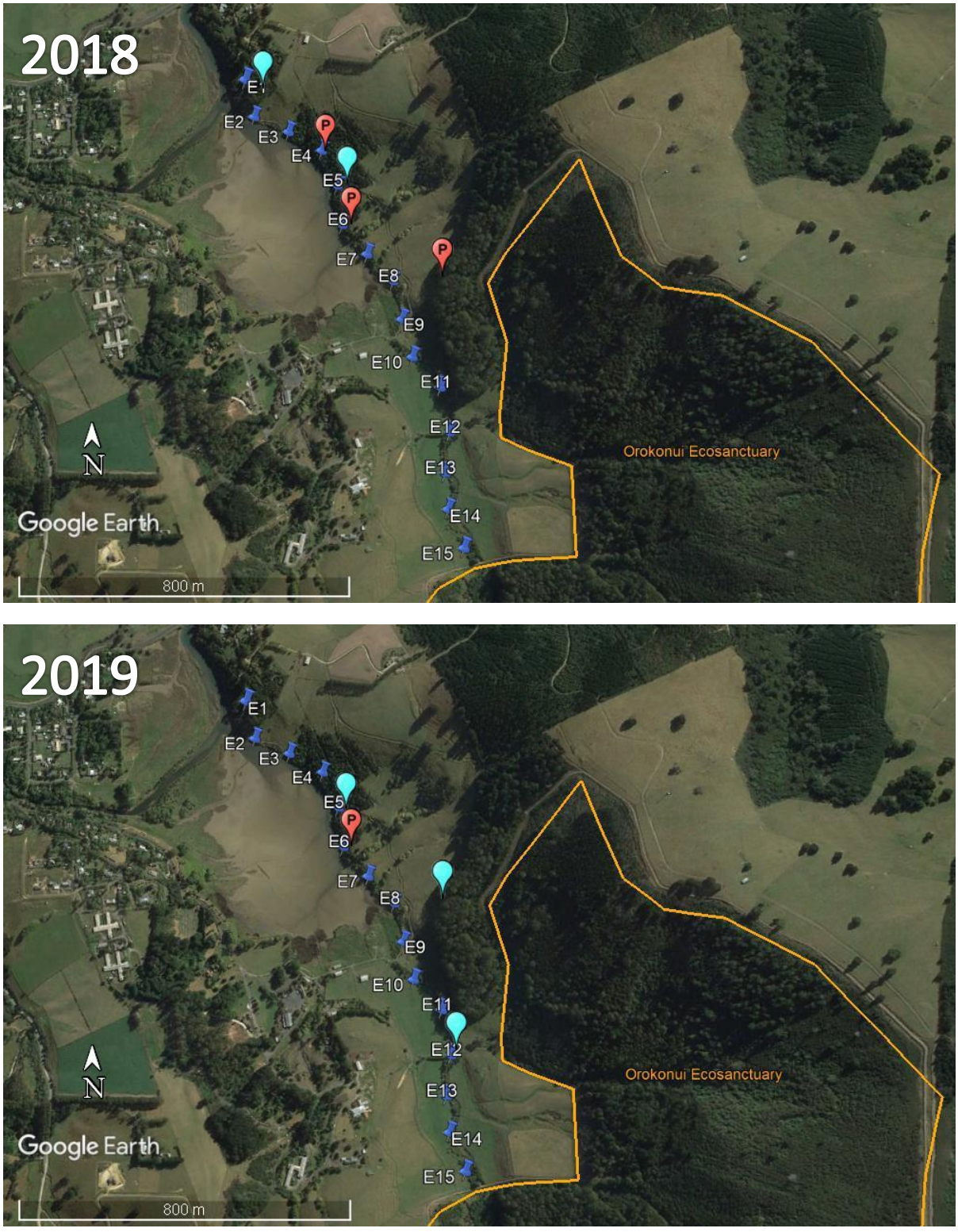

Fig. 6: Maps showing presence of robins recorded from the Estuary track in 2018 and 2019 following 2 surveys in August-October. Labelled dark blue pins = survey points 100m apart; cyan pins = robins identified from 2-minute surveys at each survey point; red 'P' pins = robins identified following use of playback at every other survey point.

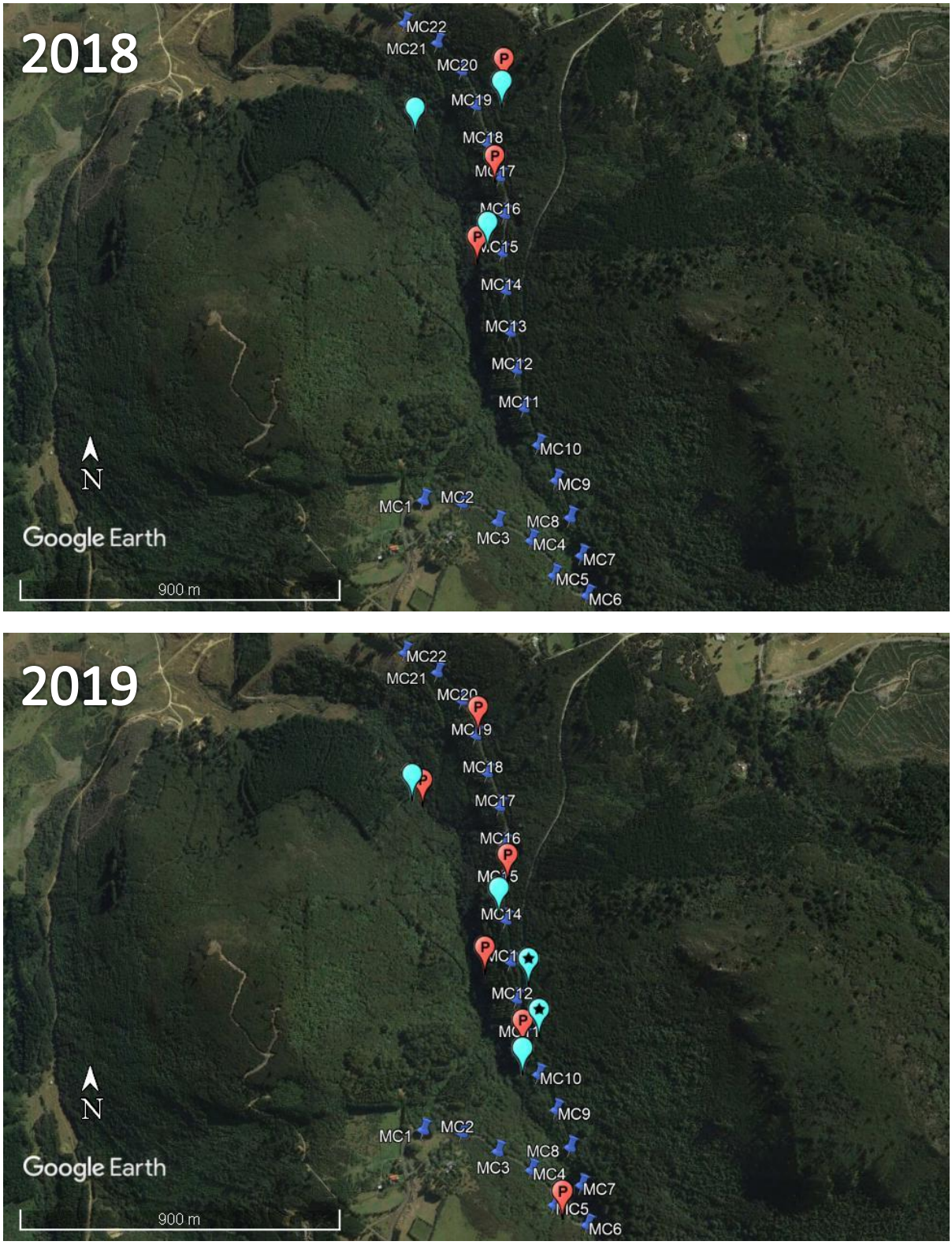

Fig. 7: Maps showing presence of robins identified from Mt Cargill Road in 2018 and 2019 following 2 surveys in September-October. Labelled dark blue pins = survey points 100m apart; cyan pins = robins identified from 2-minute surveys at each survey point (starred pins indicate uncertainty whether robin is same or 2 different individuals); red 'P' pins = robins identified following use of playback at every other survey point.

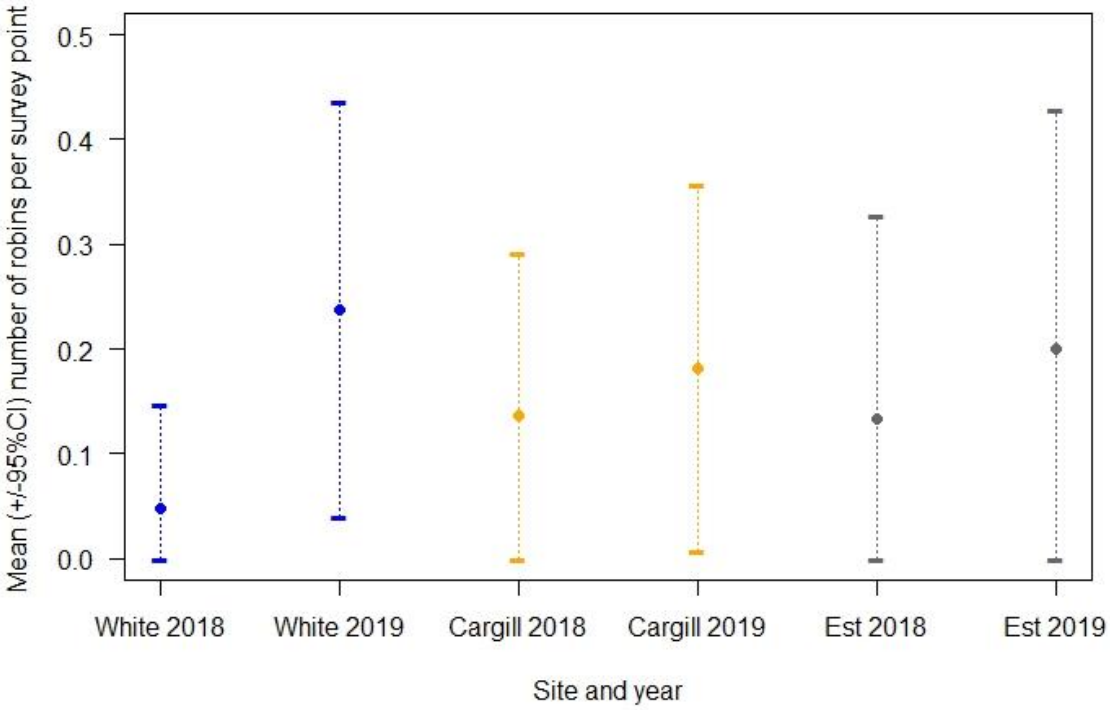

Fig. 8: Mean number of robins (with 95% confidence intervals) detected per survey point at three sites (White Road (n = 21), Mt Cargill Road (n = 22) and the Estuary track (n = 15)) in the Halo area, 2018 and 2019. Surveys were carried out twice per year between August and October.

Assessing reliability

Use of playback elicited a response from robins only at the three sites where robins had been recorded during 2-minute surveys (Table 2; Figs. 5 – 7). No robins were detected following playback at the Mihiwaka (Blueskin Road) or Cedar Farm sites. This suggests that a 2-minute survey every 100m, repeated twice in a season, was a reliable method for detecting robin presence at a site. As might be expected, playback generally detected more robins than the use of the 2-minute survey alone, but the difference was not large and the opposite was true for the Estuary track in 2019. On the whole, the two methods detected robins from similar areas (and to be conservative, one can presume them to be the same bird) but unique detections of robins were made by both methods. This accounts for the total number of robins being higher at some sites than recorded by either of the 2 methods alone.

Table 2: Summary of robin detections at 5 sites in the Halo area where playback was used in addition to 2-minute surveys. Sites were surveyed twice each year between August and October. Total # robins is an estimate of the total number of individual robins at a site combining the results of the two survey methods.

Site	2018			2019		
	Number of robins identified from:			Number of robins identified from:		
	2-min survey	Playback	Total # robins	2-min survey	Playback	Total # robins
White Road	1	2	2	5	5 – 6	5 – 6
Estuary Track	2	3	4	3	1	3
Mt Cargill Rd	3	3	4	4 – 5	6	7 – 8
Mihiwaka	0	0	0	0	0	0
Cedar Farm	0	0	0	0	0	0

Other records

Fifty one surveys were made on a casual basis by Halo volunteers and staff along 10 tracking tunnel lines in the Halo area between 2018 and March 2020 (Appendix B). Robins were reported from 2 of these lines (Fig. 9): Mopanui trig track, adjacent to the eastern side of Orokonui Ecosanctuary (multiple sightings; up to 6 robins present on 3 February 2019), and Green Road, adjacent to Mt Cargill Road (one male singing January and August 2019). One record from the Mopanui trig track included the presence of young birds on 27 January 2019. Assuming that those juvenile birds had fledged from the site and not recently dispersed from the Ecosanctuary, this would indicate that robins had bred successfully at this site.

Robins were also reported from a further 10 sites within the Halo area by members of the public (Fig. 9). These robin sightings were widely spread and in all directions around Orokonui Ecosanctuary and were almost all made outside of the robin breeding season (see Appendix C for full details). Six of the reports were from sites more than 1.5 km from Orokonui. The farthest away from the ecosanctuary was at Graham's Bush, 3.2 km from Orokonui as the robin flies, seen in March 2020. It is worth noting here that 1 or 2 robins had been reported from Graham's Bush in 2017, but subsequent visits to the site that year failed to find them and no robins have been reported from there in the intervening years.

Fig. 9: Map showing robin sightings reported by Halo volunteers and staff, Birds NZ and members of the public in the Halo area between January 2018 and March 2020. Blue pins = 2018; yellow pins = 2019; green pins = 2020. One pin represents one or more robins present.

Birds NZ robin monitoring

The number of robins located at the Bird NZ study site increased steadily between 2016 and 2018, but seemingly held steady in 2019 (Table 3). It is impossible to get an accurate total for the number of robins at the site as most birds are unbanded. The first robin pair and nest at the site were found in 2017. Since then, the number of pairs and nesting attempts has increased. Pairs have been found in the same territories between years, with the exception of one pair that disappeared between 2018 and 2019. At least 3 nests have fledged young, although nest success remains relatively low. Most nests that were being monitored failed from unknown causes – either they were found empty or they were too high off the ground to be able to see inside after failure. In 2019, a nestling from one failed nest was found dead outside the nest with injuries to its skull, suggesting predation was the probable cause of failure. The study is not yet complete and so only approximate estimates of daily nest survival rates, calculated using the Mayfield method and assuming constant survival rates over time, are available in the interim. These estimates provide nest survival rates over 39 days (18 days incubation and 21 days at nestling stage) of up to 27%, and indicate that breeding was more successful in 2019 compared with the previous years.

Five robins at the site were colour banded in 2019. Visits to try and resight these birds will be undertaken after winter 2020, and more birds will be banded at this time also.

Table 3: Minimum number of robins and robin pairs located by Birds NZ members between August and December each year at a forestry block to the east of Orokonui Ecosanctuary. Additional robins were present outside the study site area but have not been included in the totals here. *Not all nests at the site were found each year. Nest survival rates should be treated with caution because of small sample sizes, lack of frequent nest checks and improbable assumptions regarding constant survival rates over time.

Year	Number of robins (# pairs)	Number of successful nests / total monitored*	% chance nest survived to fledge	Cause of nest failure		
				Aband	Pred	Unkn
2016	4 (0)	NA	NA	NA	NA	NA
2017	6 (1)	0 / 1	0.2 %	1	0	0
2018	12+ (5)	1 / 6	4 %	1	0	4
2019	12+ (5)	2 / 7	27 %	0	1	4

Conclusions

Robins were recorded at 3 of the 5 sites surveyed in 2018 and 2019 but were not detected at any of the 7 sites surveyed in 2019 only. The 12 sites surveyed had habitat types considered suitable for robins, and were at varying distances and directions from Orokonui Ecosanctuary. The three sites where robins were recorded were within 1.5 km of the ecosanctuary at their closest point, and contained a mixture of native and exotic forest and scrub.

As well as providing baseline data of robin presence at the 12 sites for comparison with future surveys, this study aimed to determine whether between years (1) sites remained occupied by robins; (2) the number of territories and/or robins increased within a site; (3) new sites were colonised. These three measures are considered to provide some indication that the current mammalian predator control regime is proving effective at suppressing mammalian predators to low enough levels for biodiversity gains. It is not possible to establish causality, however, without comparisons with surveys at sites without predator control. Results from 5 sites surveyed in both 2018 and 2019 provide support that the first two measures are being met, as robins were found at the same 3 sites in both years, and frequently in the same territories within a site. There was also a non-significant increase in the number of robins recorded at each site between 2018 and 2019. However, the surveys provided no evidence for robins colonising new sites in 2019, as they remained absent from Mihiwaka (Blueskin Road) and Cedar Farm in that year.

It was unknown before the surveys were undertaken which of the 12 sites robins would be recorded at, but the number of sites with robins was lower than expected. Although investigation of factors influencing robin colonisation of sites is beyond the scope of this study, one can speculate about why robins were not present at some sites which have seemingly suitable habitat, especially those sites that are relatively close to the ecosanctuary. Possible reasons include a lack of continuous habitat for robins to disperse through from the ecosanctuary; a lack of food; a lack of conspecifics; and high numbers of

predators. The presence of rats at a site, in particular, is known to result in fewer robins being able to establish[17], but stoats, possums and feral cats will also negatively impact robin colonisation.

Results from camera traps[18] , tracking tunnel and chew cards (Halo Project; unpubl. data) and trap catch per 100 nights (1 January 2017 – 1 November 2019; Trap.NZ) indicate that the robin survey sites of Mihiwaka (Blueskin Road), Cedar Farm and Grahams Bush have relatively high levels of rat and/or stoat encounters. Feral cats are also widespread in the Halo area[18]. Since the beginning of January 2020, a network of A24 self-resetting traps (1 trap per ha) have been deployed throughout 178 ha of Mihiwaka, and it is hoped that these traps will be effective at reducing rats and stoats to low levels and result in robins establishing there.

Sites where surveys were undertaken were considered to have suitable habitat for robins, based on vegetation type ascertained by GIS or local knowledge prior to the surveys. However, other habitat factors such as food availability and microclimate details were not taken into consideration. If these factors were unfavourable for robins, then robins would be less likely to settle at these sites even with effective predator control in place[19]. Juvenile robins are more likely to settle at a location where other robins are present, even at low population densities[20]. This attraction to conspecifics makes sense in terms of a breeding strategy. Thus, juvenile robins dispersing from Orokonui might pass through suitable habitat in the Halo area during autumn in their search for a potential mate, but will not stay at these sites if no other robins are there at that time.

Robins are considered to be relatively poor fliers, which means they will be less likely to reach sites within the Halo area that are not connected to Orokonui Ecosanctuary by a continuous forest corridor. Orokonui is considered to have high forest connectivity with areas outside of the fence and all of the 12 survey sites have forest connectivity with the Ecosanctuary. Therefore, there is less support for this explanation.

Robins are strongly territorial and usually respond to robin calls played in their territory. Playback used at 5 sites in 2018 and 2019 provided a level of confidence that 2 minute surveys every 100m were reliable for detecting robins if they were present at a site, but there remains a chance that the surveys produced false negatives for robin presence at some sites. That is, robins were present at a site but were not detected during the surveys. In addition, playback provided evidence that some robins were present within a site in 2018

[17] Armstrong DP et al. 2006. Estimating the viability of a reintroduced New Zealand robin population as a function of predator control. The Journal of Wildlife Management, 70: 1020-1027.
[18] Veale AJ. 2019. Review of camera trapping pilot study and recommendations for monitoring mustelids in the Halo. MWLR contract report LC3641 for Predator Free Dunedin.
[19] Michel P et al. 2010. Habitat selection in reintroduced bird populations: a case study of Stewart Island robins and South Island saddlebacks on Ulva Island. NZ Journal of Ecology, 34: 237-246.
[20] Richard Y. 2007. Demography and distribution of the North Island robin (*Petroica longipes*) in a fragmented agricultural landscape. PhD thesis, Massey University.

but were not detected from 2-minute surveys until 2019, which would overinflate the apparent increase in numbers at a site between the two years. Imperfect detection of a species is acceptable in point sampling methodology, but for comparisons of indices to be meaningful, the methods assume that detectability remains constant across sites and years. The methods used in this study were designed to minimise variability in detectability, but whether detectability remained constant was not assessed per se. If it was not constant, an option would be to measure changes in occupancy rather than changes in relative abundance, using multi-season occupancy modelling, which takes imperfect detection into account and which can incorporate variable probability of detection in the models[21].

Use of playback usually enhances detectability and therefore more birds are recorded at a site. Playback use can be beneficial when a species is at very low density, or if presence at a site needs to be ascertained[22]. Playback was not used as a primary survey technique in this study because playback does have some drawbacks when monitoring species. When species are at higher densities, it is possible for surveys to become saturated (i.e. the species is detected from every survey point) and therefore the study loses the ability to detect a change in relative abundances at moderate to high species densities. Species behaviour is also affected by playback use; for example, robins are often drawn towards the playback location, which, at low population densities, makes it hard to accurately establish where a territory is located and it increases the chance of double counting an individual bird. Playback can also make some robins (possibly females or non-breeding males) become wary and cryptic and harder to detect (GP, pers. obs.).

Other records from Halo staff and volunteers, Birds NZ and members of the public provided information on robin presence from a further 13 sites in the Halo area between 2018 and 2020. The majority of these sightings were made in the non-breeding season and do not necessarily mean that robins have settled at those locations. One of these records was from a 2-minute survey site where robins had not been recorded, but the sighting was made in January 2020, 3 months after the surveys. Robin absence was also documented from 8 Halo tracking tunnel lines, which may prove useful baseline data to compare with future monitoring results. Besides the obvious benefits of obtaining information about where robins are being seen outside of the 12 main survey sites, the extra robin observation records obtained by Halo volunteers provided valuable information indicating that robins possibly bred successfully at one location.

All available robin records (including survey results) point to the main areas populations have established as being along Mt Cargill Road (a km either side of Green Rd), to the east of

[21] MacKenzie DI et al. 2003. Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. Ecology, 84: 2200-2207.
[22] Greene T. 2012. A guideline to monitoring populations: Version 1.0. Department of Conservation report DOCDM-870579. Available from: https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/birds/

Orokonui Ecosanctuary towards Osborne, at locations through Doctors Point, and north of Orokonui towards White Road. Breeding is confirmed to the east of Orokonui and is likely to be occurring in the other 3 areas.

Without every robin being individually identifiable, for example by a unique colour band combination, it is impossible to know whether it is the same robin detected in a territory year after year. It is possible that annual emigration of juvenile birds from Orokonui Ecosanctuary fills voids left by the death of the previous territory holder. For a comprehensive examination of whether robins are benefiting from predator control, it is essential to measure survival rates of individual robins, whether birds are breeding and their breeding success. These measures were outside the scope of this study. However, an ongoing Birds NZ study at a 40 ha site in the Halo area has provided some information on robin breeding success since 2016. In 2019, Birds NZ also initiated a colour banding project at the site which will provide information on survival rates in the future. Sample sizes are small, but monitoring has shown that the number of breeding pairs and nest survival rates at the site have continued to increase since 2016, with the highest estimated nest success (27%) reported in 2019. Most nests failed from unknown causes. These nest survival estimates are below those from within the ecosanctuary (2010-2013 average: 72%) and Silver Peaks (2010-2014 average: 48%) and only slightly higher than the Silverstream robin population (2010-2014 average: 9%)[23]. During Jones' 2010-2014 nest monitoring study, the Silver Peaks had initially low but rapidly increasing relative abundances of rats and possums following an aerial 1080 drop; and Silverstream had initially high relative abundance of rats and possums, but rat levels declined to low levels following installation of A24 traps[24]. Nest cameras ascertained that stoats were the primary predators of robin nests at that site[23] and reinforce the usefulness of cameras for establishing the cause of nest failure. Trap.NZ records from the Birds NZ study site show that rats were frequently caught at the site between 2018 and 2019 (especially earlier in 2018), while the number of stoats caught at the site, initially low, increased in 2019. While the results of the Birds NZ study cannot be extrapolated through the wider Halo area, they do hint that robins breeding elsewhere in the Inner Halo might not be doing as well as desired. If this is the case, it is unlikely that robin populations outside Orokonui Ecosanctuary will become self-sustaining.

[23] Jones MAT. 2016. Predation as a primary limiting factor: a comparison of the effects of three predator control regimes on South Island robins (*Petroica australis*) in Dunedin, NZ. MSc. Thesis, University of Otago.
[24] Schadewinkel RB et al. 2014. Effects on South Island robins (*Petroica australis*) from pest control using aerially applied 1080 poison. NZ Journal of Ecology, 38: 315-321.

Recommendations

Ongoing biodiversity outcome monitoring is essential to gauge the effectiveness of predator control operations. It is recommended that the 12 sites used in this study are resurveyed for robins in 2-4 years' time using the methods described above, and the results from future surveys compared with those obtained in 2019. A longer period between surveys will most likely result in more measurable changes, but more frequent surveys would be useful to assess the outcome of specific management at a site.

Playback is not recommended as a primary survey method, but might be useful in future surveys to ascertain whether robins are present at sites where no robins have been recorded during 2-minute surveys.

Despite using methodology that minimised variation in detectability, there is no certainty that probability of detection remained constant throughout the surveys. Occupancy modelling takes imperfect detection and varying rates of detectability into account and it is recommended that use of this analysis is considered in future surveys in addition to investigating changes in relative abundance

Reports of robin sightings in the Halo area by volunteers and members of the public could assist Halo staff keep track of where robin populations might be establishing and breeding between survey years and sites. This is useful for outcome monitoring purposes and for engaging the community in Halo operations. Members of the public should be encouraged to report robin sightings, along with photos for verification purposes, to Halo staff or via eBird or iNaturalist.

It is recommended that current predator control activities be reviewed along Mt Cargill Road (a km either side of Green Rd), to the east of Orokonui Ecosanctuary towards Osborne, at locations through Doctors Point, and north of Orokonui towards White Road to ensure that operations in these areas are providing as much protection for robin populations as possible. The issue of feral cats should also be considered.

Kill trap records do not provide an indication of how many mammalian predators are left alive in the Halo area. Monitoring rats, stoats and feral cats in the four main areas where robins are found would provide valuable information to help targeted predator control. Predator monitoring at other seemingly suitable sites in the Halo where robins have not yet established could also prove beneficial.

Birds NZ do not have the resources to supply nest cameras to help determine the cause of nest failure. The Halo Project could collaborate with Birds NZ by loaning them cameras to use in future breeding seasons.

Expanding robin nest monitoring and banding to other areas in the Halo is recommended to provide more detailed information on robin survival and nest success rates.

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Appendix A

Table A.1: Detailed robin records and coordinates of survey points for 2-minute surveys at 12 sites in the Halo. Each point was surveyed twice per year. Abbr: R#*number* = individual robin identified that year; TS = male robin's territorial song; 'loc' = location; NA = no surveys undertaken.

Site	Survey Point	Lat	Long	2018	2019
White Road	W1	-45.74084	170.59886	0	0
	W2	-45.74010	170.59964	R#1: TS <100m NE	R#1: c.100m ESE
	W3	-45.73921	170.59974	0	0
	W4	-45.73831	170.59988	0	0
	W5	-45.73751	170.60051	0	0
	W6	-45.73674	170.60119	0	0
	W7	-45.73603	170.60205	0	0
	W8	-45.73553	170.60452	0	0
	W9	-45.73632	170.60517	0	0
	W10	-45.73718	170.60559	0	0
	W11	-45.73805	170.60593	0	0
	W12	-45.73890	170.60635	0	R#2: TS >100m S
	W13	-45.73975	170.60676	0	0
	W14	-45.74063	170.60715	0	R#2: TS>100m W
	W15	-45.74151	170.60754	0	0
	W16	-45.74235	170.60707	0	R#3: TS 50-100m SW
	W17	-45.74314	170.60629	0	R#4: TS 50m W
	W18	-45.74382	170.60543	0	0
	W19	-45.74468	170.60546	0	R#5: TS <50m NE
	W20	-45.74498	170.60670	0	R#5: TS <50m NNW
	W21	-45.74587	170.60708	0	0
Estuary Track	E1	-45.74933	170.58207	R#1: TS <100m SE	0
	E2	-45.75020	170.58235	0	0
	E3	-45.75056	170.58352	0	0
	E4	-45.75102	170.58466	R#2: TS ~100m SE	0
	E5	-45.75183	170.58519	R#2: c.15m away	R#1: TS <50m SSE
	E6	-45.75274	170.58537	R#2: TS loc as above	R#1: TS <100m N
	E7	-45.75344	170.58622	R#2: TS loc as above	R#1: TS loc as above R#2: TS 200m E
	E8	-45.75407	170.58710	0	R#1: TS loc as above R#2: TS loc as above
	E9	-45.75495	170.58740	0	0
	E10	-45.75580	170.58777	0	0
	E11	-45.75647	170.58869	0	0
	E12	-45.75748	170.58900	0	R#3 Seen (male) at E12 R#3 heard towards E12
	E13	-45.75838	170.58886	0	0 0
	E14	-45.75918	170.58897	0	
	E15	-45.76001	170.58949	0	
Mt Cargill Road	MC1	-45.78799	170.57373	0	0
	MC2	-45.78807	170.57499	0	0
	MC3	-45.78850	170.57616	0	R#1: TS >100m NNE
	MC4	-45.78894	170.57727	0	0
	MC5	-45.78973	170.57801	0	0
	MC6	-45.79023	170.57911	0	0
	MC7	-45.78934	170.57893	0	0
	MC8	-45.78847	170.57856	0	0
	MC9	-45.78762	170.57809	0	0
	MC10	-45.78680	170.57750	0	R#2: TS ~100m N
	MC11	-45.78593	170.57701	0	0
	MC12	-45.78505	170.57676	0	0
	MC13	-45.78417	170.57656	0	0
	MC14	-45.78318	170.57640	0	R#2 or 3: TS >100m SSE R#4: TS <20m NW

	MC15	-45.78228	170.57627	R#1: TS distant NNE	R#4: TS loc as above
	MC16	-45.78138	170.57635	R#1: TS loc as above R#2: TS ~100m SSW	0
	MC17	-45.78048	170.57618	0	0
	MC18	-45.77967	170.57575	R#1: TS ~100m N	R#5: TS distant WSW
	MC19	-45.77876	170.57535	R#1: TS ~50m ENE	0
	MC20	-45.77792	170.57486	R#1: TS loc as above R#3: TS >100m SW	0
	MC21	-45.77723	170.57401	R#3: TS loc as above	0
	MC22	-45.77674	170.57288	0	0
Cedar Farm	CF1	-45.79686	170.60612	0	0
	CF2	-45.79655	170.60490	0	0
	CF3	-45.79628	170.60365	0	0
	CF4	-45.79613	170.60239	0	0
	CF5	-45.79575	170.60119	0	0
	CF6	-45.79553	170.59995	0	0
	CF7	-45.79493	170.59897	0	0
	CF8	-45.79426	170.59813	0	0
	CF9	-45.79374	170.59705	0	0
	CF10	-45.79339	170.59585	0	0
	CF11	-45.79317	170.59461	0	0
Mihiwaka	MH1	-45.79695	170.60753	0	0
	MH2	-45.79631	170.60844	0	0
	MH3	-45.79560	170.60924	0	0
	MH4	-45.79480	170.60982	0	0
	MH5	-45.79403	170.61046	0	0
	MH6	-45.79325	170.61112	0	0
	MH7	-45.79267	170.61018	0	0
	MH8	-45.79199	170.60934	0	0
	MH9	-45.79129	170.61016	0	0
	MH10	-45.79053	170.61084	0	0
	MH11	-45.78977	170.61151	0	0
	MH12	-45.78890	170.61181	0	0
	MH13	-45.78808	170.61249	0	0
	MH14	-45.78907	170.61080	0	0
	MH15	-45.78841	170.61040	0	0
Reynoldstown Road	RR1	-45.80913	170.61489	NA	0
	RR2	-45.80830	170.61557	NA	0
	RR3	-45.80731	170.61554	NA	0
	RR4	-45.80642	170.61547	NA	0
	RR5	-45.80577	170.61642	NA	0
	RR6	-45.80550	170.61773	NA	0
	RR7	-45.80486	170.61864	NA	0
	RR8	-45.80402	170.61913	NA	0
	RR9	-45.80321	170.61969	NA	0
	RR10	-45.80250	170.62048	NA	0
Grahams Bush	GB1	-45.80963	170.58878	NA	0
	GB2	-45.80946	170.58754	NA	0
	GB3	-45.80905	170.58638	NA	0
	GB4	-45.80865	170.58520	NA	0
	GB5	-45.80810	170.58415	NA	0
	GB6	-45.80791	170.58293	NA	0
	GB7	-45.80727	170.58184	NA	0
	GB8	-45.80637	170.58180	NA	0
	GB9	-45.80558	170.58241	NA	0
	GB10	-45.80533	170.58117	NA	0
	GB11	-45.80571	170.58007	NA	0
	GB12	-45.80603	170.57883	NA	0
	GB13	-45.80640	170.57764	NA	0
	GB14	-45.80728	170.57750	NA	0
	GB15	-45.80809	170.57820	NA	0
	GB16	-45.80787	170.57692	NA	0
	GB17	-45.80721	170.57597	NA	0

	GB18	-45.80696	170.57475	NA	0
	GB19	-45.80743	170.57358	NA	0
Purakaunui Inlet	PI1	-45.74620	170.62828	NA	0
	PI2	-45.74669	170.62923	NA	0
	PI3	-45.74707	170.63041	NA	0
	PI4	-45.74729	170.63167	NA	0
	PI5	-45.74817	170.63198	NA	0
	PI6	-45.74881	170.63289	NA	0
	PI7	-45.74975	170.63280	NA	0
	PI8	-45.75063	170.63298	NA	0
	PI9	-45.75144	170.63361	NA	0
	PI10	-45.75232	170.63342	NA	0
	PI11	-45.75254	170.63214	NA	0
	PI12	-45.75236	170.63080	NA	0
	PI13	-45.75235	170.62953	NA	0
	PI14	-45.75317	170.62874	NA	0
	PI15	-45.75404	170.62839	NA	0
	PI16	-45.75485	170.62883	NA	0
	PI17	-45.75557	170.62958	NA	0
	PI18	-45.75582	170.63083	NA	0
	PI19	-45.75662	170.63136	NA	0
	PI20	-45.75741	170.63057	NA	0
	PI21	-45.75798	170.62953	NA	0
	PI22	-45.75872	170.62877	NA	0
	PI23	-45.75968	170.62885	NA	0
	PI24	-45.76018	170.62779	NA	0
	PI25	-45.76105	170.62749	NA	0
Osborne	OS1	-45.76617	170.62010	NA	0
	OS2	-45.76536	170.62052	NA	0
	OS3	-45.76481	170.62148	NA	0
	OS4	-45.76394	170.62187	NA	0
	OS5	-45.76312	170.62248	NA	0
	OS6	-45.76251	170.62346	NA	0
Mihiwaka Station Road	MS1	-45.77931	170.62026	NA	0
	MS2	-45.77843	170.62060	NA	0
	MS3	-45.77753	170.62033	NA	0
	MS4	-45.77679	170.62103	NA	0
	MS5	-45.77685	170.62239	NA	0
	MS6	-45.77712	170.62360	NA	0
	MS7	-45.77628	170.62411	NA	0
	MS8	-45.77590	170.62526	NA	0
	MS9	-45.77525	170.62622	NA	0
	MS10	-45.77441	170.62670	NA	0
	MS11	-45.77403	170.62788	NA	0
Deborah Bay	DB1	-45.79283	170.62126	NA	0
	DB2	-45.79339	170.62239	NA	0
	DB3	-45.79411	170.62316	NA	0
	DB4	-45.79485	170.62394	NA	0
	DB5	-45.79559	170.62486	NA	0
	DB6	-45.79621	170.62595	NA	0
	DB7	-45.79674	170.62703	NA	0
Signal Hill	SH1	-45.86229	170.54713	NA	0
	SH2	-45.86258	170.54612	NA	0
	SH3	-45.86291	170.54495	NA	0
	SH4	-45.86326	170.54367	NA	0
	SH5	-45.86339	170.54217	NA	0
	SH6	-45.86334	170.54084	NA	0
	SH7	-45.86275	170.54016	NA	0
	SH8	-45.86263	170.53802	NA	0
	SH9	-45.86261	170.53682	NA	0
	SH10	-45.86129	170.53690	NA	0

Table A.2: Detection (1) and non-detection (0) of robins at 3 Halo sites in 2018 and 2019. Two surveys were carried out per year, resulting in paired 0 and 1 at each survey point.

Survey Point	White Road		Estuary track		Mt Cargill Road	
	2018	2019	2018	2019	2018	2019
1	0 0	0 0	1 0	0 0	0 0	0 0
2	0 1	1 1	0 0	0 0	0 0	0 0
3	0 0	0 0	0 0	0 0	0 0	0 0
4	0 0	0 0	0 0	0 0	0 0	0 0
5	0 0	0 0	0 1	1 0	0 0	0 0
6	0 0	0 0	0 0	0 0	0 0	0 0
7	0 0	0 0	0 0	1 0	0 0	0 0
8	0 0	0 0	0 0	0 0	0 0	0 0
9	0 0	0 0	0 0	0 0	0 0	0 0
10	0 0	0 0	0 0	0 0	0 0	1 0
11	0 0	0 0	0 0	0 0	0 0	1 0
12	0 0	0 0	0 0	1 1	0 0	0 0
13	0 0	0 1	0 0	0 0	0 0	0 0
14	0 0	0 0	0 0	0 0	0 0	0 1
15	0 0	0 0	0 0	0 0	0 1	0 0
16	0 0	1 1	-	-	0 0	0 0
17	0 0	0 1	-	-	0 0	0 0
18	0 0	0 0	-	-	1 0	0 1
19	0 0	0 1	-	-	1 1	0 0
20	0 0	0 0	-	-	0 0	0 0
21	0 0	0 0	-	-	0 0	0 0
22	-	-	-	-	0 0	0 0

Appendix B

Table B.1: Details of robins sighted along Halo tracking tunnel lines 2018 – March 2020. Monitoring undertaken by Halo staff and volunteers during usual tracking tunnel operations. Abbr: TS = territorial singing male; Ad = adult bird seen; Juv = young bird seen; NA = no data available.

Site	Route	Date	Time	# robins	Notes
Mopanui trig track	Mopanui Road – L8 tracking tunnels #1-10	**18/11/2018**	**07:45-09:00**	**1 – 3**	**TS**
		24/11/2018	**16:00-17:15**	**2**	**TS**
		2/12/2018	**08:30-09:30**	**1 – 3**	**TS**
		27/1/2019	**09:00-10:00**	**3 – 4**	**Ad + Juv**
		3/2/2019	**08:30-09:30**	**2 – 6**	**TS**
		10/2/2019	**08:30-09:45**	**2**	**Ad**
		17/2/2019	**10:30-11:00**	**3 – 4**	**TS**
		11/05/2019	**08:30-10:00**	**2 – 5**	**TS**
		12/05/2019	**08:45-10:00**	**2**	**Ad**
		19/05/2019	09:00-09:45	0	
		28/07/2019	08:55-09:45	0	
		4/08/2019	**09:00-09:45**	**1**	**TS**
		1/02/2020	08:00-09:00	0	
		2/02/2020	09:00-09:45	0	
		9/02/2020	09:00-09:30	0	
Waitati Estuary track and tracking tunnel line	Orokonui road DOC carpark – Estuary track – L5 tracking tunnels #1-10	11/11/2018	16:05-17:20	0	
		18/11/2018	17:15-18:35	0	
		24/11/2018	15:20-16:10	0	
		2/12/2018	15:45-16:15	0	
		12/05/2019	11:20-12:05	0	
		2/11/2019	10:40-12:30	0	
		3/11/2019	12:40-13:30	0	
Hailes tracking tunnel line	Blueskin Road – L6 tracking tunnels #1-10	10/11/2018	18:10-19:10	0	
		11/11/2018	15:40-16:15	0	
		11/05/2019	10:25-11:40	0	
		12/05/2019	10:15-10:40	0	
Green Road tracking tunnel line	Green Road – L10 tracking tunnels #1-10	15/3/2018	c.2 hours	0	
		11/11/2018	11:45-13:30	0	
		18/11/2018	15:30-16:30	0	
		25/11/2018	12:05-13:15	0	
		27/1/2019	**09:45-11:15**	**1**	**TS**
		11/2/2019	12:00-13:00	0	
		17/2/2019	12:30-13:30	0	
		4/08/2019	**11:30-12:15**	**1**	**TS**
Osborne Road – Mapoutahi Pa site	Osborne Road – L1 tracking tunnels #1-10	10/11/2018	16:15-17:45	0	
		2/12/2018	09:00-09:45	0	
		27/1/2019	14:00-15:10	0	
		3/2/2019	11:00-12:05	0	
		10/2/2019	10:00-10:45	0	
		17/2/2019	10:15-10:50	0	
Gums, Osborne	L3 tracking tunnels #1-10	11/11/2018	12:40-14:00	0	
		18/11/2018	10:30-11:50	0	
		24/11/2018	09:30-10:30	0	
		02/12/2018	12:45-13:30	0	
		27/1/2019	12:15-13:45	0	
		3/2/2019	12:10-13:25	0	
		10/2/2019	09:00-09:55	0	
		17/2/2019	10:55-12:05	0	
West Mihiwaka	Cedar Farm track – L7 tracking tunnels #1-10	10/3/ 2018	c.2 hours	0	
		1/08/2018	NA	0	
Cedar Farm	Vehicle track – L2 tracking tunnels #1-10	10/3/2018	c.2 hours	0	
		28/07/2018	NA	0	
Port Chalmers lookout	L9 tracking tunnels #1-10	5/08/2018	NA	0	
J Chapman's	L4 tracking tunnels #1-10	19/08/2018	13:30-14:30	0	

Appendix C

Table C.1:

Site	Distance (m) from Orokonui Ecosanctuary	Date	Details
McKessar Rd	800	2016 - 2019	At least 4 pairs plus other robins present in area
Cedar Creek, Blueskin Rd	200	25/12/2018	Same or different robin present here also 28/2/2019
219 Doctors Point Rd, Waitati	1,600	Autumn 2019	Single bird reported from property; present 6 months
Thornicroft Rd, Waitati	900	21/3/2019	Single bird reported; possibly robins present in area since 2018
Volco, Mt Cargill Rd	1,600	23/3/2019	2 birds seen and maybe a 3rd calling further up track
Sawyers Bay Reservoir	2,700	15/4/2019	Male bird territory calling
Purakaunui School Road	1,600	8/6/2019	Report from iNaturalistNZ
SW Osborne	1,900	19/10/2019	Single bird seen
Mihiwaka – Blueskin Rd	1,400	21/1/2020	Report from eBird
Graham's Bush	3,200	14/3/2020	Single bird seen near trap 1
Waitati cemetery, Orokonui Rd	700	23/3/2020	Single robin heard

Appendix D

Table D.1: List of additional bird species heard or seen during 2-minute robin surveys in 2018 and 2019. ++ indicates heard frequently.

Year	2018 and 2019 combined					2019 only						
	White Rd	**Estuary track**	**Mt Cargill Rd**	**Mihiwaka Blueskin Rd**	**Cedar Farm**	**Osborne**	**Purakaunui Inlet**	**Mihiwaka Station Rd**	**Grahams Bush**	**Reynoldstown Rd**	**Deborah Bay**	**Signal Hill**
Bellbird	++	++	++	+	+	+	+	+	+	+	+	+
Tui	+	+	+	+	+		+	+	+	+	+	+
Fantail	+	++	+	+	+	+	+	+	+	+		+
Grey warbler	++	+	++	+	++	+	+	+	+	+	+	
Silvereye	+	+	++	++	++			+	+	+	+	+
Brown creeper	++	+	+	+	+				+			
Tomtit	+		++	+	++				+			
Robin	+	+	+									
Rifleman	+		+	+								
Kereru	+	+	+	+	+		+	+		+		
Shining cuckoo	+		+	+	+						+	
Kaka			+									
Falcon		+	+									
Harrier	+	+		+		+		+				
Welcome swallow	+	+		+						+		
Kingfisher	+	+								+		
Paradise shelduck		+					+	+	+		+	+
Mallard		+					+			+		
Pukeko		+				+						
Masked lapwing		+										
Pied Oystercatcher							+					
White-faced heron							+					
Black backed gull							+	+		+	+	
Blackbird	+	+	+	+	+	+	+	+	+	+	+	+
Songthrush	+	+	+	+	+				+	+	+	
Chaffinch	++	++	++	++	++			+		+	+	
Skylark	+	+	+	+								
Redpoll	+	+	+	+	+							
Dunnock	++	+	++	+	++	+		+		+	+	
Greenfinch		+	+		+							
Goldfinch	+	+	+	+						+		
Yellowhammer	+	+				+						
House sparrow	+					+	+		+	+		+
Starling	+								+		+	+
Eastern rosella	+	+	+	+	+		+					
Magpie	+	+						+				+