Acoustic survey of the diurnal bird population in the Rimutaka Forest Park: December 2015

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for the Rimutaka Forest Park Trust Volunteers
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Summary
In December of 2015 the Trust deployed acoustic recorders at 75 sites in the Rimutaka Forest Park, in order to estimate the relative abundance of diurnal bird species. This was the first time such a comprehensive survey of day birds had been carried out in our region. We followed the counting protocol used by researchers at Victoria University of Wellington. Results were analysed by counting presence of each species in 30x 10 second snippets (from identified bird calls), for a total of 5 minutes per site. The most commonly calling species were tomtits, tui/bellirds, blackbird/thrushes, grey warblers, long-tailed cuckoos, and whiteheads. Other species recorded include chaffinches, riflemen, fantails, silvereyes and shining cuckoos. In addition to the main survey carried out in spring 2015, we carried out a smaller survey in March-April 2016 at the 5 minute bird counting stations in the Catchpool Valley, in order to compare the two techniques.

Introduction
The Rimutaka Forest Park Trust's vision is a thriving forest ecosystem, rich in indigenous species, to be enjoyed by the wider community. Part of our current 3-year plan is to facilitate a measurable improvement in the forest ecosystem and increased abundance of existing indigenous flora and fora, through pest control, revegetation, and raising public awareness. In order to achieve this we first need to establish a baseline of existing plant and animal species through habitat and species surveys. In 2015 the Trust was awarded a biodiversity community fund. A key part of our proposal was to monitor the presence/absence and relative density of bird species. We had already conducted acoustic recording surveys of brown kiwi since 2011, but wished to also carry out a comprehensive survey of diurnal bird species over a wide range of Park habitats. After consultation with Stephen Hartley (VUW), James Griffiths (DOC) and Angus Hulme-Noir (DOC) on 30th November 2015, we planned and carried out a deployment DOC automated acoustic recorders over more than 70 sites from 3rd December 2015 to 11th January 2016 (Figure 1). Site altitudes ranged from 73 to 702m with a mean altitude of 382m and a median of 410m.

Our plan had to be rapidly developed from scratch in order to meet the required time window (spring 2015), and given we only had 11 recorders, these had to be moved numerous times in relays in order to cover all sites on suitable (low-wind, low-rain) days by the end of spring. We were advised by Stephen and James to make our deployment as random as possible during each deployment interval; that is, rather than deploy recorders in one area at a time, we had to scatter them over the whole park area and this made retrieving and redeploying very time consuming. Deployments were done by a team of over 10 volunteers. Recorders were moved once it was judged that they had been in place for at least 1 “good weather” morning. Despite best intentions, at a few sites the weather was significantly worse (especially at higher altitudes) than we had judged from Wainuiomata. In addition, some of the recorders developed mechanical faults. Nevertheless, we were able to collect usable data at 75 sites, with 65 sites providing very low-noise, high quality recordings.

Once the data had been collected, we analysed at least 1 session (1 day's recording) per site. We chose days that were staggered or random compared to other sites whose recording days overlapped. This was difficult given the small number of days each recorder was left at each site, so the selection of days to analyse cannot be considered to be completely random (the ideal situation). In addition, we analysed 2 sessions at 3 sites to compare data from different days for repeatability.

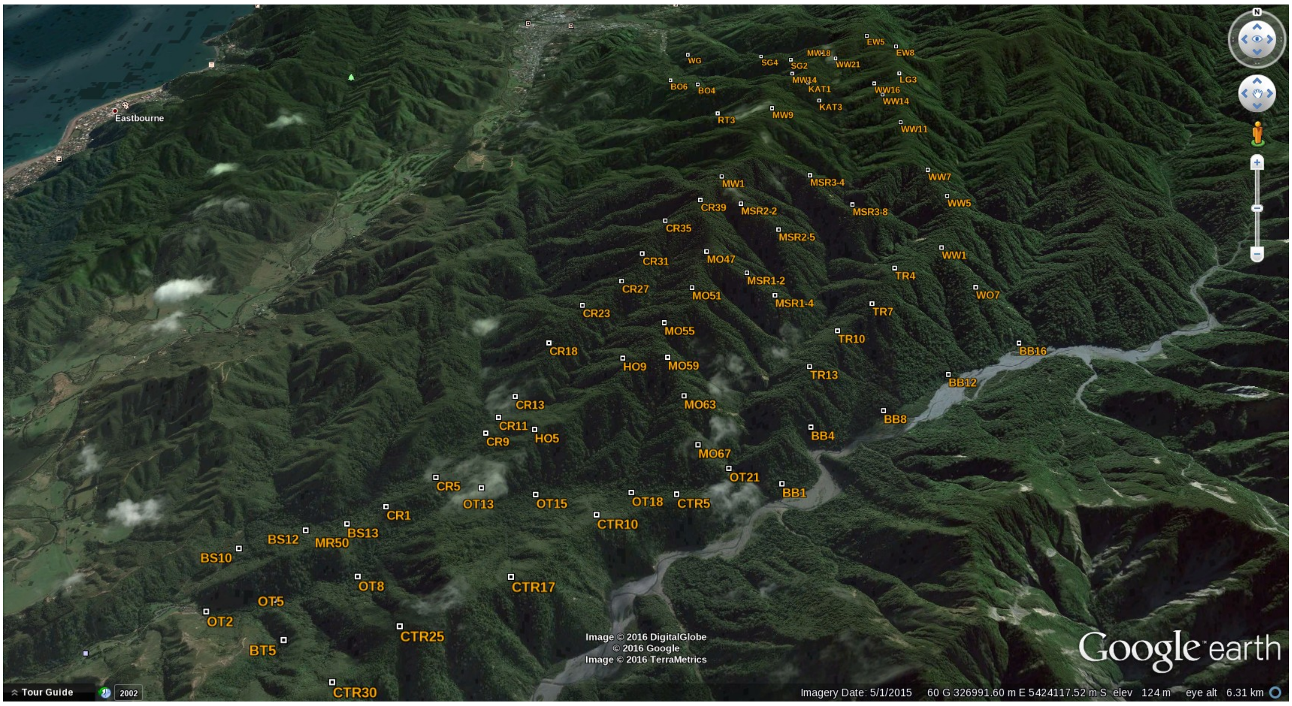


Figure 1. Google Earth snapshot of the acoustic recorder sites deployed in the main survey in December 2015. MW=McKerrow Track; CR= Clay Ridge; OT=OrongorongoTrack; BT=Butcher Track; CTR=Cattle Ridge Track; BB=Big Bend Track; WO, WW, SG, WG=Whakanui Track; EW=East Whakanui; BO=Boys Brigade track; MSR are side ridges down off the McKerrow track towards the Turere stream.

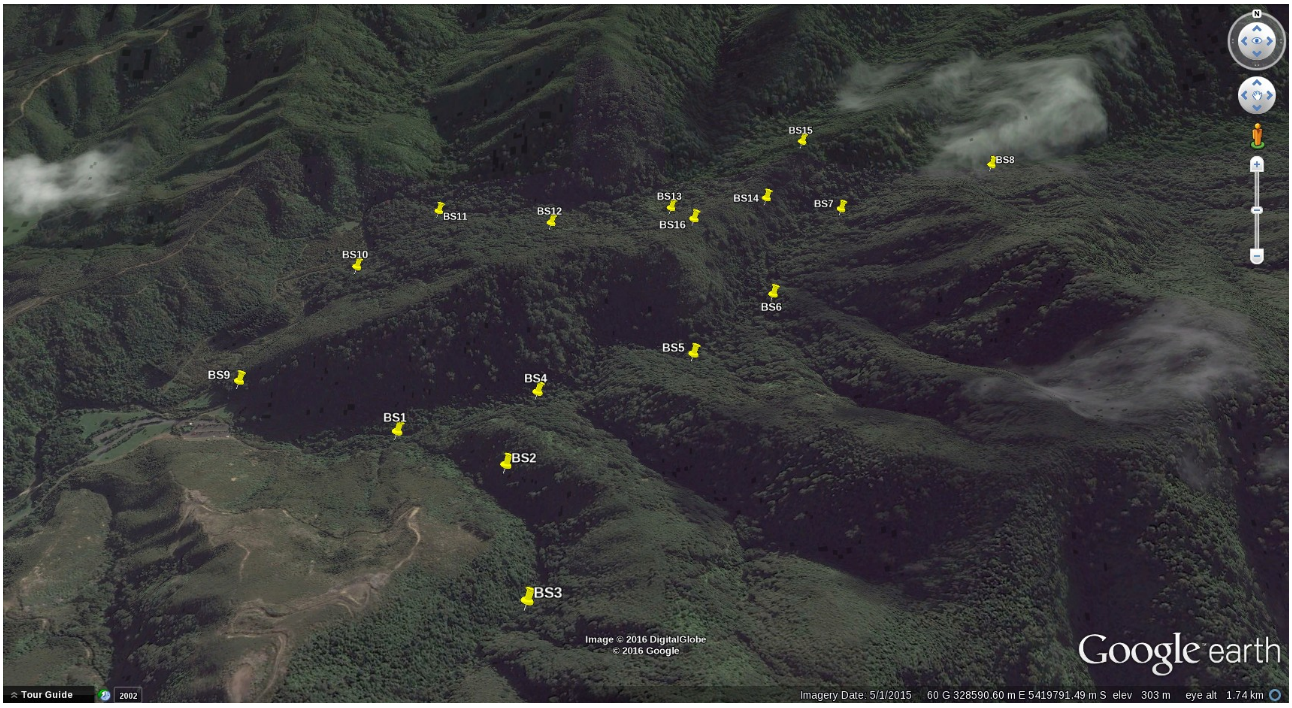


Figure 2: Google Earth snapshot of the 5 minute bird count stations monitored and compared to acoustic recorders in March-April 2016. The prominent ridge is Middle Ridge.

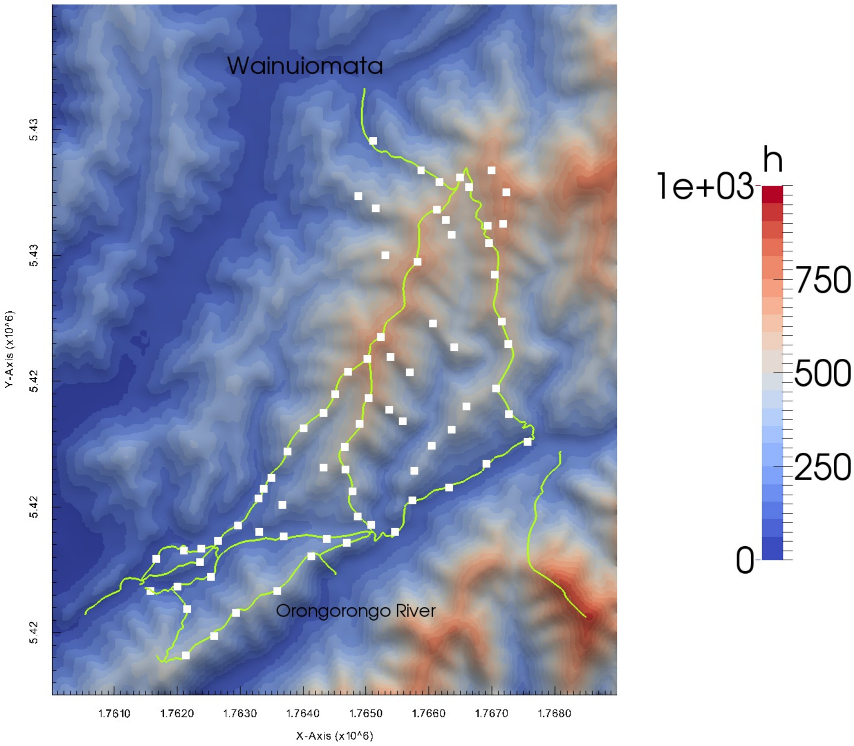


Figure 3: Map view of the acoustic recorder sites deployed in the main survey in December 2015 (squares). The background colours show topographic height in metres. Green are the main DOC tracks (McKerrow, Whakanui, Clay Ridge, Orongorongo, Big Bend, Mt Matthews, Cattle Ridge, Butcher Track, Middle Ridge, 5 mile, and Nga Taonga). The map is plotted in NZTM.

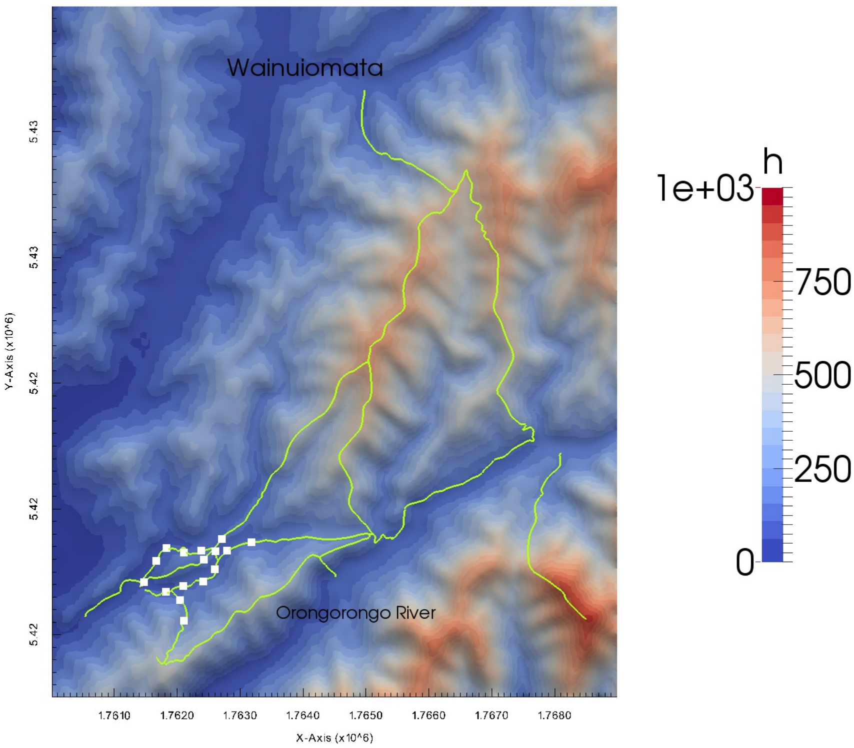


Figure 4: Map view of the 5 minute bird count stations surveyed and compared to acoustic recorder data in March-April 2016 (squares).

Detailed method:

(1) Deployment and collection of data

The 11 DOC acoustic recorders were deployed on a continuous basis, with swapping of 8 Gb sound cards and replacement of non-rechargeable AA batteries in the field. Small moisture-absorbing gel packs were placed in the housing to reduce moisture; however, several recorders developed mechanical faults (mostly from moisture problems) over the 1.5 month deployment interval, and had to be brought in and fixed. As a result we lost several sites data; in general we tried to redeploy at sites that had not achieved sufficiently high-quality recordings but this was not always feasible given the tight timeframe. We also had significant background noise at some sites, mostly weather but also at 2 sites, loud buzzing sounds from flies when acoustic recorders were located near possum traps. Recorders were fixed onto trees using cable ties, near to some locatable point (by marker and/or handheld GPS), mostly stoat traps, but also a wooden gate (WG) at the start of the Whakanui track, and several of the bird count stations in the Catchpool Valley. We used an online, shared spreadsheet in google docs to record where each acoustic recorder was, which sound card was in it, and who had deployed it; this spreadsheet also contained detailed notes on how to locate each recorder relative to the marker and/or trap, since we tried to hide the recorders from public view as much as possible. No recorders were stolen or tampered with during the 2 month-long deployment period.

We tried to stagger the deployments so that recorders were evenly distributed over the park at each time, but for a few difficult-to-reach tracks, this was not possible given our limited volunteer time. Volunteers were provided with laminated cards outlining how to change the batteries and sound cards, and troubleshooting guides. Many volunteers were needed, on average going out 2-3 times per week, to collect the data.

All sound cards were downloaded by SE onto 2 external hard drives, using out previously-established file naming protocol.

(2) Acoustic analysis and scoring

Scoring was carried out by S.E. using the freeware code “Audacity” to open the wav files and select the first 10 seconds from each minute for a total of 30 minutes (generally from 07:00-07:30am, though a few of the early December sites were analysed from 08:00-08:30am). Using headphones and visualising the spectrograph, we recorded all bird calls that could be heard, even if very faint, as long as they were identifiable. S.E. required considerable upskilling of bird identification by call – particularly for some of the more obscure calls (e.g., tomtit vs blackbird vs other bird high-pitched “seeps”). Unidentified calls were emailed to several more experienced ornithologists to confirm what they were. S.E. also made use of the “nz birds online” site, Xeno Canto, and some sample wav files of tomtits provided by Nyree Fea and Stephen Hartley. In the end, most “unidentified” calls were identified, while the few remaining unidentifiable calls (<10 total) were not included in the final count.

For each site, a day as selected for analysis based on:
- recording quality; quality was ranked as 1 (excellent; low noise level, high likelihood of hearing distant birds and high-pitched birds eg riflemen); 2 (some interference from wind gusts, light rain and/or cicaca, flies or mechanical noise); 3 (poor quality, significant background noise from wind, rain or mechanical problems); and 4 (unusable).
- where several high-quality days of recording were available, we used random sampling of the day cf. other sites running at the same time.

During each 10 second snippet, the number of calls for each species were recorded into a notebook. The total calls per species for the 30 10-second samples were then transferred to a spreadsheet.

Because it is difficult to distinguish some similar-sounding bird species from acoustic recordings alone, on the advice of Stephen Hartley, we lumped several similar-sounding species into "supergroups" of:
- tuis and bellbirds
- goldfinches and dunnocks
- blackbirds and thrushes

From observational experience and the 5 minute bird count calibration outlined in Appendix B, we expect each of these groups to be dominated by tuis, goldfinches, and blackbirds, respectively.

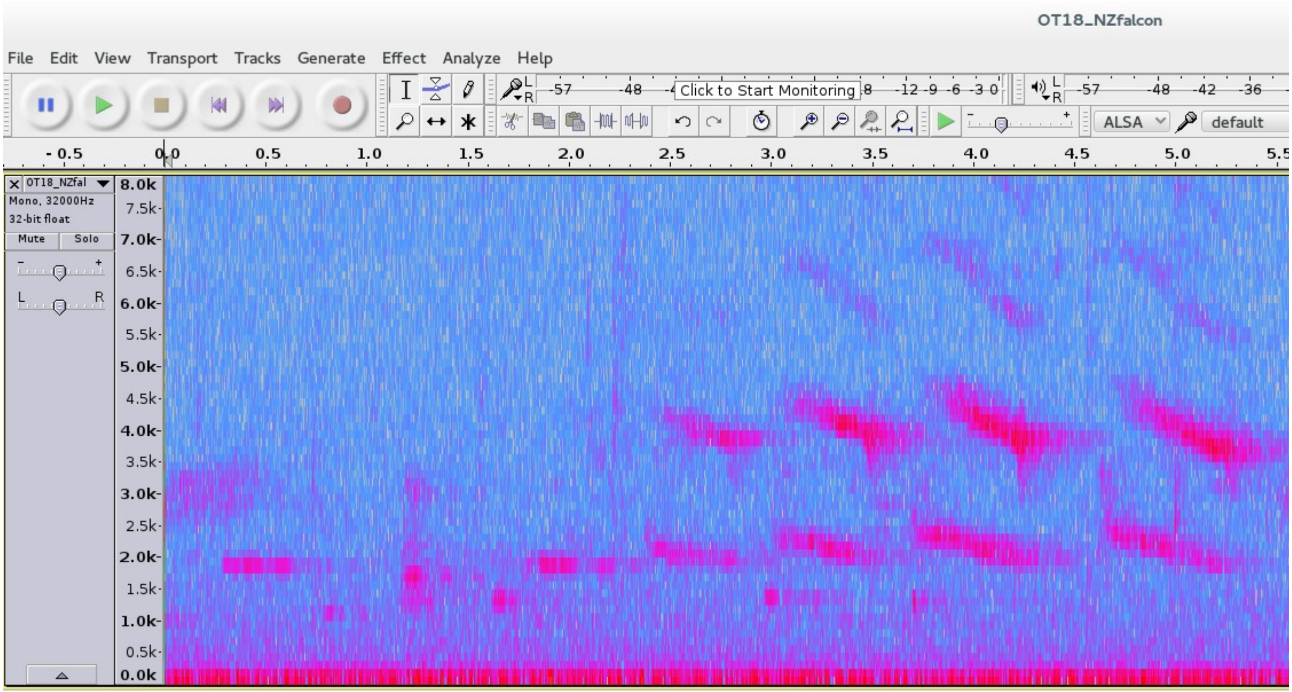


Figure 5. Example of Audacity screenshot showing spectogram with tui and NZ falcon calls at site OT18.

(3) Scoring and analysis

(a) Percentage and call rates: compilation for all sites

Our tally per bird species scored a 1 when a species was present (identified by calling) on a 10-second snippet. We summed the number of snippets it was present on, and then divided this by the total number of calls present on all snippets (regardless of species) to calculate the calls from each species (Figure 6a). 26% of the total summed calls at all sites were made by tomtits.

The calling rate (the number of ten-second sound snippets in which a species could be heard calling divided by the total number of 10-second snippets) was computed for the sum of all sites. For example, 1303 tomtit calls were recorded at 75 sites (plus 3 of the sites that had an extra analysis session to check repeatability). This gives a calling rate for tomtits of 1303/(78×30) = 0.56 (Figure 6b).

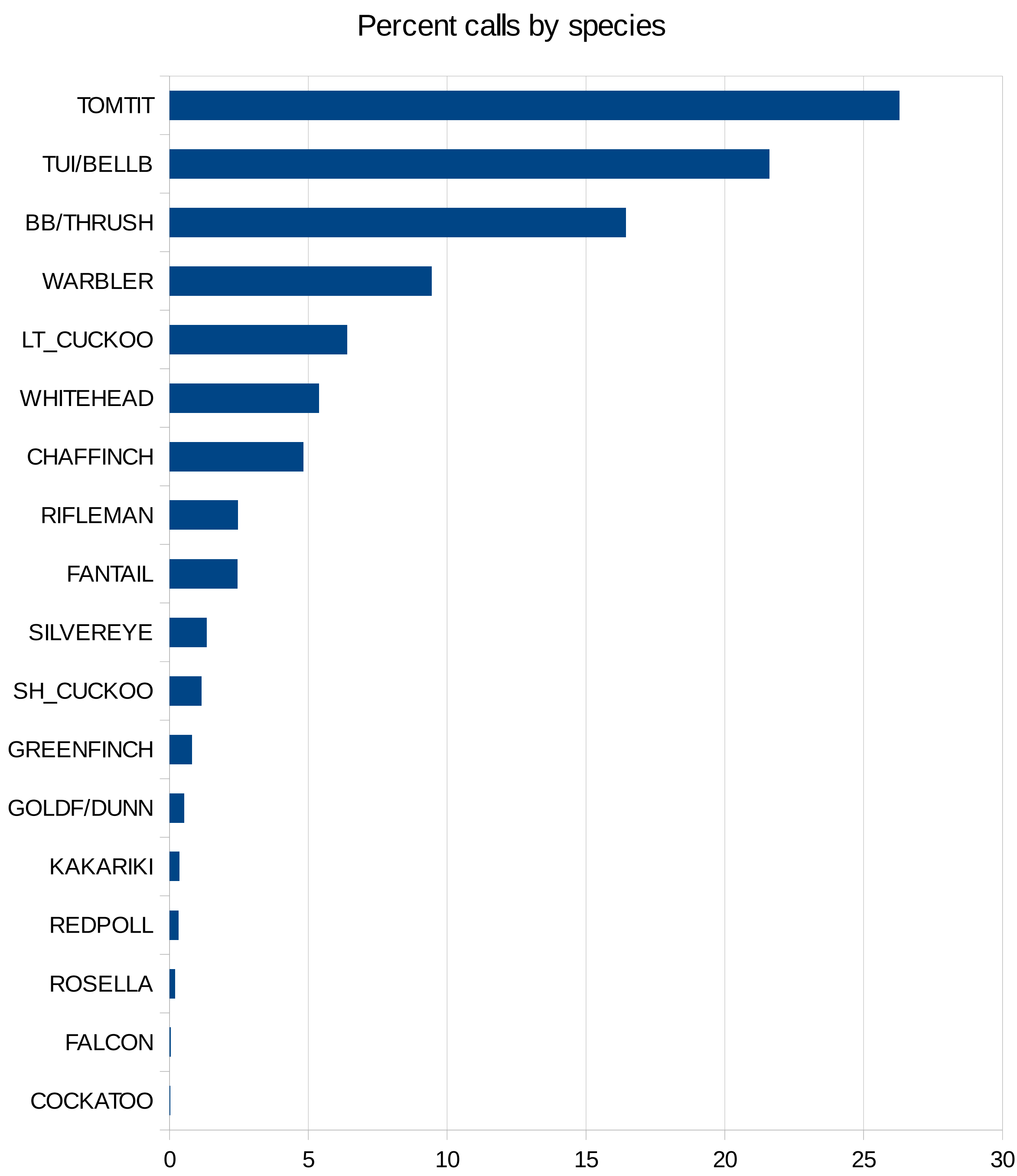


Figure 6(a) Compiled percentage of total calls for each species from 78 analyses (75 sites, 3 sites had 2 analyses). Note that the percentages sum to 100. A total of 4959 calls were recorded on 2340 10-second snippets, with 10 calls omitted as we could not identify them.

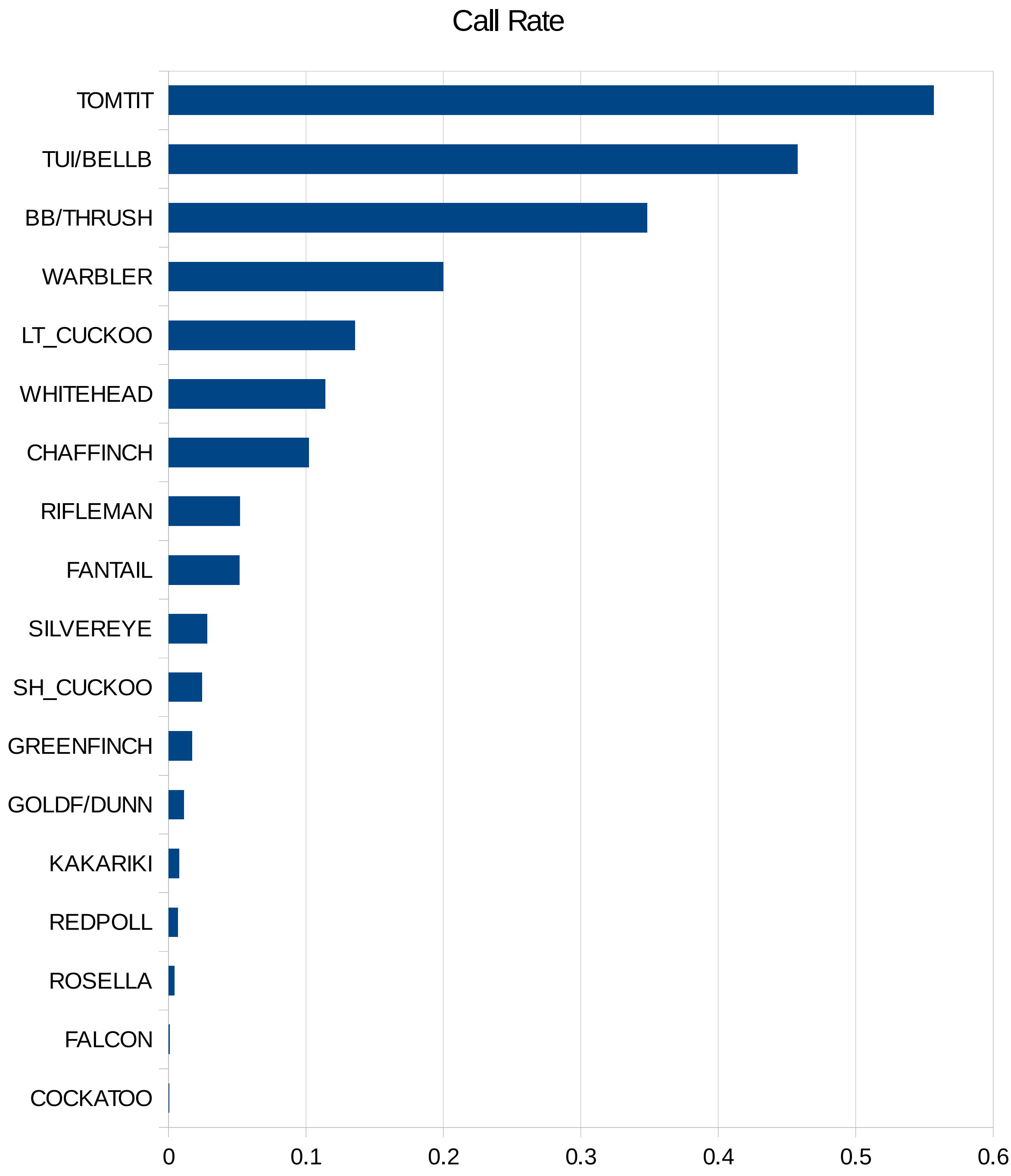


Figure 6(b). Compiled call rates for each species from 78 analyses (75 sites, 3 sites had 2 analyses).

Figure 6 shows that in December 2015- early January 2016 the most frequent calls summed over the entire range of the analysis were made by tomtits, tui/bellbirds, blackbird/thrushes, and warblers (73% of the total calls recorded). A moderate number of calls were made by long-tail cuckoos, whiteheads, and chaffinches (17%). Next were riflemen, fantails, silvereyes and shining cuckoos (over 7%). Other bird species with a significant presence were green and goldfinches, kakariki, redpolls, and eastern rosella. Calls of sulphur-crested cockatoos were recorded at 1 site, and NZ falcons at 2 sites (falcons are also occasionally observed by trappers in the park). No kaka sounds or NZ kingfishers were recorded.

The data in Figure 6 cannot be equated directly to bird numbers or relative density of each species in the park, for the following reasons:
- bird species present in flocks of several birds may call numerous times within each 10-second snippet, but only count as “1” presence per snippet. This will tend to underestimate the number of silvereyes and finches for example, compared to bird species that have 1 bird engaged in territorial calling (e.g., male tomtits, tuis), where only 1 bird may call repeatedly over many consecutive minutes.
- acoustic recordings with a lot of background noise can obscure high-pitched calls from species such as riflemen more than lower pitched calls (eg from tui/bellbirds), leading to sampling bias.
- calling rates will vary significantly throughout the year, especially for migrants such as the cuckoos (e.g., as has been observed in previous surveys in the Orongorongo River- Brockie, 1992).
- variability from day-to-day at each site, and between-site variability, is significant (see later in this report). Although summing the data smooths out some of these variations, the data samples a variety of high and low altitude, remote bush vs. bush edges, and other features. Whiteheads are more prominent at higher, more remote sites for example.

Species	Count	Percentage of total calls	Call rate (snippets with identified calls/ total number of snippets analysed)*
Tomtit	1303	26.3	.5568
Tui/Bellbird	1071	21.6	.4577
Blackbird/Thrush	815	16.4	.3483
Grey Warbler	468	9.4	.2000
Long-tailed cuckoo	317	6.4	.1355
Whitehead	267	5.4	.1141
Chaffinch	239	4.8	.1021
Rifleman	122	2.5	.0521
Fantail	121	2.4	.0517
Silvereye	66	1.3	.0282
Shining Cuckoo	57	1.2	.0244
Greenfinch	40	0.8	.0171
Goldfinch/Dunnock	26	0.5	.0111
Kakariki	18	0.4	.0077
Redpoll	16	0.3	.0068
Eastern Rosella	10	0.2	.0043
NZ falcon	2	0.04	.0009
Suphur-crested cockatoo	1	0.02	.0004
TOTAL	4959	100	2.12

Table 1. Percent and call rates summed for all sites, by bird species.: total snippets analysed = 2340.*

Comparison with previous bird surveys

Calling rates (Table 1) are in general higher than those observed in a smaller acoustic recorder survey to the north of our study area for blackbird/thrushes, tui/bellbird, chaffinch, riflemen and tomtits (reference sites of Hartley et al., 2016, unpublished report). This difference may result from different habitat and the fact that the reference site survey in Hartley et al. recordings were made at different times of year, and over a number of years (2012-2015). In addition, our threshold for acceptance criteria for bird presence was lower than that used by Hartley et al., since we spent a lot of time determining faint and unidentified calls. Particularly notable in our results is the high proportion of 10-second snippets that had tomtit calls- over 50% of snippets analysed had recorded tomtits, and tomtits made up 26% of all bird calls recorded in the park in December 2015- January 2016. Many tomtit sequences appeared to be the same bird calling minute after minute (i.e. had the same frequency, pattern, and volume) suggesting that we were counting the same bird numerous times over the 10 second snippets with a total duration of 30 minutes.

Field monitoring of bird species by 5 minute bird counts has been carried out since August 2009, headed by Ian Armitage (Armitage, 2009 – the report can be found at http://www.rimutakatrust.org.nz/5mbc/5mbc.htm). 20 bird stations approximately 200m apart were monitored throughout the Cacthpool Valley. Counts were made of the birds seen and heard at each station at monthly intervals from August 2009 to July 2010, also in January and February 2012.There was one night visit in January 2012. Most counts were made between 8 am and 2 pm, in fine weather and always on weekdays. 30 bird species (18 indigenous, 12 introduced) were recorded, with the most common species being silvereyes, bellbirds, grey warblers, tui, chaffinches, kereru, fantails and blackbirds. In Appendix B we recount an attempt to compare acoustic recorder data and the 5 minute bird count network data in March/April 2016. Although there are differences between the 2 methods- the most notable being that “call rates” from acoustic recorder data are much higher- the main bird species detected were similar. Tomtits are less prominent in the Catchpool valley data compared to the wider network (with more high altitude sites) summarised here. Notable differences between the two approaches are (a) that the 5MBC method includes visual sightings of birds (and they are numerous) by experienced observers as well as vocal calls of birds, in contrast to the acoustic method where only sounds are recorded, but (b) that the acoustic method allows for continuous recording over a longer but defined period than does the 5MBC method and it is very likely to record species (providing the birds are vocal) that would not be recorded by an observer who is only watching and listening for five minutes. Two other benefits of the acoustic method is that it is likely to record high frequency calls that many observers cannot easily hear (depending on their hearing ability), such as rifleman and sometimes fantail, and the acoustic method can be used at night.

Brockie (1992) reported on a number of different bird survey methods carried out by DSIR in the 1970s-80s in the field station area at Browns Stream (Orongorongo Valley). Nesting surveys from this region indicated that silvereyes were the most numerous, followed by grey warblers, fantails, tomtits, riflemen, blackbirds, thrushes, chaffinches, and bellbirds (Brockie, 1992, figure 126). 5 minute bird counts in the Orongorongo rata-rimu forest recorded an average of 0.9 bellbirds/5 minutes, which is equivalent to a call rate of (0.9/30)=0.03 (since there are 30 10-second snippets per 5 minutes). They recorded 0.3 blackbird calls per 5 minutes (a call rate of 0.01). This is significantly lower than the call rate for blackbirds/thrushes in Table 1.Brockie (1992) also reported in a study by altitude the calls per 5 minutes for all bird species, finding ca. 10 calls per 5 minutes at the field station, corresponding to a call rate of 0.33 birds per 10-second snippet cf. our rate of 2.1. We suggest that the higher call rates we observed can mostly be explained by the different protocols between 5 minute bird counts and acoustic recording methods. 5 minute bird monitoring only counts a particular bird once per 5 minute session if it can be identified as calling from the same location throughout the 5 minute interval, whereas the acoustic monitoring may count the same bird multiple times over 5 minutes sample time (once per 10-second snippet). Also, 5MBCs do not count faint calls more than ca. 50m away, whereas there is no distance limit for acoustic monitoring. It should also be noted that a comparison between the two methods found (Appendix B) that bird calling rates recorded during times when a 5MBC human observer was also simultaneously present were significantly lower than average, presumably owing to the effect of the human disturbance suppressing bird calls.

(b) Effect of altitude

39 out of 75 sites have heights > 400m (note that none of bird count stations used in the March-April calibration are above 400m; Appendix B). Figure 7 shows that tomtits, long-tailed cuckoos, whitehead and riflemen all call more commonly at altitudes > 400m compared to the average for all sites, whereas finches call less frequently. Kakariki (not shown in figure) also call preferentially at higher altitudes.

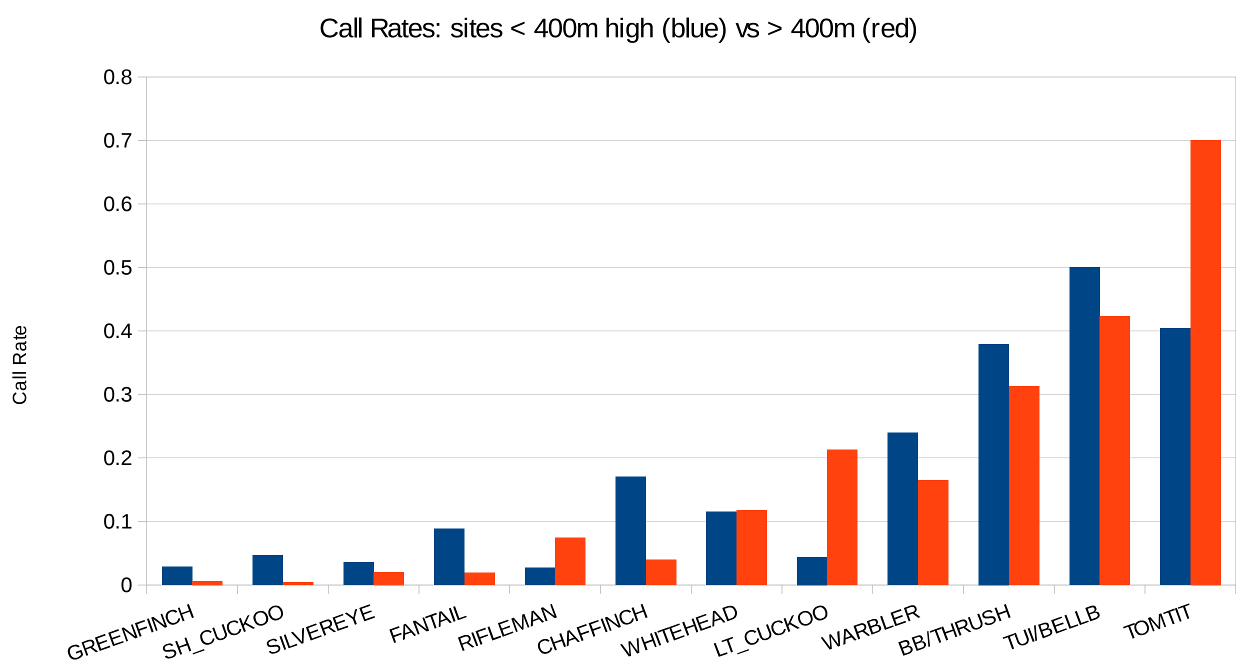
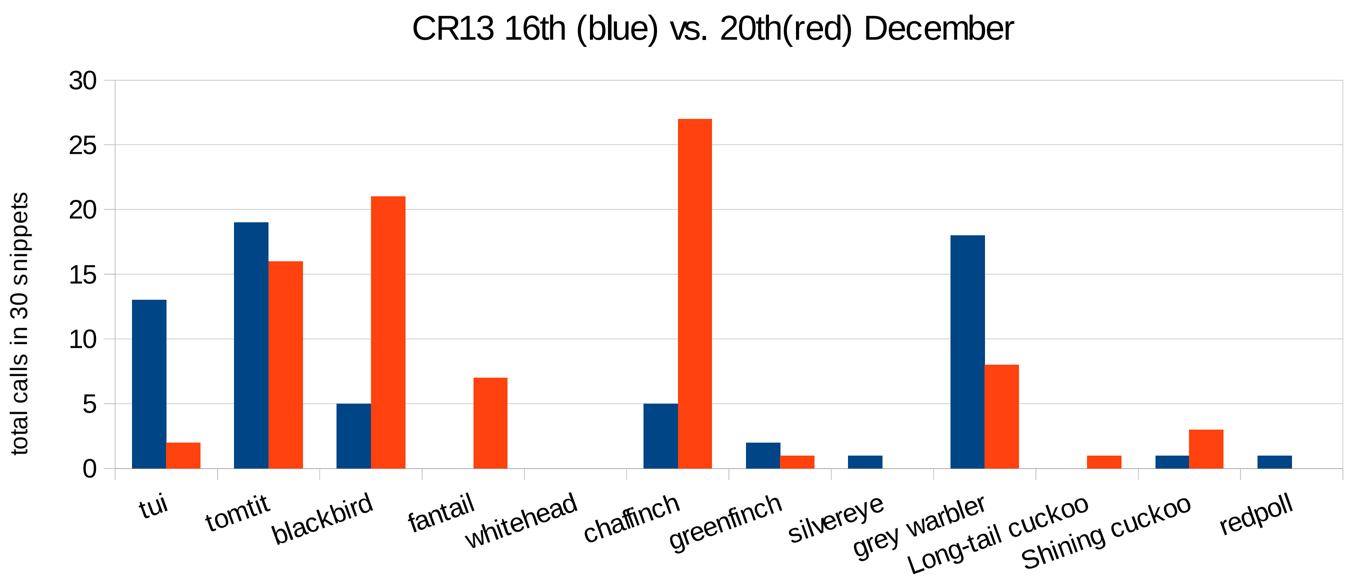


Figure 7. Effect of altitude on calling rates of 12 most commonly-calling species in the park. Red columns are calling rate for sites > 400m high. Blue are for sites with altitude < 400m.

(c) variability in call rates: space and time

The data presented above are summed and averaged over enough sites to smooth out day-to-day variability. Individual sites do show variability from day-to-day (e.g., Figure 8).



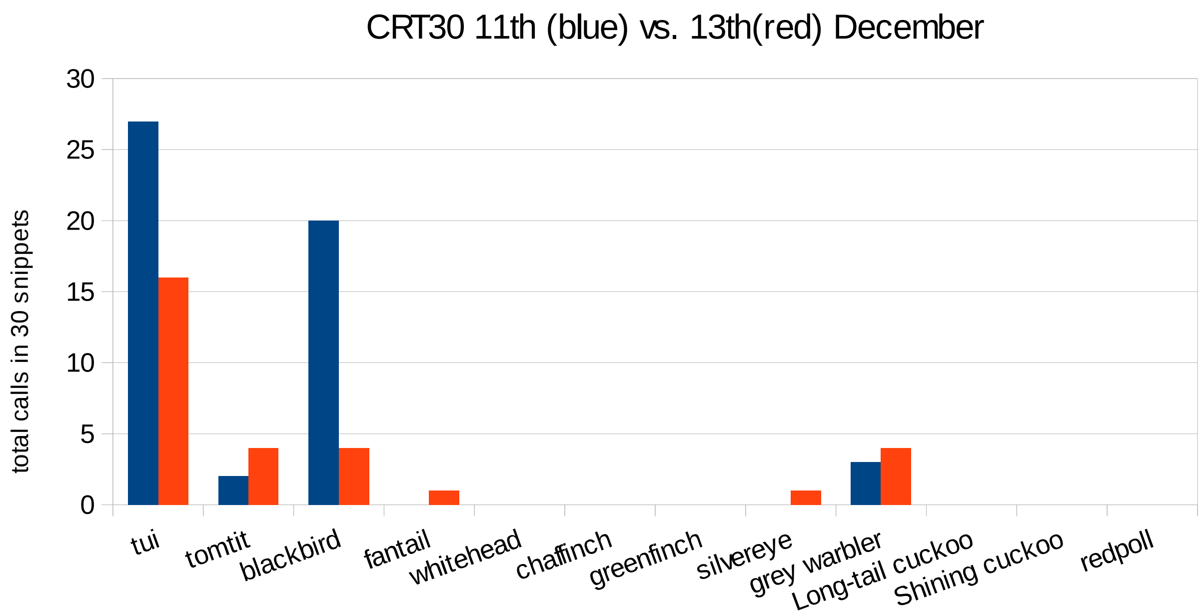


Figure 8. Illustration of varaibility in total calls detected on different days (top) CR13 (Clay Ridge track); (bottom) CRT30 (Cattle Ridge track)

The spatial variation in call rates must be interpreted cautiously because of the day-to-day site variability. Nevertheless, maps showing call rate distributions illustrate some of the spatial trends in the data (Figures 9-21). The most frequent callers (tomtits, tui/bellbirds, blackbird/thrushes, and warblers) have call rates widely distributed over the park. Whiteheads and rifleman are mostly located in high-altitude kamahi/beech forest, while chaffinches prefer lower regions closer to the bush edge.

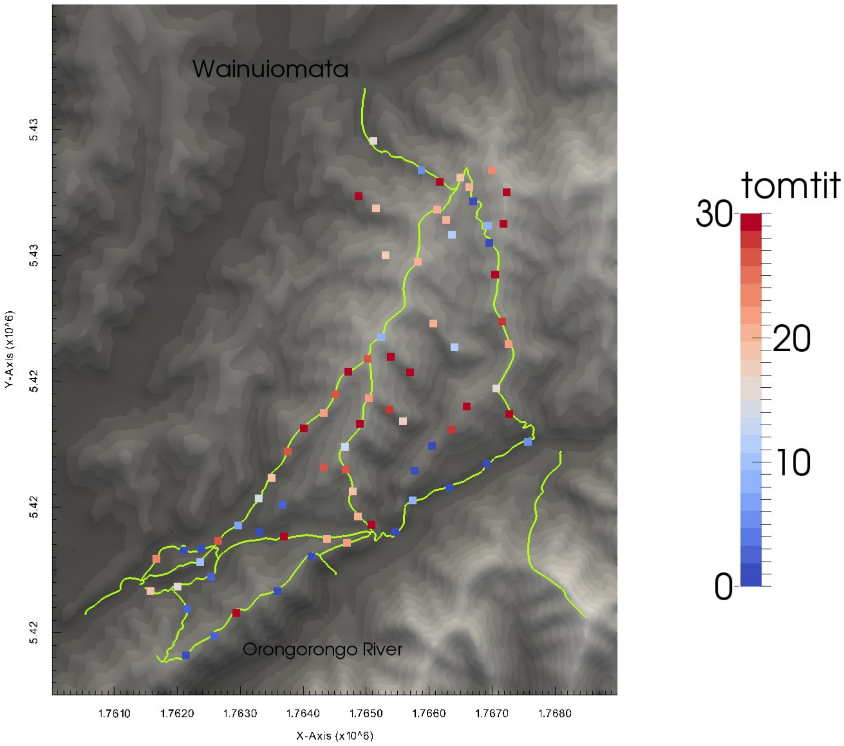


Figure 9. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for tomtits.

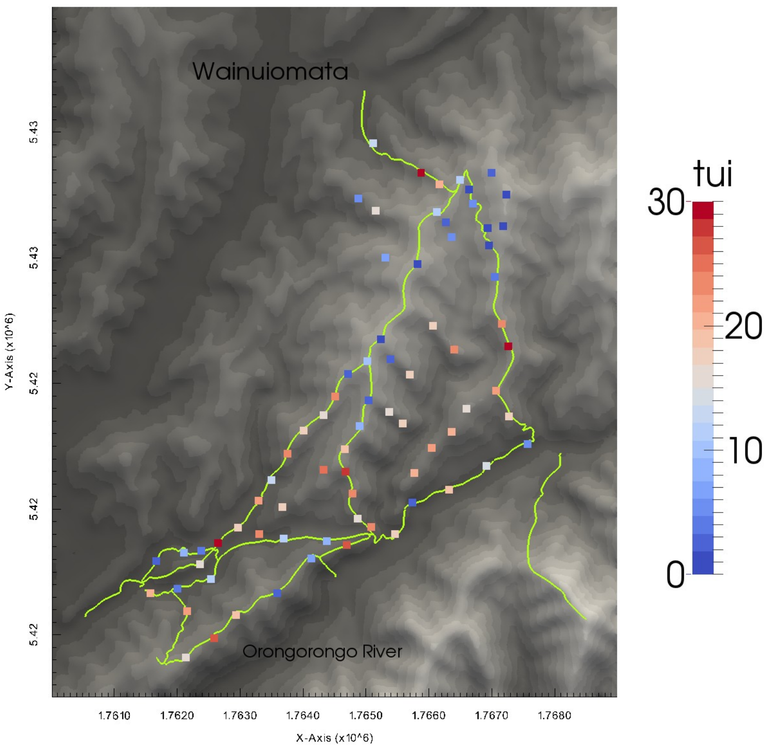


Figure 10. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for tui/bellbird supergroup.

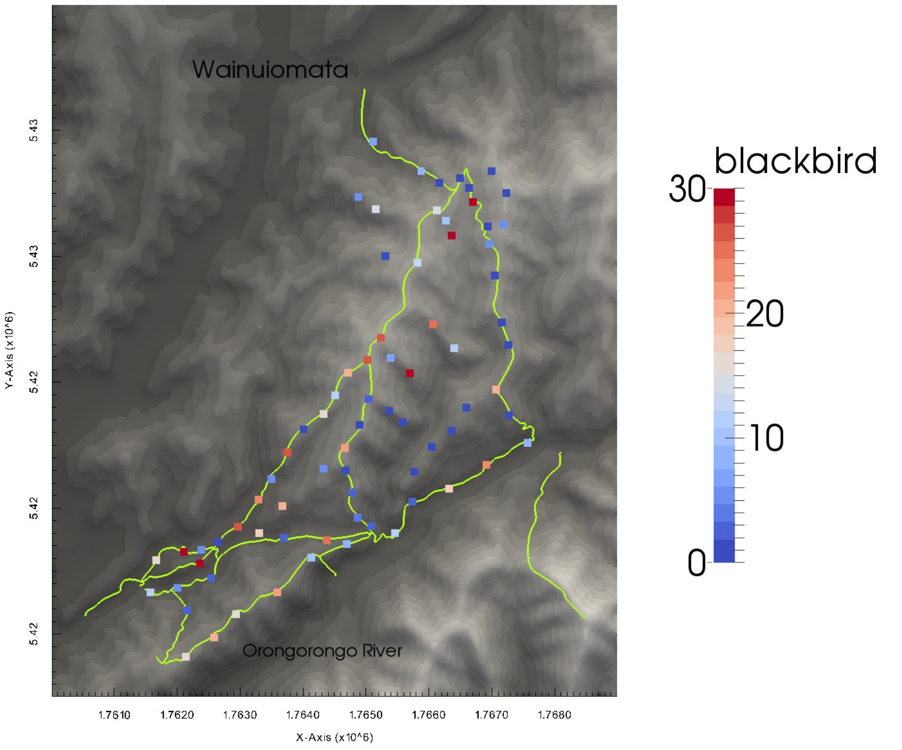


Figure 11. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for blackbird/thrush supergroup.

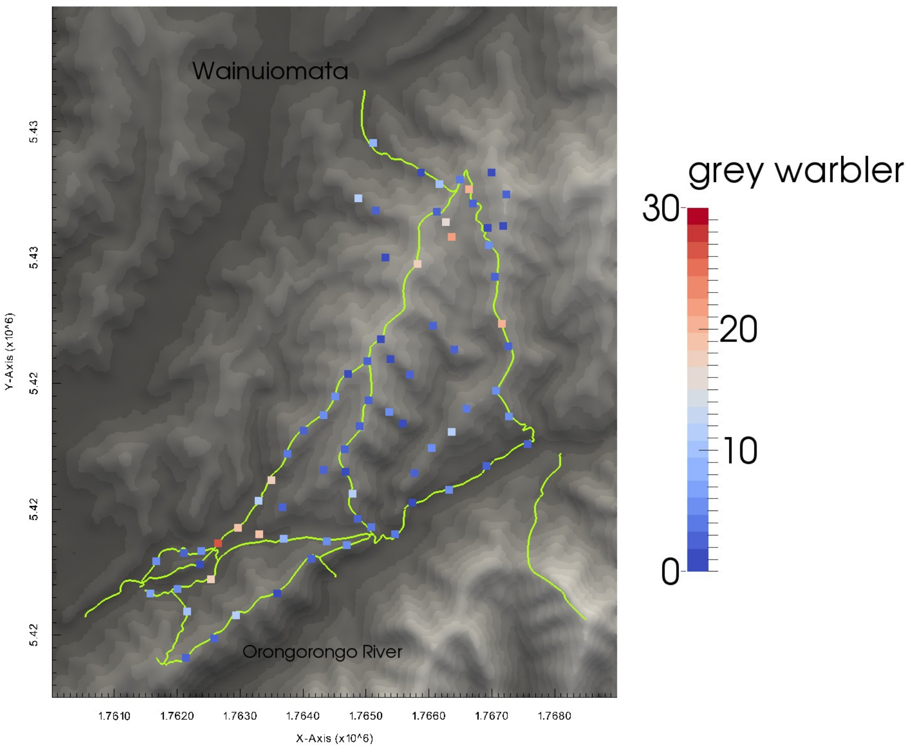


Figure 12. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for grey warblers.

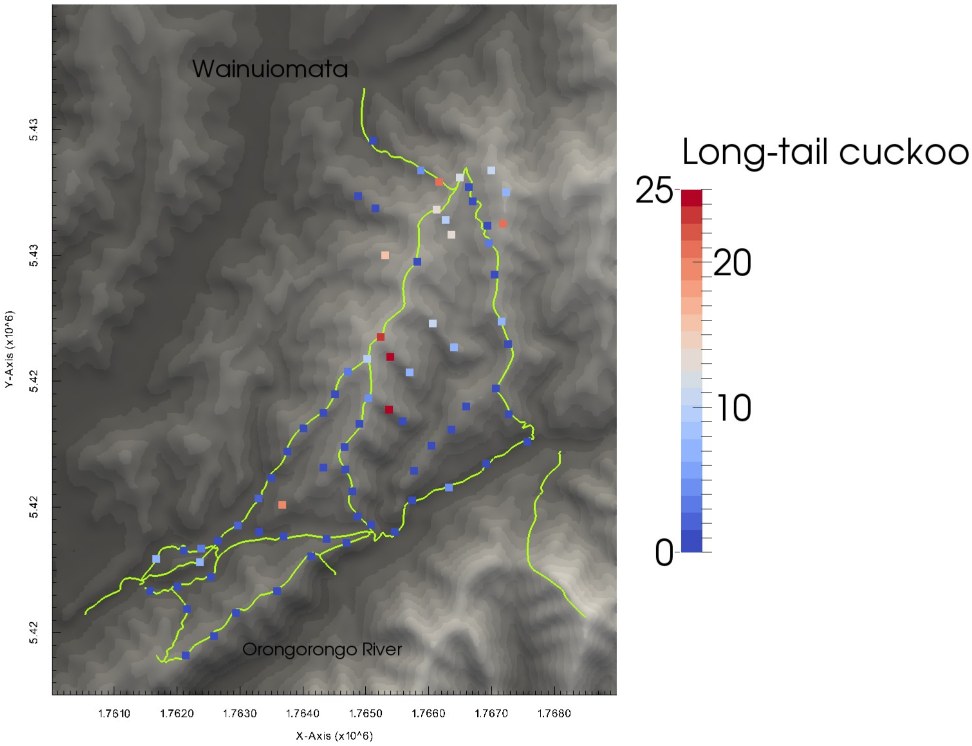


Figure 13. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for long-tailed cuckoos.

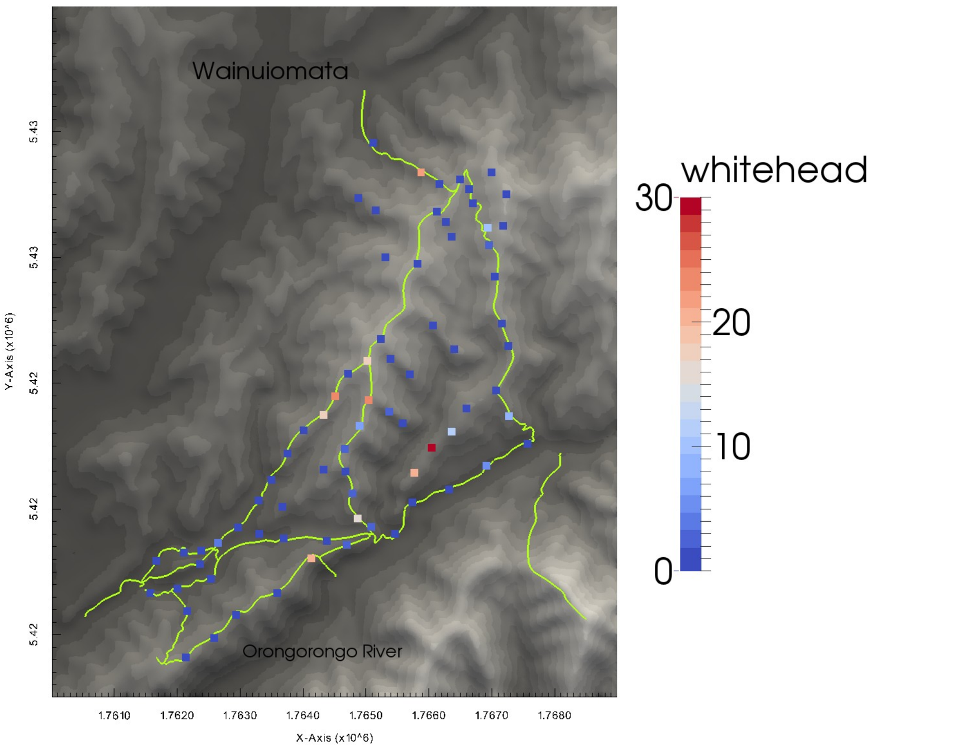


Figure 14. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for

whiteheads.

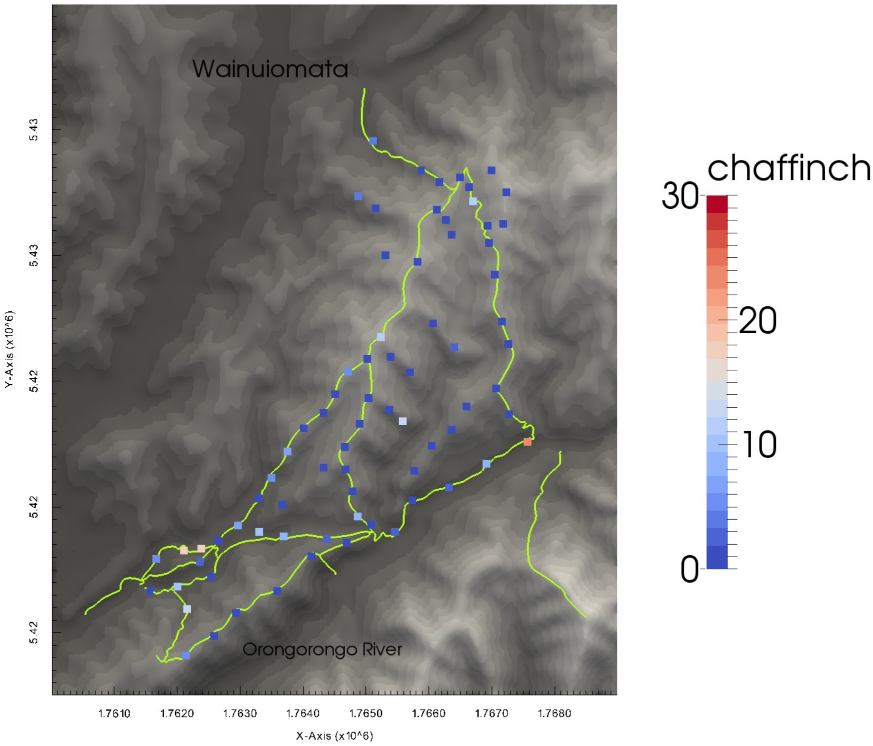


Figure 15. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for chaffinches.

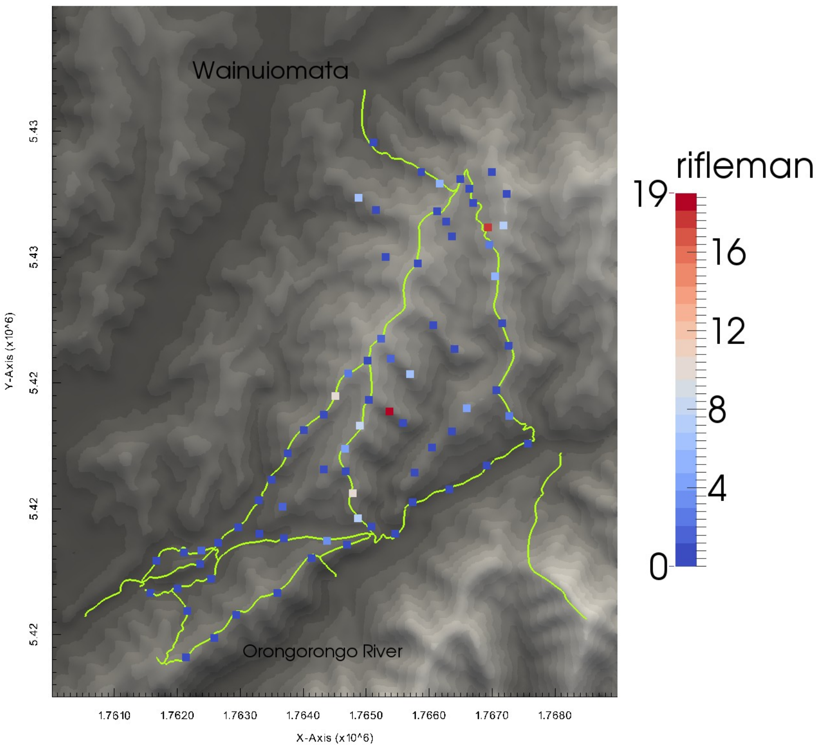


Figure 16. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for rifleman.

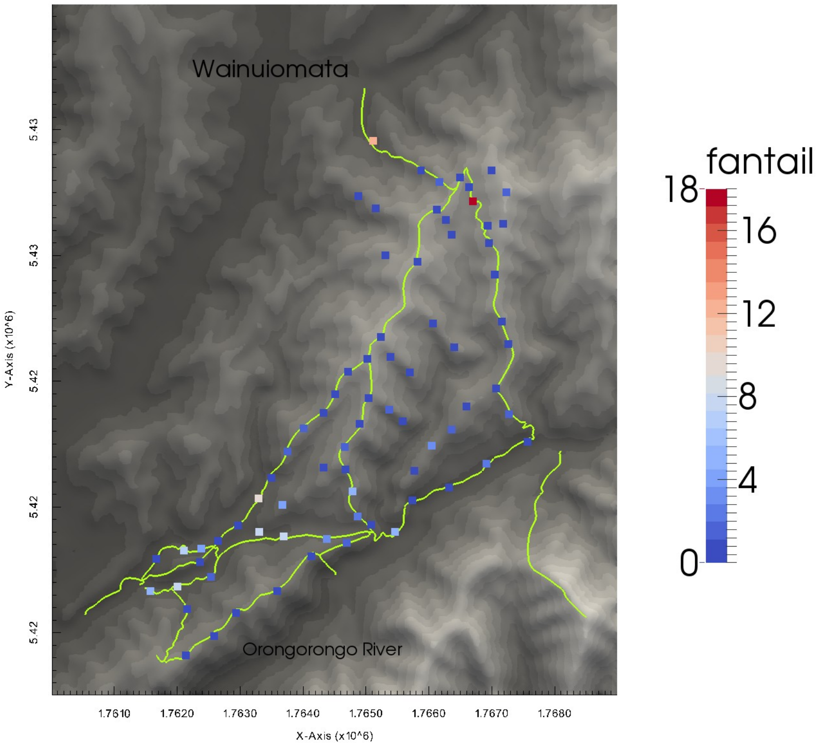


Figure 17. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for fantails.

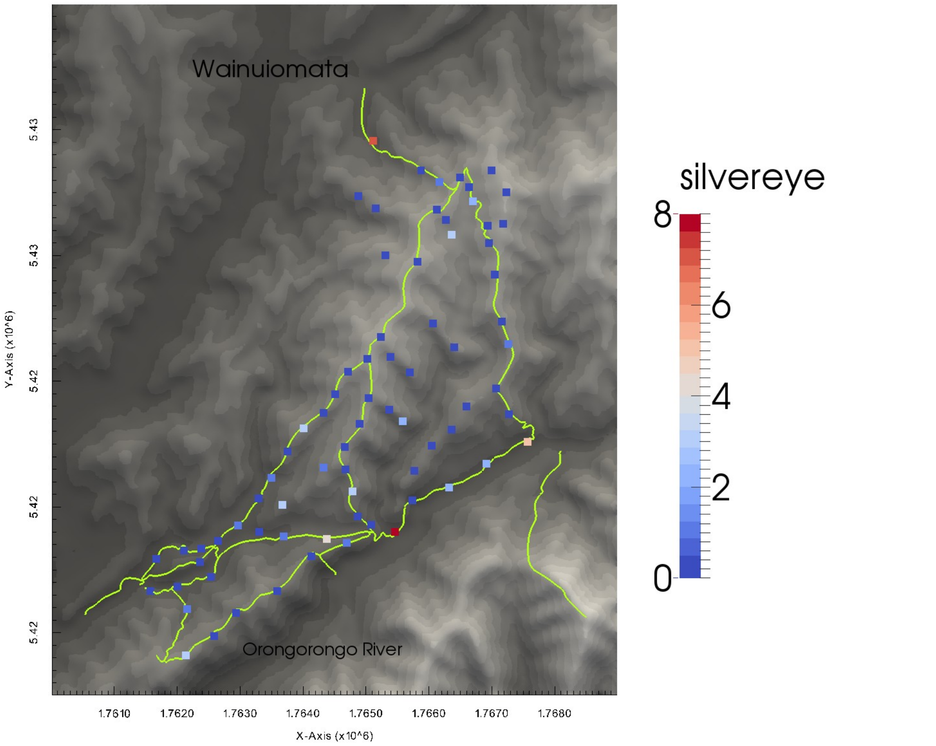


Figure 18. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for silvereyes.

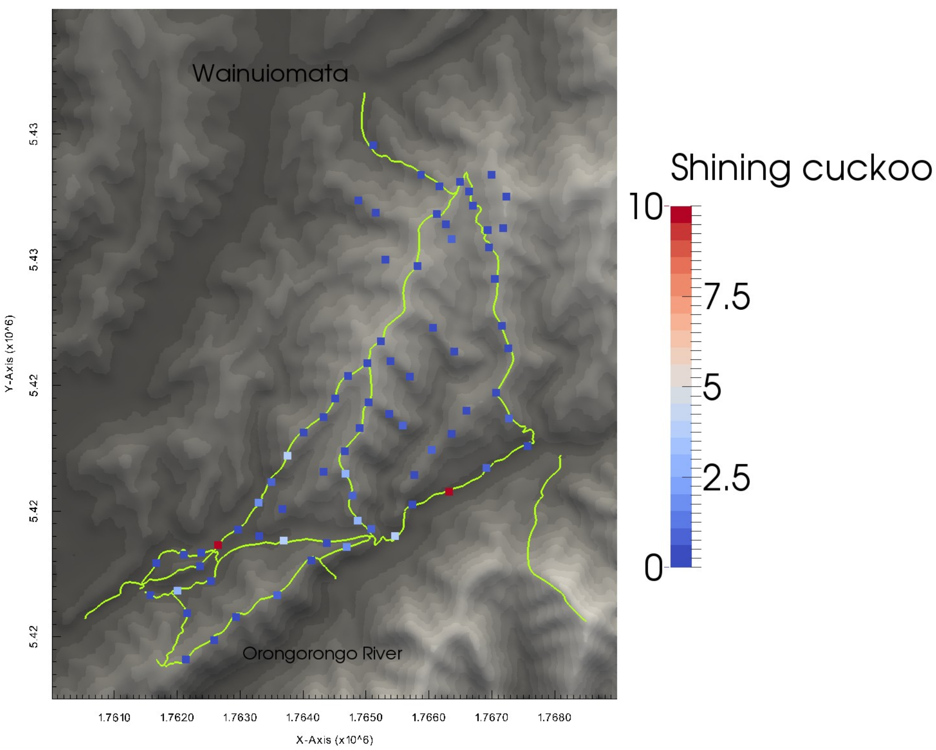


Figure 19. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for shining cuckoos.

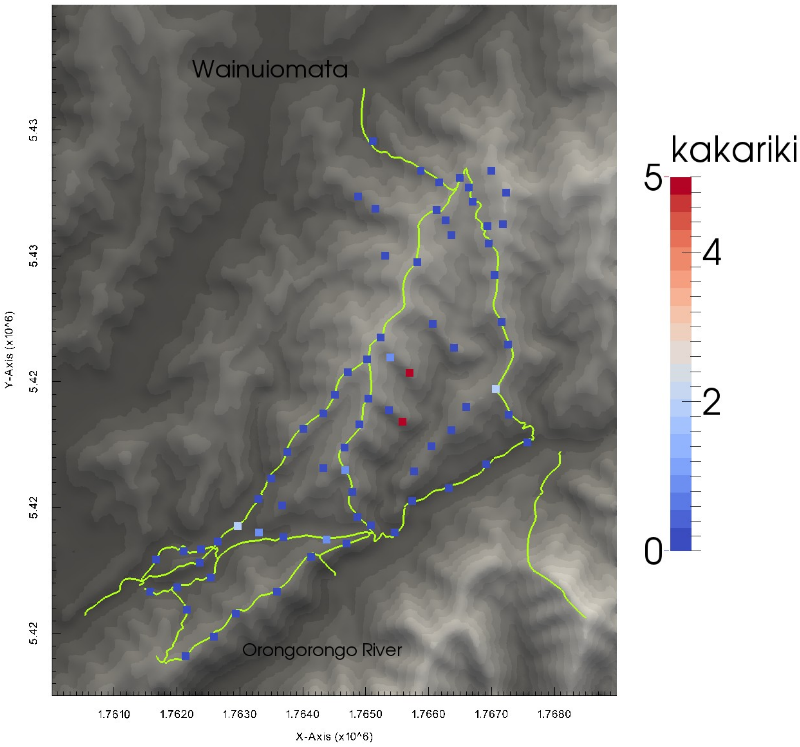


Figure 20. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for kakariki.

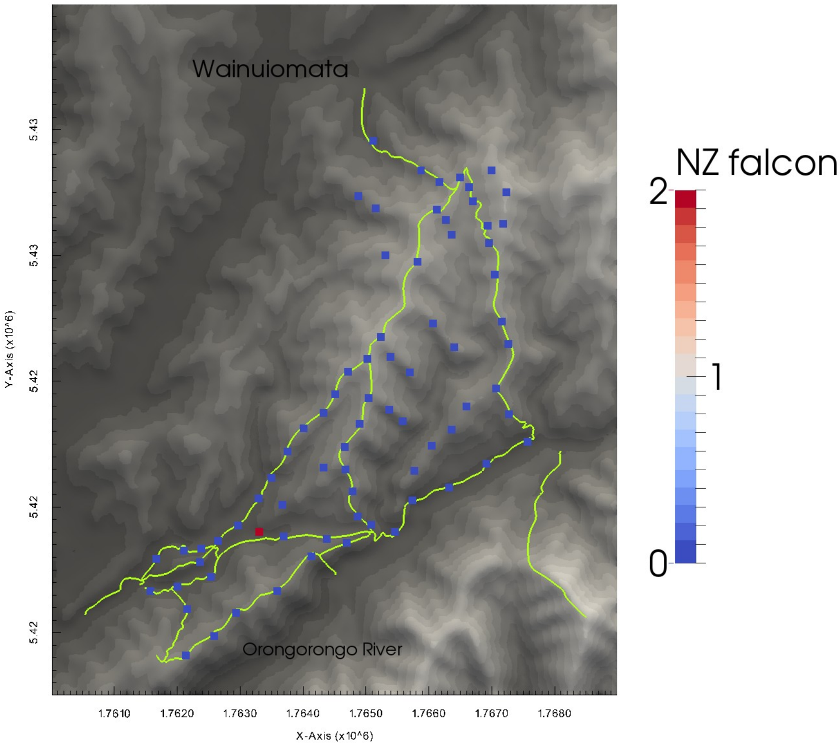


Figure 21. Spatial distribution of calls (number of calls per 30 snippets analysed at each site) for NZ falcon.

(4) Summary

This report outlines the first in what we hope will be a yearly series of acoustic recorder surveys throughout the Rimutaka Forest Park. It represents hundreds of hours of volunteer time collecting and analysing the data. While time-consuming, and bearing in mind the restrictions in the methodology of acoustic monitoring and the natural variability in bird calls per site and from year-to-year (e.g., as a result of seasonal or climate fluctuations), we hope that these results will provide a baseline through which we can monitor long-term changes in bird presence/absence and relative density through time.

Our main conclusions from the 2015 data are:
- tomtits are the most widely-distributed and frequently-calling species we observed, though we think that there is considerable over-emphasis of tomtit densities using our technique, since many of the recordings record a succession of 10-second snippets with highly repetitive calls suggesting 1-2 birds calling throughout the analysed sessions;
- other widely distributed and frequently-calling species are: tui/bellirds, blackbird/thrushes, grey warblers, long-tailed cuckoos, and whiteheads.
- rifleman presence may well be underestimated because any noise or degradation in the acoustic signal preferentially masks high frequency calls. Riflemen are predominantly found at higher altitudes away from bush edges
- close to the bush edge, numerous finch species are present; also eastern rosellas and redpolls. Since the 5MBC stations in the Catchpool valley are not far from the bush edge and all at low altitude, their results may not fully reflect the diversity and distribution of bird species in the Park.

Acknowledgements
The volunteers who helped deploy and retrieve the recorders were: Susan Ellis, Melody McLaughlin, Ned Bruno, Alwyn Rees, Rosemary and Alan Thompson, Ian Turner, Margot Fry, Innes and Sarah Hutchinson, Penny Evans, Ingrid Greenslade, Douglas Kwan, Peter Cooper, and Pierre Tellier. Planning and organisation of deployments was carried out by: Susan Ellis, Melody McLaughlin and Alwyn Rees. 4 of the acoustic recorders we used are on loan from Ed Abraham at Dragonfly Consulting. Stephen Hartley, James Griffiths, and Angus Hulme-Noir helped with advice while we were planning the survey. Stephen Hartley and Nyree Fea provided invaluable advice concerning the analysis of the data. Ian Armitage helped with the 5MBC calibration in Appendix B. Ian Armitage, Nyree Fea and Maarten Vink also helped identify some of the trickier bird recordings.

Appendix A: Site locations - acoustic recorder survey, December 2015 - early January 2016

name	Easting	Northing	Height	Long	Lat	Date analysed	Second analysis
BB1	1765463	5421604	144	174.97757	-41.34007	08/12/15	
BB4	1765734	5422106	222	174.98067	-41.33550	13/12/15	
BB8	1766326	5422306	160	174.98769	-41.33358	15/12/15	
BB12	1766912	5422688	167	174.99458	-41.33002	11/12/15	
BB16	1767570	5423032	161	175.00234	-41.32678	19/12/15	
BS10	1761666	5421175	75	174.93233	-41.34471	05/01/16	
BS12	1762102	5421305	90	174.93750	-41.34344	29/12/15	
BS13	1762385	5421342	119	174.94087	-41.34305	11/01/16	
BO4	1765157	5426753	431	174.97251	-41.29378	12/12/15	
BO6	1764881	5426949	372	174.96917	-41.29207	07/12/15	
BT5*	1762162	5420377	170	174.93847	-41.35179	16/12/15	
CR1	1762645	5421460	118	174.94395	-41.34194	04/12/15	
CR5	1762970	5421706	145	174.94776	-41.33966	08/12/15	
CR9	1763294	5422135	145	174.95152	-41.33573	14/12/15	
CR13	1763499	5422467	179	174.95388	-41.33270	16/12/15	20/12/15
CR18**	1763753	5422878	390	174.95680	-41.32895	25/12/15	
CR23	1764012	5423253	429	174.95980	-41.32552	07/12/15	08/12/15
CR27	1764332	5423500	454	174.96355	-41.32324	14/12/15	
CR31	1764508	5423789	507	174.96557	-41.32060	19/12/15	
CR35	1764715	5424151	576	174.96795	-41.31730	24/12/15	
CR39	1765027	5424359	645	174.97162	-41.31536	05/01/16	
CTR5	1764693	5421428	248	174.96842	-41.34181	08/12/15	
CTR10	1764136	5421210	306	174.96182	-41.34389	12/12/15	
CTR17*	1763595	5420665	385	174.95551	-41.34891	15/12/15	
CTR25*	1762934	5420312	400	174.94770	-41.35222	08/12/15	
CTR30*	1762585	5419947	385	174.94363	-41.35557	11/12/15	13/12/15
CTR35*	1762135	5419635	410	174.93834	-41.35847	14/12/15	
EW5	1766998	5427356	654	174.99432	-41.28797	27/12/15	
EW8	1767237	5427005	702	174.99727	-41.29108	24/12/15	
HO5	1763674	5422030	261	174.95609	-41.33660	25/12/15	
HO9	1764332	5422624	410	174.96379	-41.33112	24/12/15	
KAT1	1766274	5426567	560	174.98590	-41.29522	12/12/15	
KAT3	1766360	5426327	500	174.98699	-41.29737	16/12/15	
LG3	1767180	5426504	669	174.99673	-41.29560	19/12/15	
MO47	1765043	5423736	577	174.97198	-41.32097	05/01/16	
MO51	1764899	5423319	528	174.97037	-41.32475	01/01/16	
MO55	1764662	5422959	478	174.96764	-41.32804	24/12/15	
MO59	1764675	5422596	486	174.96789	-41.33130	27/12/15	
MO63	1764783	5422250	375	174.96927	-41.33440	25/12/15	
MO67	1764867	5421849	306	174.97038	-41.33799	26/12/15	
MR50*	1762358	5421126	200	174.94061	-41.34501	06/01/16	
MSR1-2	1765366	5423546	535	174.97588	-41.32261	28/12/15	
MSR1-4	1765586	5423366	445	174.97856	-41.32419	29/12/15	
MSR2-2	1765386	5424386	607	174.97590	-41.31505	01/01/16	
MSR2-5	1765696	5424136	527	174.97967	-41.31723	05/01/16	
MSR3-4	1766071	5424920	539	174.98393	-41.31010	20/12/15	
MSR3-8	1766408	5424542	476	174.98806	-41.31343	17/12/15	
MW1	1765238	5424699	669	174.97405	-41.31226	28/12/15	
MW9	1765823	5425899	642	174.98069	-41.30134	09/12/15	
MW14	1766127	5426727	558	174.98410	-41.29382	08/12/15	
MW18	1766501	5427236	517	174.98842	-41.28915	27/12/15	
OT2*	1761576	5420666	73	174.93139	-41.34930	04/12/15	
OT5*	1762006	5420736	81	174.93651	-41.34858	08/12/15	
OT8*	1762536	5420886	120	174.94280	-41.34713	04/12/15	
OT13	1763306	5421602	168	174.95180	-41.34053	08/12/15	
OT15	1763696	5421536	150	174.95648	-41.34104	13/12/15	
OT18	1764376	5421496	211	174.96461	-41.34127	16/12/15	
OT21	1765086	5421716	225	174.97303	-41.33914	24/12/15	
RT3	1765305	5426008	529	174.97448	-41.30046	23/12/15	
SG2	1766173	5427165	478	174.98453	-41.28986	06/12/15	
SG4	1765880	5427355	409	174.98098	-41.28822	29/12/15	
TR4	1766603	5423598	469	174.99064	-41.32189	19/12/15	
TR7	1766360	5423233	395	174.98784	-41.32523	19/12/15	
TR10	1766046	5422975	334	174.98416	-41.32761	17/12/15	
TR13	1765770	5422579	320	174.98097	-41.33123	19/12/15	
WG*	1765116	5427821	160	174.97174	-41.28418	03/12/15	
WO7	1767276	5423475	379	174.99871	-41.32285	19/12/15	
WW1	1767064	5423889	445	174.99607	-41.31917	14/12/15	
WW5	1767264	5424592	505	174.99826	-41.31280	12/12/15	
WW7	1767158	5424948	541	174.99690	-41.30961	08/12/15	
WW11	1767048	5425701	594	174.99537	-41.30286	14/12/15	
WW14	1766961	5426199	604	174.99420	-41.29839	12/12/15	
WW16	1766931	5426474	571	174.99376	-41.29592	09/12/15	
WW21	1766636	5427090	534	174.99008	-41.29044	05/12/15	
XA4	1766705	5426867	573	174.99097	-41.29244	21/12/15	

* = height estimated only.; **= GPS location estimated only

Appendix B: Comparison between 5MBC monitoring and acoustic monitoring during survey of Catchpool Valley, March-April 2016

name	Easting	Northing	Height	Long	Lat
BS1	1761823	5420682.5	74	174.93433	-41.34911
BS2	1762050	5420547.5	134	174.93708	-41.35028
BS3	1762110	5420225.5	210	174.93788	-41.35316
BS4	1762094	5420777.4	104	174.93755	-41.34820
BS5	1762412	5420850.4	135	174.94133	-41.34748
BS6	1762596	5421037.4	163	174.94347	-41.34576
BS7	1762788	5421333.3	93	174.94569	-41.34305
BS8	1763177	5421475.2	131	174.95030	-41.34170
BS9	1761476	5420836.5	54	174.93015	-41.34779
BS10	1761666	5421174.5	75	174.93233	-41.34471
BS11	1761828	5421381.5	67	174.93421	-41.34281
BS12	1762102	5421305.4	90	174.93750	-41.34344
BS13	1762385	5421342.4	119	174.94087	-41.34305
BS14	1762607	5421327.3	152	174.94353	-41.34315
BS15	1762713	5421524.3	165	174.94474	-41.34135
BS16	1762429	5421197.4	183	174.94144	-41.34435

These bird monitoring stations were set up around the Catchpool loop in 2009 by Ian Armitage and Peter Cooper. White disks are located on nearby trees (except for BS9, where the marker is missing). See Figures 2 and 4 for locations on map.

From 26 March to 6th April in 2016, we deployed acoustic recorders at BS1, 3, 5, 6, 7, 8, 9, 13 and 14. On 26th March, 1st April and 6th April S.E. (with help from Ian Armitage on 6th April) went around the stations conducting 5 minute bird counts. Since there was some overlap between 5MBC and acoustic recordings, we yelled “start” and “stop” to calibrate methods at some of the sites. More generally, since the recorders were analysed from 08:30-9:30 each morning, (taking 30 consecutive 10-second snippets at the beginning of each minute-mark) whereas the 5MBC were recorded continuously over 5 minutes at each site, we compared the 5MBC results with acoustic recordings from earlier in the morning.

Date	26th March 2016	1st April 2016	6th April 2016
Sites sampled (Acoustic recordings)	BS1, 5, 6, 7, 8, 9, 13, 14	BS1, 3, 9	BS1, 3, 6, 7, 8, 13, 14
Sites sampled (5 MBCs)	BS9, 10, 11, 12, 13, 16	BS1, 2(2), 3, 4	BS1, 3(3), 5, 6(2), 7(2), 8(2), 10, 13, 14(3), 16

Table B2. Days/sites analysed. Numbers in brackets indicate more than 1 analysis per day.

Results (Figures B1-B4) are generally reassuring in that the same species were recorded by both methods. The 5MBC data records more silvereyes, warblers and finches. We believe this is a real difference, despite the small sample size- it is consistent with the observation that small, flocking species such as silvereyes tend to be underestimated by acoustic recordings (which tallies one presence per 10 second snippet even when multiple birds are calling).

Acoustic recordings scored during the time that human observers were present showed a noticeable dip in bird call rates in the time period surrounding the 5MBC (compared to other times e.g. snippets scored 15 minutes later), presumably due to human disturbance and noise.

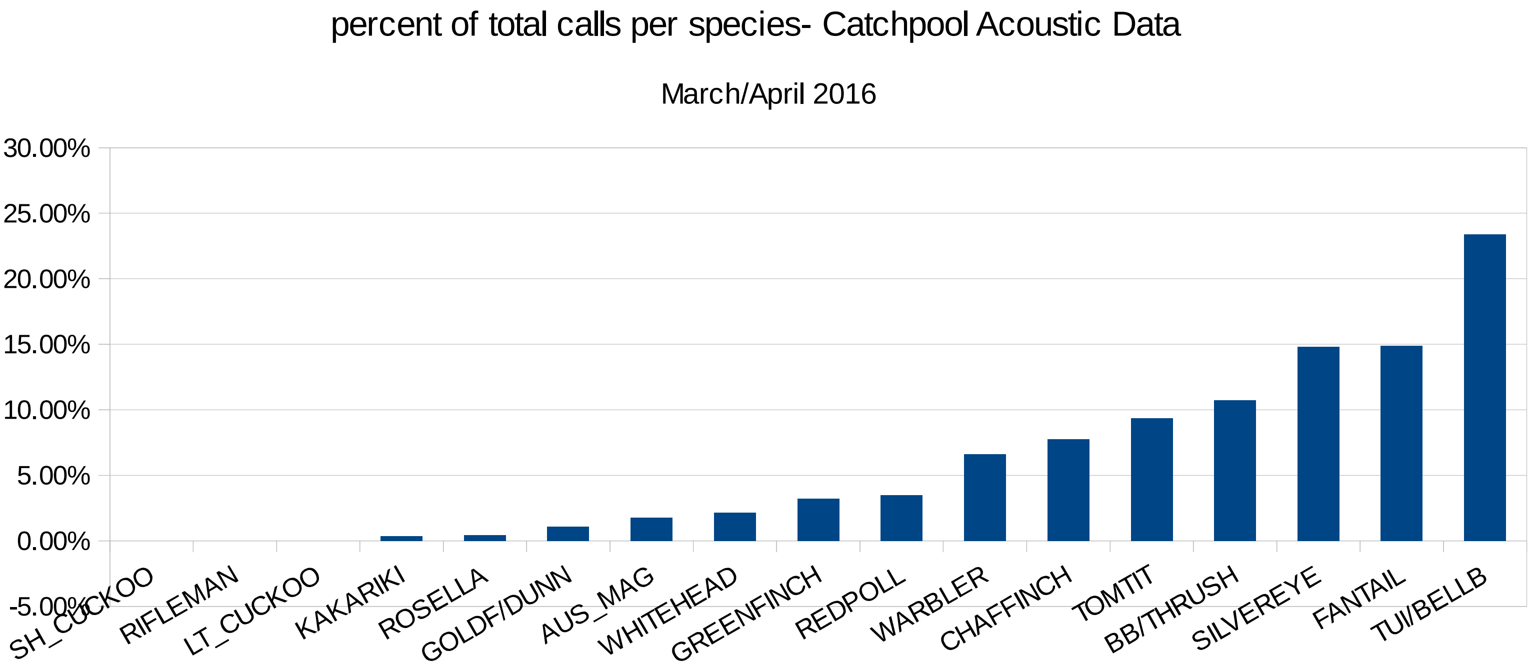


Figure B1. Relative percentage of calls for each species from the acoustic recorders (each site was analysed on 26 March, 1 April and 6 April).

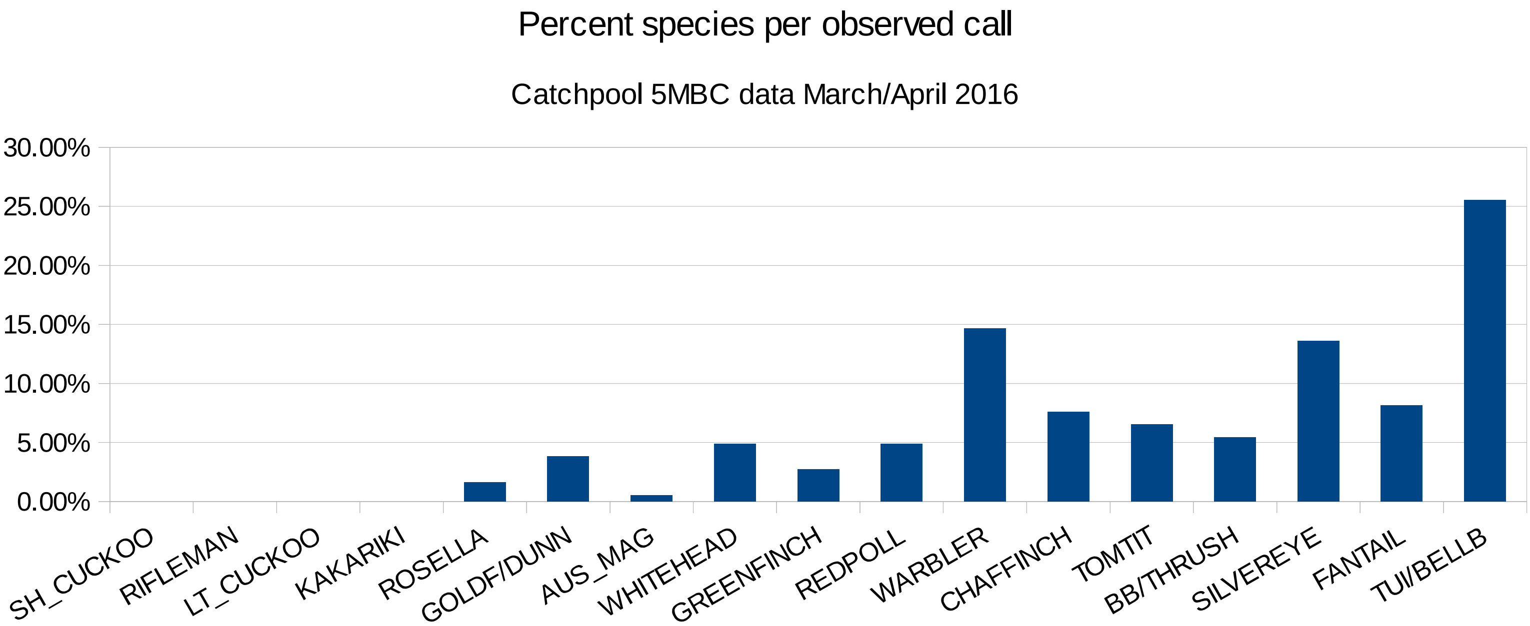


Figure B2. Relative percentage of calls for each species from the 5MBC.

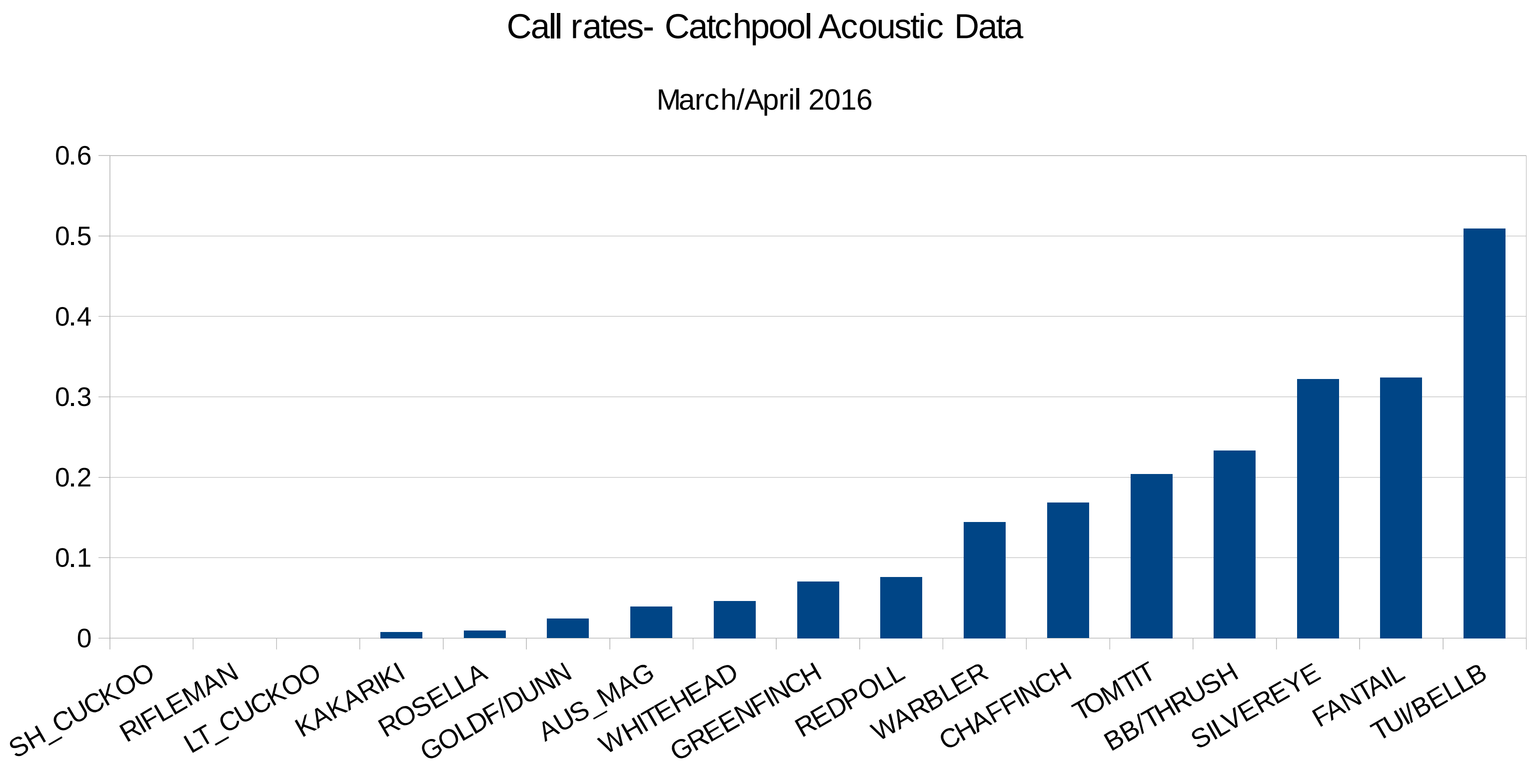


Figure B3. Call rate per species from the acoustic recorders (number of 10-second snippets recording species call, divided by total snippets analysed).

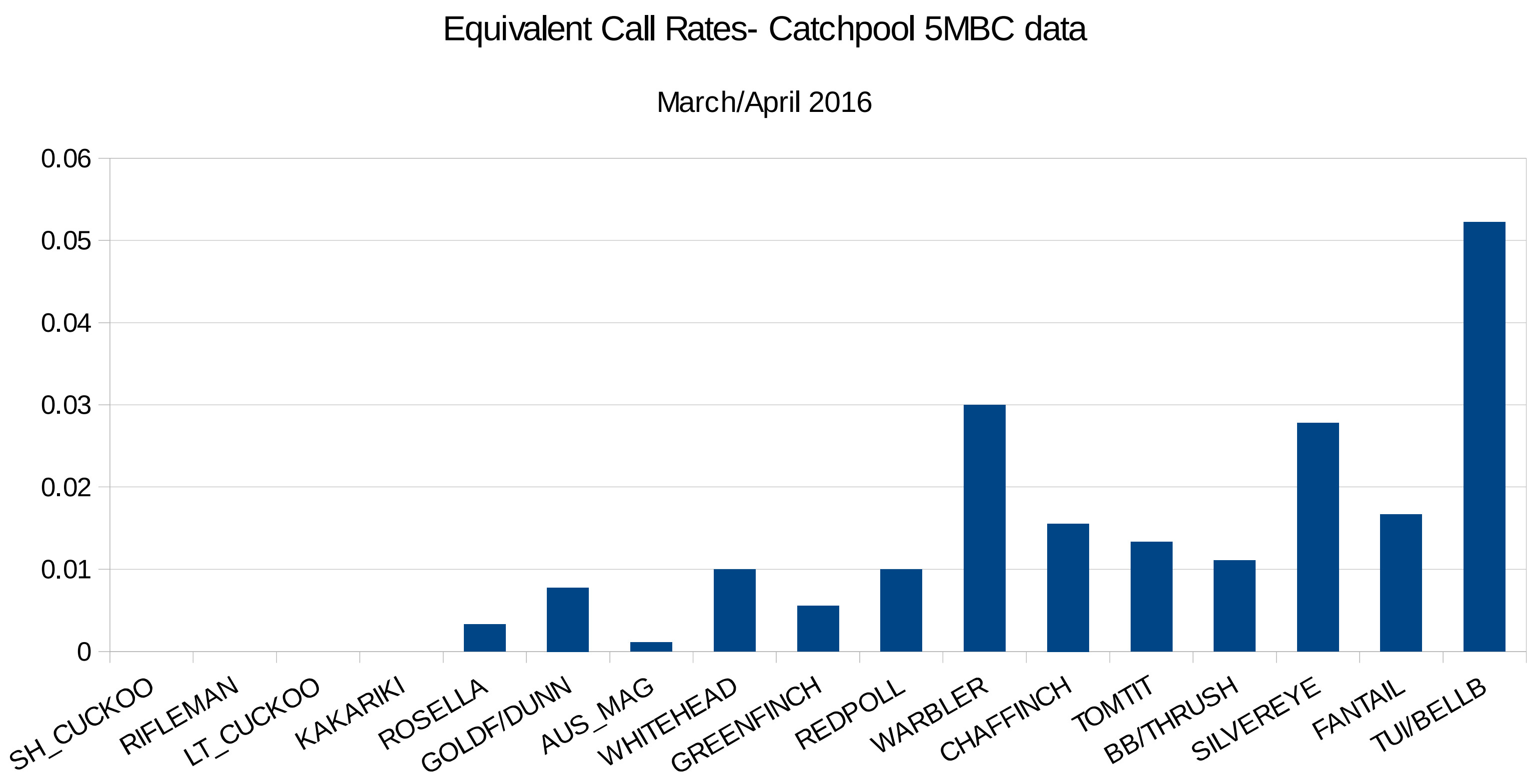
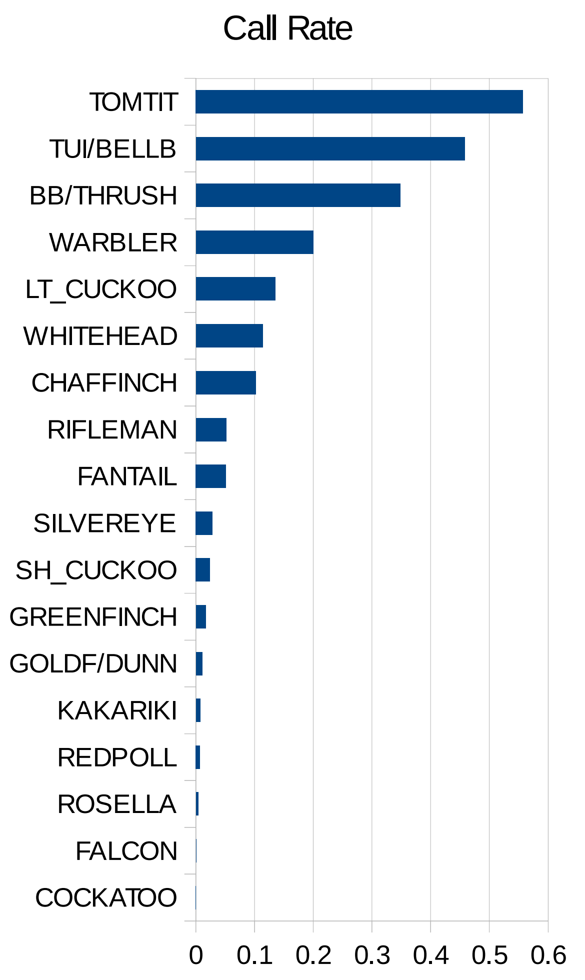
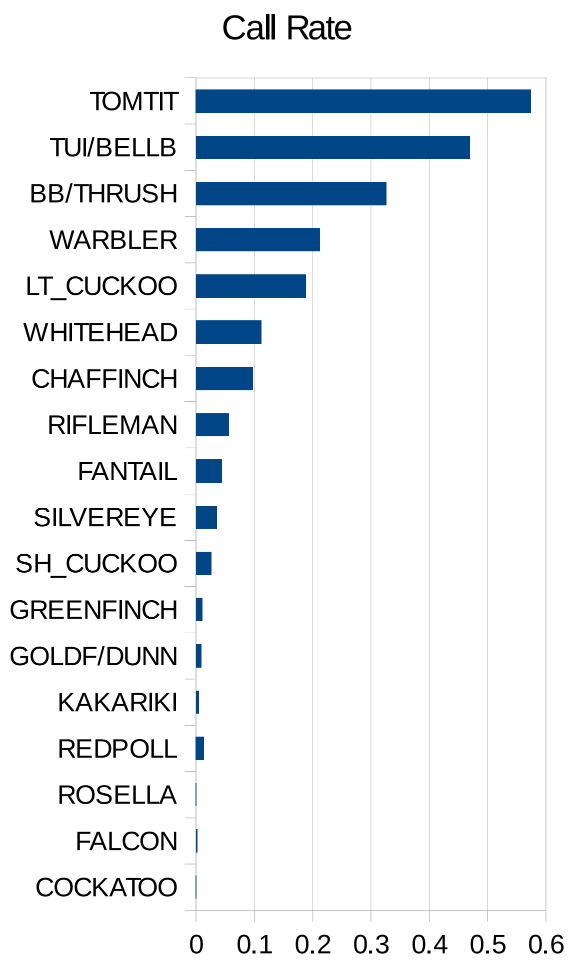


Figure B4. Call rate per species calculated from the 5MBC.

Appendix C: Comparison between acoustic monitoring summing all sites vs. only half the sites (Dec 2015-Jan 2016 survey)

We sampled 75 sites from 3rd December 2015 to 11th January 2016. To test how different our data would be if we only sampled half this number of sites, we show below the comparison in average call rates for 78 analyses (including 3 stations sampled twice) vs. 39 analyses. For the smaller sample, we deleted every second site in the table shown in Appendix A.





This makes little difference for the top 4 species recorded, but does significantly change call rates for: Long-tailed cuckoos, fantails, silvereye, greenfinches, kakariki, and redpoll.