Acoustic survey of the North Island Brown Kiwi population in the Remutaka Forest Park from 2011-2018

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Summary

From 2011 to 2018 the Remutaka Conservation Trust deployed acoustic recorders annually at up to 100 sites in the Remutaka Forest Park, in order to estimate the geographic spread and relative abundance of our introduced North Island Brown Kiwi population through time. Department of Conservation (DOC) AR4 recorders were used- mostly over the winter months- to record > 8 hours per night for 2 weeks at each site, throughout the park, with the number and spread of recorder locations increasing each year to keep up with the expanding boundary of the kiwi population. Early data were analysed using a filter developed by Dragonfly consulting, but since 2015, data were analysed using the Sound Exchange Software (SoX), with human examination and scoring of each spectrogram by hand in order to come up with a robust estimate of male and female presence/absence and call rates for each site. Some additional data from kiwi in the adjoining Wainuiomata Water Catchment were collected and analysed by Greater Wellington in 2018 and are also included here.

Results show that the kiwi population- initially introduced into the upper reaches of the Turere stream- have spread steadily through time, with kiwi calls now recorded from the northern boundary of the Wainuiomata Water Catchment (Greater Wellington block), to the Orongorongo River in the east, to the Orongorongo Track/Clay Ridge area, and the Boys Brigade in the west. Maximum call rates are located in the Turere catchment. Acoustic recorder data has been used to pinpoint breeding pairs and, in two cases, to actually locate incubation burrows to monitor breeding outcome.

Introduction

The Remutaka Conservation Trust's vision is a thriving forest ecosystem, rich in indigenous species, to be enjoyed by the wider community. Kiwi have not been historically recorded in the Park and are presumed to have died out prior to European records in the area (Fig. 1). Following our implementation of a comprehensive stoat trapping operation over > 40 sq km of the park (from 2003- present; Fig. 2), in 2006, the Trust released the first 8 North Island Brown Kiwi (*Apteryx mantelli*) sourced from the captive breeding population into the upper Turere stream. While a few more captive birds were released in subsequent years, in 2009 the Trust devised and carried out a catching expedition on Little Barrier Island which resulted in the introduction of a further 20 mixed lineage Brown Kiwi.

Our kiwi translocation proposal stated that we would monitor breeding outcome of the introduced kiwi with the goal to establish a self-sustaining population. Initially monitoring was via radio tracking of every single kiwi released plus their progeny, but by 2011, this intensive monitoring effort, carried out solely by volunteers, was becoming untenable; we were tracking over 50 kiwi, our population was breeding successfully and growing quite rapidly, and spreading into remoter parts of the Park.

With the removal of most of the adult kiwi transmitters in 2011, we have moved to less invasive monitoring techniques. Acoustic recording and call counts of adult kiwi calls is a well-established method for remote monitoring of kiwi populations (e.g., Miller and Pierce, 1995; Robertson and Colbourne, 2003, 2017; Colbourne, 2006). While a direct correlation between call rates and population density is not possible, call rates can give some indication of relative abundance (Robertson and Colbourne, 2017). In addition, since our population is entirely new and introduced at one geographic location into a large Forest Park with plenty of suitable habitat, we were interested to see how the population would spread out through time. Acoustic recorders can be used to detect kiwi calls on the outskirts of a population and thus to map the boundaries of the kiwi zone through time.

This brief report outlines the results from 7 years of acoustic monitoring for kiwi in the Remutaka Forest Park and the adjoining Wainuiomata Water Catchment. In 2011 we purchased out first 4 recorders, with a generous donation from Dragonfly Consulting of 4 more, giving a total of 8 recorders. At that time no suitable nation-wide protocol had been developed for data storage and metadata so we established our own protocol. With only 8 recorders, the data collected from 2011-2013 was limited to the tracks bounding the core kiwi release area. In 2014 we purchased an additional 10 recorders, and since then our recorder pool has grown to more than 30, allowing us to cover a larger area.

Recorders are placed on suitable trees (mostly near stoat traps on our track network, to make it easy to locate them and match with GPS coordinates) for 2 weeks recording for 8 hours per night, typically starting an hour after dusk with the exact time varying depending on the time of year. The bulk of our surveys were carried out from May to September each year although a few sites were recorded during the summer. The AR4s were set to record low frequency data (0-4 kHz) and downloaded onto external hard drives (2 drives per dataset, i.e. creating 2 backup disks in case of disk failure). The data from 2011-2013 were analysed using an experimental filter developed by Ed Abraham from Dragonfly Consulting. This creates a statistical dataset, scored and verified by humans, estimating call rates (kiwi calls per hour of data collected, excluding very noisy nights). It was found however, that the need to deliver large amounts of data back and forth from Wainuiomata to Wellington, and wait for the filter to be run, was too cumbersome. In 2014, we developed our own method to convert each wav file into a sonogram that could be rapidly viewed as an image file on a laptop computer. This used the Sound Exchange Software (SoX) on a Linux operating system to create image files. An entire night's files (15 minutes per file for 8 hours i.e. 36 files) could be scrolled through and scored within about 2 minutes, so that analysing one site takes about half an hour. While this is still a lot of work, it means that every files since 2014 has been analysed and scored by a human, so that we have a complete record of call rates and presence/absence of kiwi rather than a statistical sample. Like the earlier data, we excluded very noisy files from our call rate calculations, although we did process noisy files to check for kiwi calls when possible, so that we would have as complete an estimate as possible of where kiwi were calling for presence/absence plots.

The kiwi release area in the upper Turere stream is flanked by the McKerrow and Whakanui tracks. In 2011 we deployed recorders on these 2 tracks, plus some side ridges, and then expanded to cover a track network over > 40 sq. km by 2017. Site altitudes ranged from 73 to 702m with a mean altitude of 382m and a median of 410m.

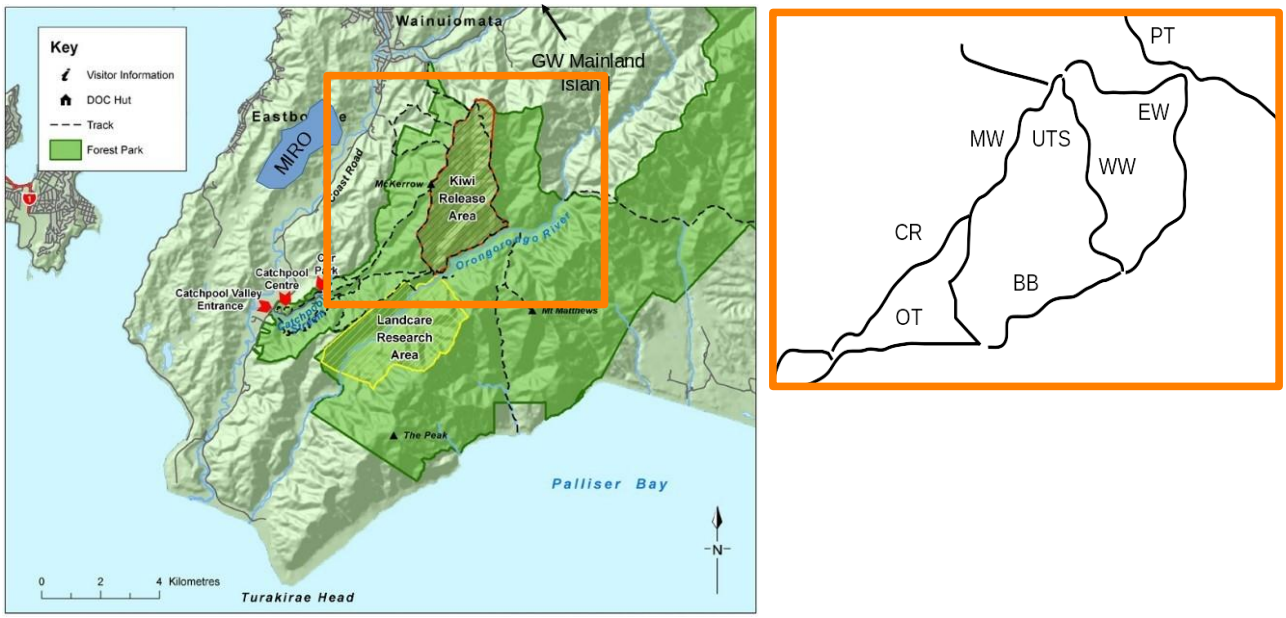

Figure 1. (Left) Location of the Remutaka Forest Park (green) showing kiwi release site from 2006-2009 (hatched region, Turere catchment). Also shown are the adjacent Wainuiomata Water catchment with Skull Gully mainland island area, and Mainland Island Restoration Organisation (MIRO) trapped zone in blue. (Inset) Line drawing of the main tracks and areas mentioned in text. UTS=Upper Turere Stream; MW = McKerrow Track; WW = Whakanui Track; EW = East Whakanui Track; PT = Pack Track; CR = Clay Ridge; OT = Orongorongo Track.

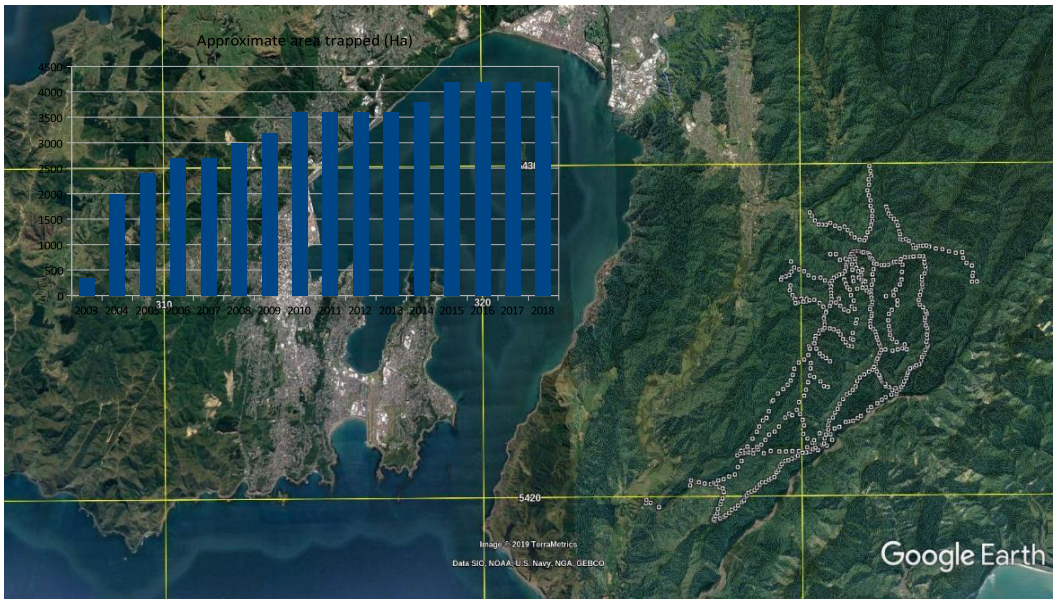

Figure 2. Location of DoC 200 stoat trap sites (white boxes) and plot showing approximate trapped area through time in the Remutaka Forest Park. Other traps (A24s, A12s, Trapinators) not shown. Yellow grid shows 10 km spacing (NZTM).

Results

We first show kiwi presence/absence plots through time (Fig. 3). These are presented as a series of time snapshots, where data from 2011-2013, 2014-2015, and 2016-2017 has been amalgamated, since it was not possible to collect data all around the network in any one calendar year. We did not collect data in 2016.

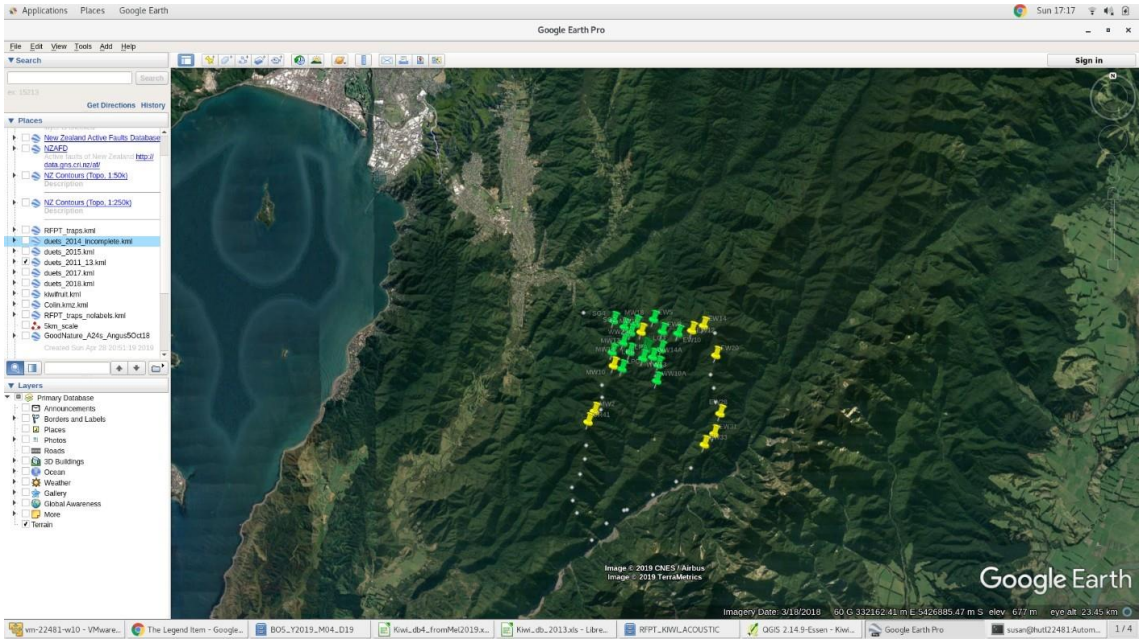

Figure 3(a). Presence/absence results for amalgamated data 2011-2013. Yellow= single (male or female) kiwi calls present, green=duets present, white=measured, no calls.

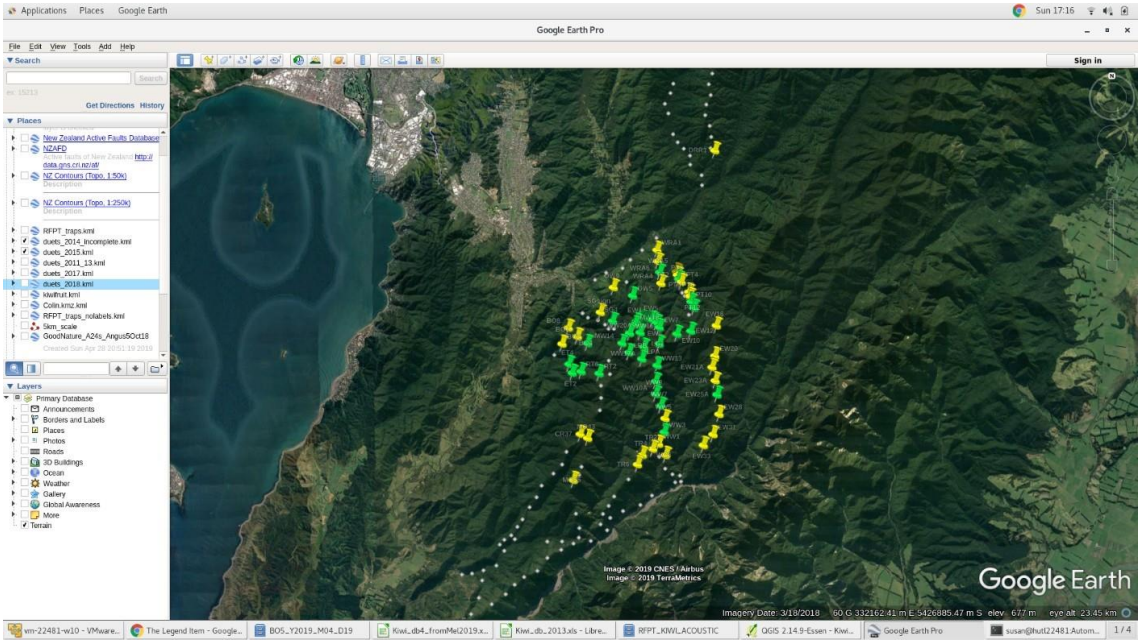

Figure 3(b). Presence/absence results for amalgamated data 2014-2015. Yellow= single (male or female) kiwi calls present, green=duets present, white=measured, no calls.

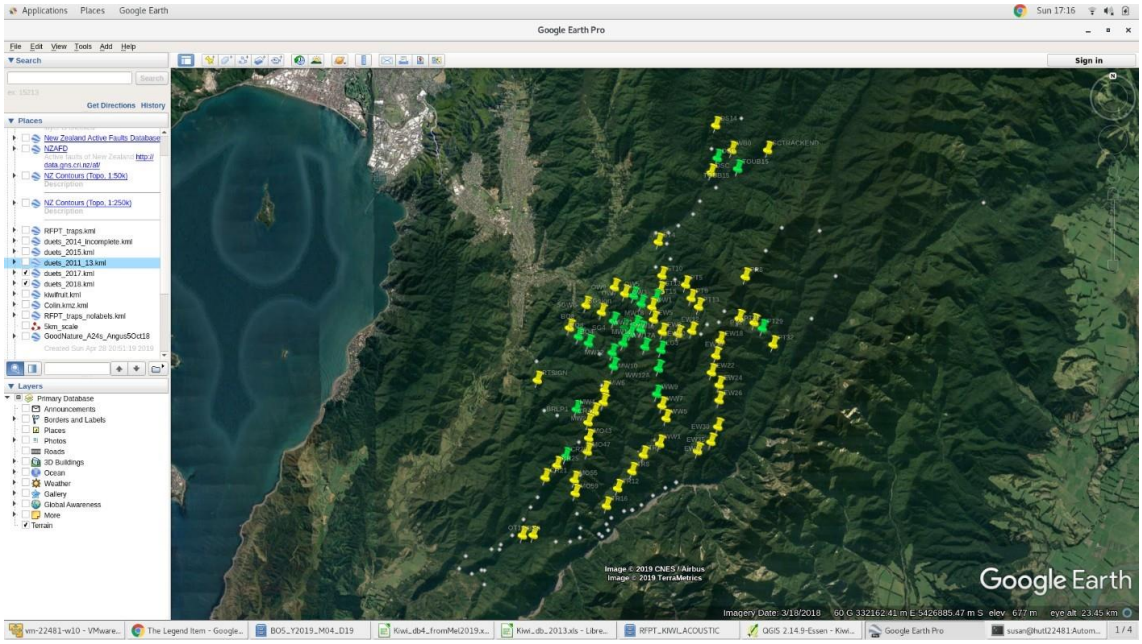

Figure 3(c). Presence/absence results for amalgamated data 2017-2018. Yellow= single (male or female) kiwi calls present, green=duets present, white=measured, no calls.

Results show how kiwi call distribution has spread through time from the initial release site. Kiwi have spread south along the McKerrow, Whakanui and East Whakanui tracks, so that calls have now been picked up along the Orongorongo Track, Big Bend track, and Clay Ridge track. At the same time, kiwi calls in the Pack Track region of the Water Catchment- initially because of the establishment of 1 breeding pair (Colin and Kiwifruit) near the start of the track- have spread southward almost to the water intake on the Orongorongo River. And notably, kiwi have settled in the vicinity of the Greater Wellington mainland island at Skull Gully (aided by release of a few of our “operation nest egg” juvenile kiwi into this region).

Note that there are some issues with the data presented in Fig. 3- in particular, the call data in 2011-2013 may have underestimated kiwi range because we did not collect data to the west of the McKerrow track. However, until 2011 we were tracking all adult birds, and the distribution in Fig. 3(a) matches quite well the GPSed bird locations from radio tracking, giving us confidence that the acoustic data is robust (see Fig. 5). Fewer duets were recorded in 2017-18 than in 2014-16 over the north-east part of the Turere catchment. We think this is a function of (1) less sites collected within the Upper Turere catchment (between the McKerrow and Whakanui tracks) for the later survey; and (2) differences in date of collection for the sites along the Whakanui and Lost Glenys tracks. Kiwi duets are most common during breeding season (April-June) rather than later in the winter. There will also be some variability from year-to-year. Nevertheless the spread in call area through time is encouraging.

The same data plotted in terms of average call rates per hour in the main kiwi area (Fig. 4) show that in 2011-2013, the highest call rates were located at site LPB which is very close to the 2006 release site. Subsequent years show high call rate areas spreading to the entire upper Turere stream catchment, with local hotspots along the Sunny Grove track, Big Bend track, and Pack Track- although the call rates are not monotonically increasing, possibly because of the different collection periods in each year discussed above, and/or because of variability in the locus of kiwi activity and territories vs. location of the recorders over time.

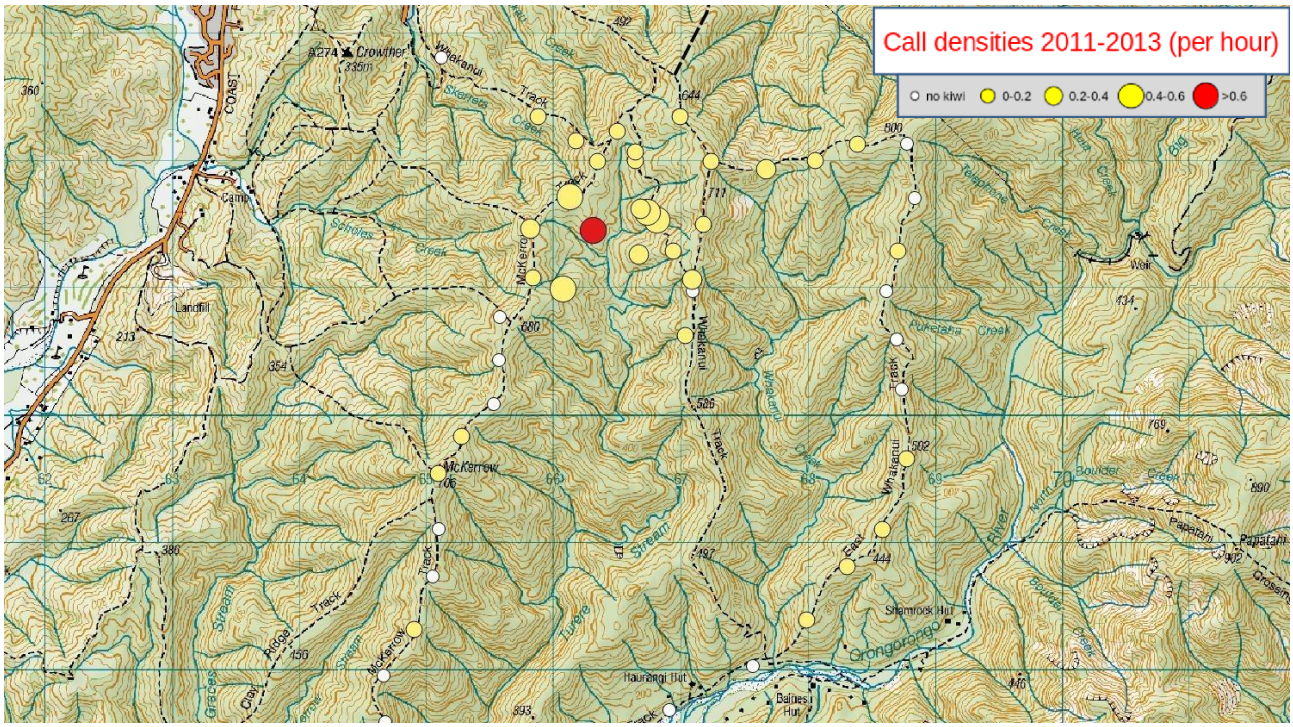

Figure 4(a). Call rates (average calls per hour of non-noisy data collected) for the time period 2011-2013. Only the main Remutaka Forest Park kiwi area is shown.

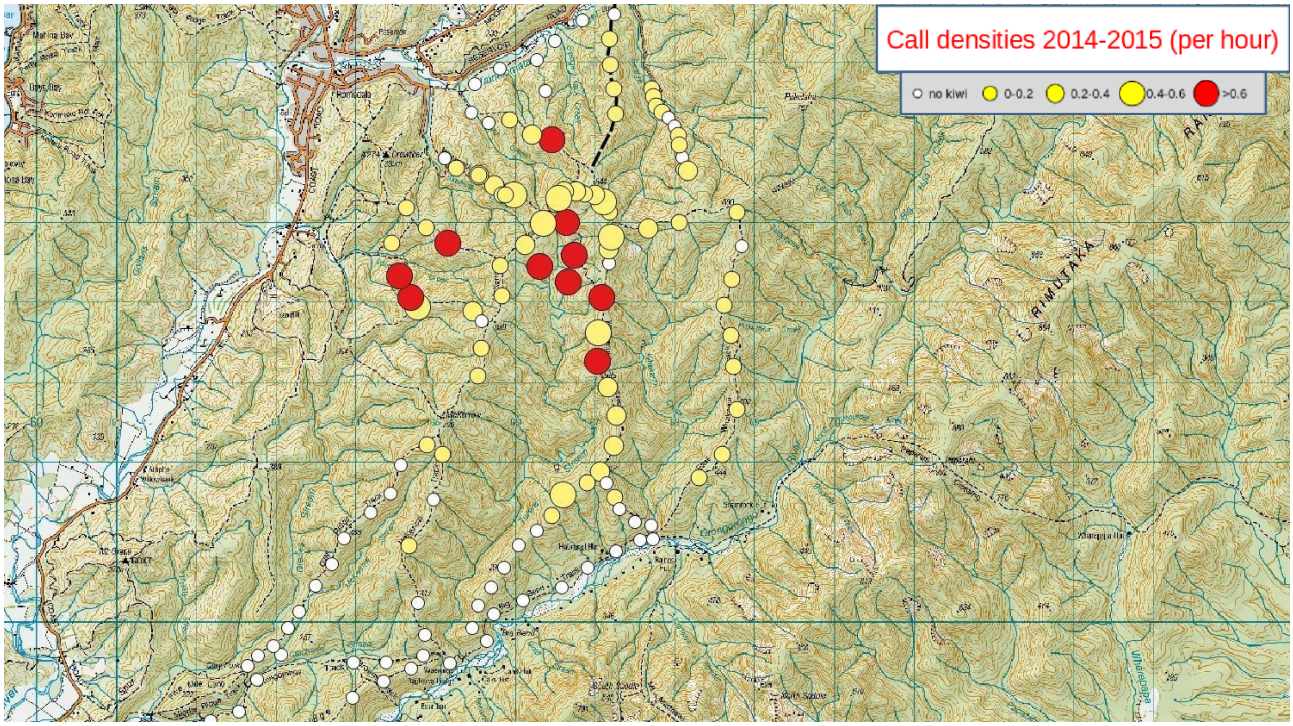

Figure 4(b). Call rates (average calls per hour of non-noisy data collected) for the time period 2014-2015.

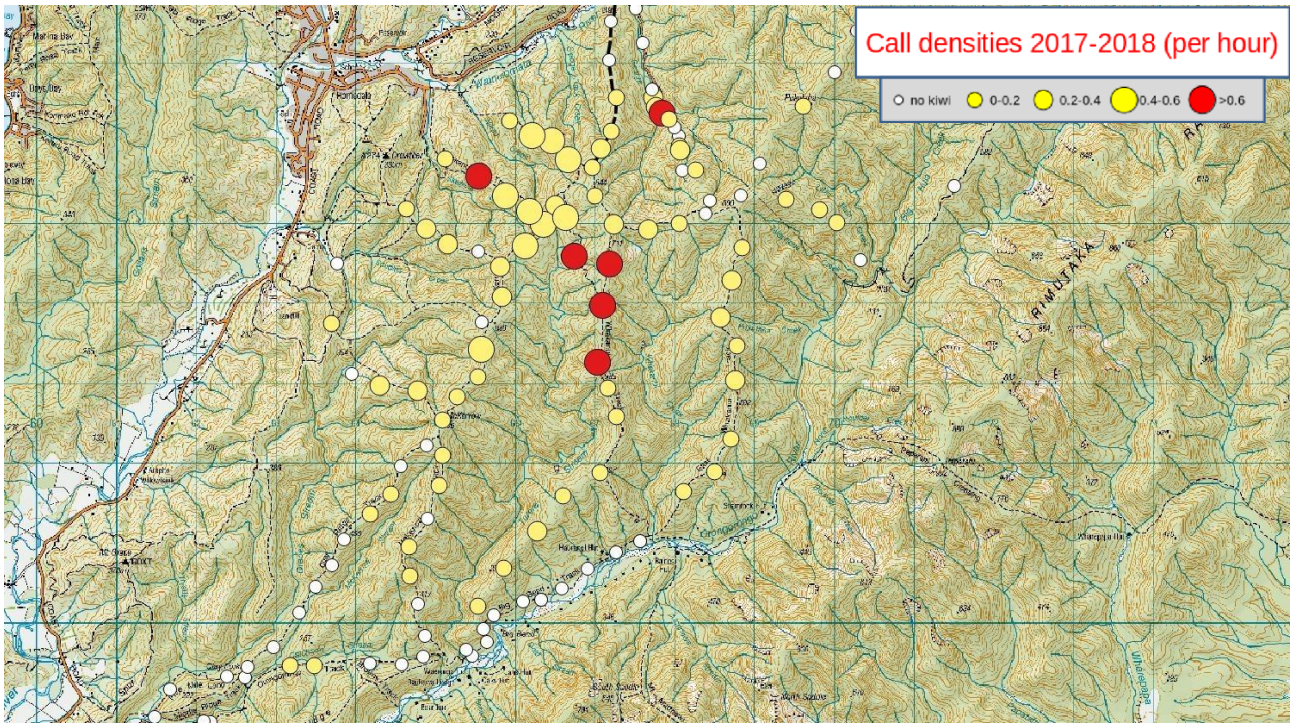

Figure 4(c). Call rates (average calls per hour of non-noisy data collected) for the time period 2017-2018.

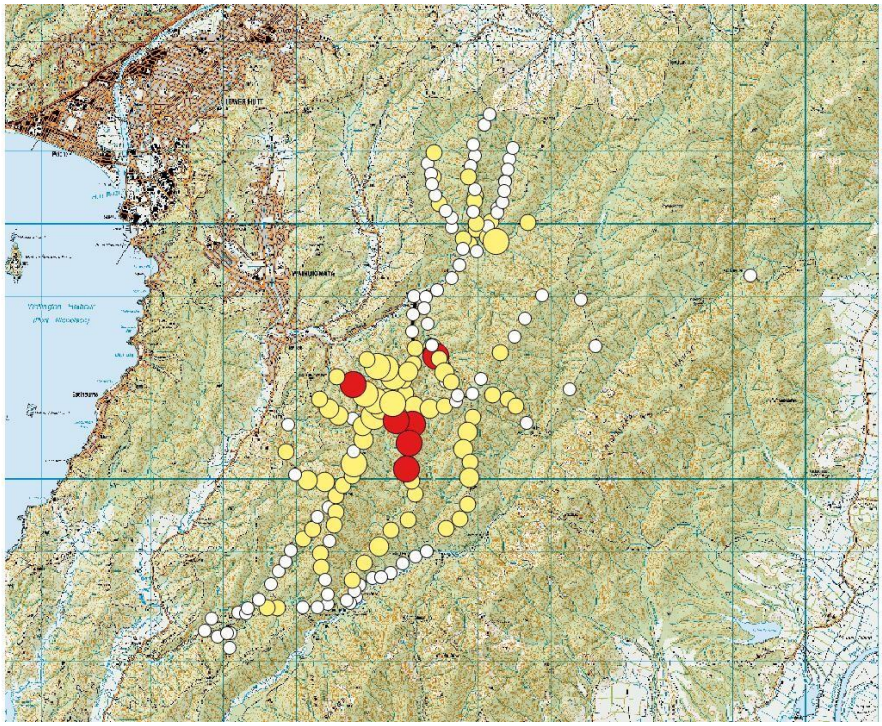

Figure 4(d) Call rates for 2017-2018 at larger scale showing spread into Greater Wellington catchment.

The data we had collected from 2009-2010 (shortly before all radio tags were taken off our population) has given us the chance to compare ranges estimated from acoustic recorder data 1-3 years later, with a known population range from radio tracking (Figure 5). This shows, in general, reasonable agreement between kiwi detected from calling and those mapped from tracking. The acoustic recorders are a rather conservative method for estimating kiwi presence compared with radio tracking, since juvenile kiwi and chicks do not call; and a low density population has less

chance of being picked up by the sparse recorder network in a given 2 week period. As expected, the call distribution is slightly contracted compared with the tracking data distribution.

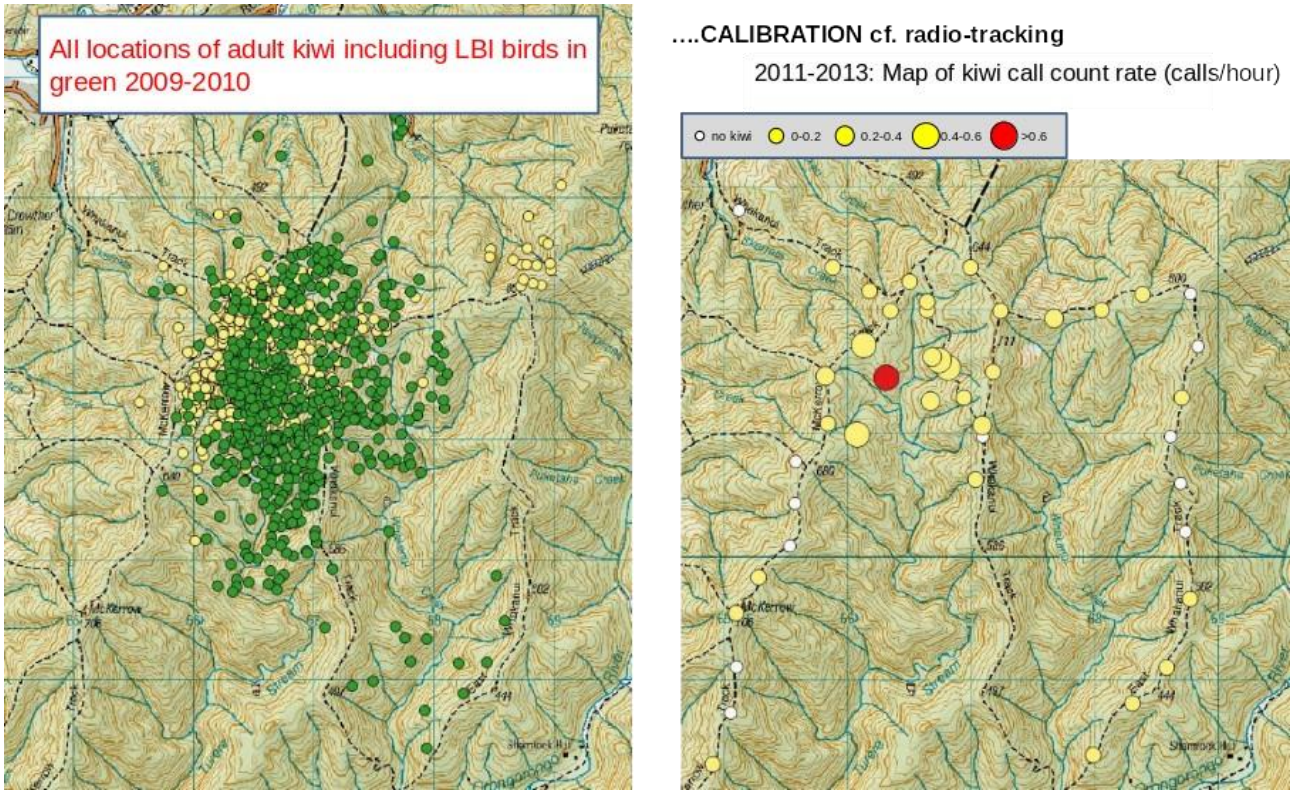

Figure 5. Comparison of 2 different monitoring techniques for a similar time period in the Remutaka Forest Park. Left panel: all locations determined by radio tracking data from 2009-2010 for the entire population of adults, subadults, juveniles and chicks in the park, including released birds, their O.N.E. progeny, and natural-hatch progeny. Right panel: 2011-2013 call rate distribution from this work.

Conclusions

The acoustic monitoring of North Island Brown Kiwi in the Remutaka Forest Park and adjacent water catchment demonstrate that the kiwi range is spreading through time. This spread is occurring around a central region with high call rates that is close to where the original kiwi were released. As such the establishment of a new kiwi population into a previously uninhabited region seems to obey Hugh Robertson's "Fear of silence" theory, where in general, new breeding pairs form around the outskirts of existing home ranges of breeding pairs. However, both the radio tracking data and the acoustic data shown here point to a modification to this theory where occasionally, a wandering pair will establish away from the existing call boundary (e.g., Colin and Kiwifruit who set up a home range at the start of the Pack Track, more than a km away from most of the other kiwi).

Our acoustic monitoring of brown kiwi in the Remutaka Park and adjacent water catchment land is ongoing. We did not collect distribution data in 2019 but are planning another park-wide survey in 2020, and every 2-3 years thereafter. Meanwhile, we have been refining our acoustic monitoring techniques, and in August 2019-January 2020 we used acoustic monitoring to document the home range and breeding success of two kiwi pairs in the Wainuiomata Water Catchment, locating their incubation burrows solely using night-time call bearings and acoustic recorders (that study will be reported in detail elsewhere). Such results are encouraging, both for the growth of our population through time and for the use of acoustic monitoring to assess population health.

Acknowledgements

This study could not have been carried out without the perseverance, dedication, and hard work of over 100 volunteers within the Remutaka Conservation Trust. We would like to thank them for trapping, kiwi monitoring, acoustic data collection, and organisation of the kiwi project over the past 17 years. We acknowledge Peter Cooper for initiating the acoustic recording programme in 2011, and the support and advice of Ed Abraham early in our study with establishment of metadata protocols, help in the field, and providing us with access to his kiwi call filter. Greater Wellington funded additional data collection and analysis in their region in 2018. Lastly, we would like to thank the Department of Conservation for technical advice, and particularly the DOC electronics lab (Stu Cockburn and Steve McKevitt) for their assistance in helping maintain our AR4 recorders. This study was funded by donations to the Remutaka Conservation Trust and by a DOC community fund via the Remutaka Conservation Trust "Join the Dots" project.

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