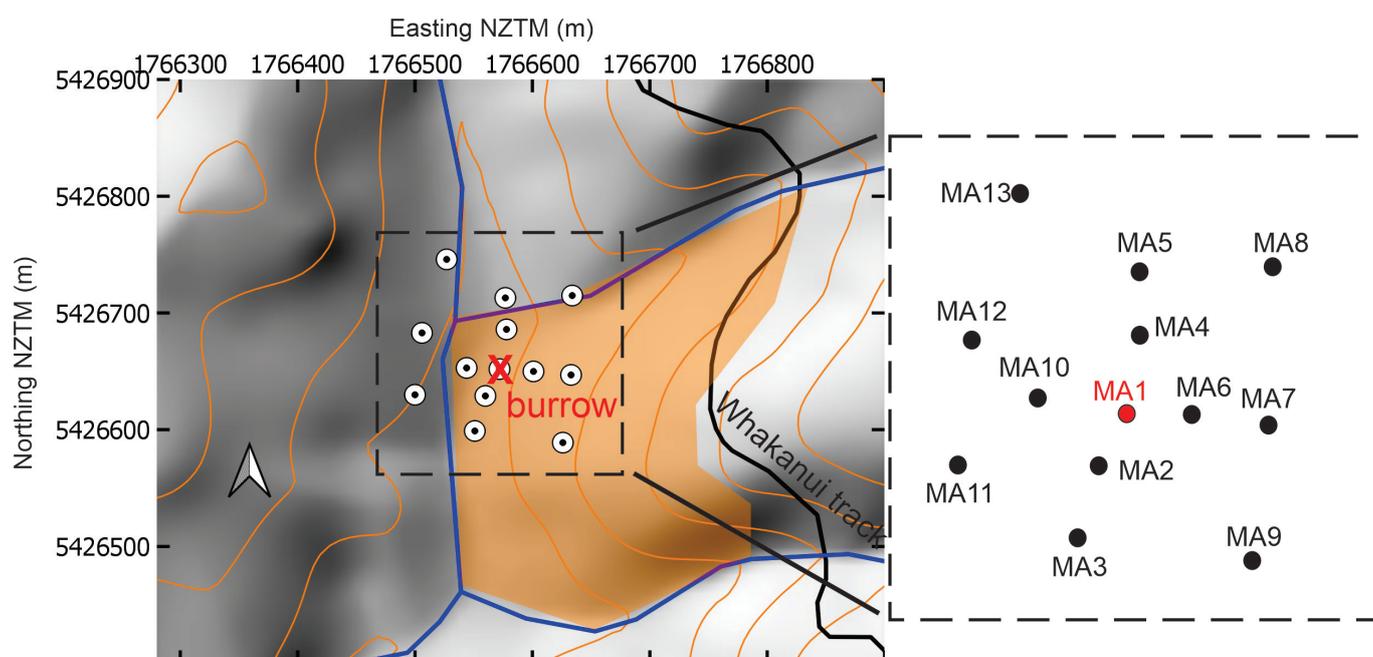


Supplementary Materials

Appendix S1. Layout of the control experiment (Marcel, December 2019–February 2020): Layout and location of the ARU grid around Marcel’s incubation burrow in the Upper Turere Stream, Remutaka Forest Park (20 December 2019–15 February 2020). The red cross indicates the location of the incubation burrow (known from radio tracking) which is the centre of the ARU grid. White circles with dots are ARU locations, with stations labelled in expanded view at right (burrow location with ARU and trailcam at station MA1 indicated in red). Ticks on boundaries indicate 100 m spacing (NZTM coordinates), and contour spacing is 25 m.



Appendix S2. Summary of nights observed of the control experiment (Marcel, December 2019-February 2020).

Survey effort	<i>n</i> (%)
Total number of nights observed with trailcam and ARUs	55
Number of noisy nights where ARUs unable to be analysed	7
Number of calm nights with no calls recorded during ARU recording interval	10
Total number of nights with no call detectable on ARU*	17
Total number of nights for which call times analysed (% of total)	38 (69)

*For the nights where no call was detected, the burrow trailcam recorded Marcel leaving the burrow on 13 nights (but not on the remaining four nights)

Appendix S3. Overview of the control experiment (Marcel, December 2019–February 2020).

Summary	<i>n</i> / time
Nights observed leaving burrow on trailcam	44
Nights ARU recorded first call	38
Nights with both first call (ARU) and trailcam exit recorded	38
Average time Marcel spent “gardening” within 1 m of burrow	3 min 20 secs
Nights where Marcel called less than 10 minutes after leaving burrow vicinity (i.e. after gardening)	23
Nights where Marcel called less than 5 minutes after leaving burrow vicinity	22

Appendix S4. Summary of causes for the seven nights with insufficient information for analysis of the control experiment (Marcel, December 2019–February 2020).

Date	Too noisy to analyse ARU	Analysed, but no call detected during ARU recording period	Trailcam did not record Marcel leaving burrow
23/12/19	X		
24/12/19		X	
26/12/19		X	
27/12/19	X		
29/12/19	X		
2/1/20	X		
9/1/20		X	
11/1/20	X		
12/1/20	X		
19/1/20		X	
25/1/20		X	X
27/1/20		X	
28/1/20		X	
3/2/20	X		
4/2/20		X	X
5/2/20		X	X
8/2/20		X	X
TOTAL	7	10	4

Appendix S5. Outline of the procedure used to estimate distance travelled by Marcel from the incubation burrow for each call.

Step 1. Before deployment, we ensured each ARU was calibrated i.e. produced similar amplitudes for a test call when no noise was present and had a similar noise floor. If not, the ARU was rejected, and another ARU was substituted.

Step 2. Six nights had first calls that were clearly close to an ARU (within 5 metres, including footsteps before and after the call; see Appendix S6). We used five of these as known source locations for estimating an approximate relationship between amplitude and distance (Appendix S7).

Step 3. We used the linear relationship between distance and amplitude derived in Step 2 to calculate the distance to the source for all remaining nights with calls. Appendix S8 shows an example for the night of 10 January 2020.

We plotted circles around each ARU station on the map (in NZTM) to determine where they intersected (Appendix

S9). Owing to the considerable uncertainty in the amplitude-distance relationship (see discussion in the main paper) each intersection pair is in a slightly different location. We chose a best-fit source and estimated uncertainty based on the misfit between different intersecting pairs of circles.

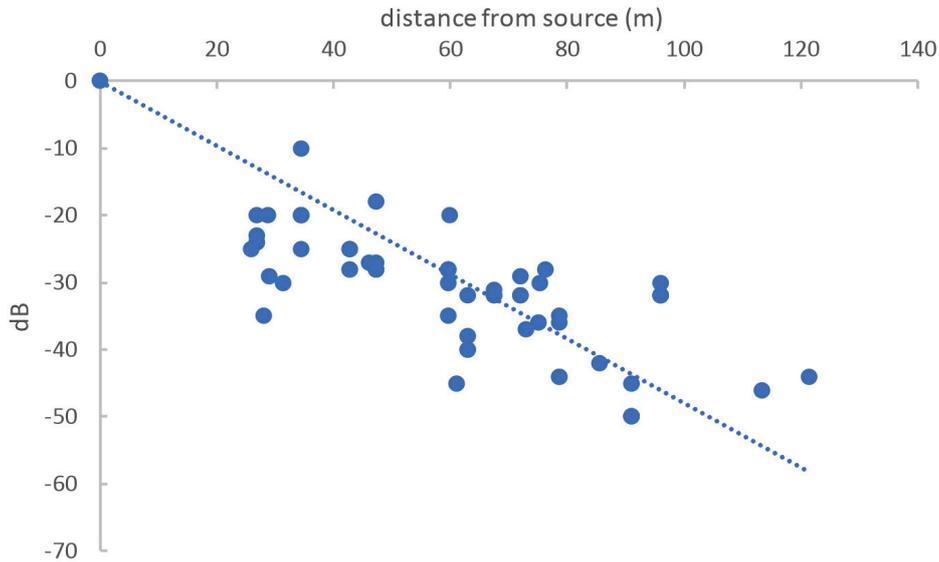
Using this method for each call, we plotted the estimated distance and uncertainty of each source location from Marcel's burrow vs. the time difference between leaving the burrow and calling, to arrive at Fig. 4 in the main article. These plots were used to compare source locations estimated from triangulation for calls within 10 minutes of Marcel leaving his burrow, compared to calls > 10 minutes after he left his burrow (Appendix S10). This demonstrated that geographic barriers (streams) influenced his path, but also that the nights where he called a long time after leaving his burrow (grey triangles) were always further away from the burrow location at MA1 compared with the calls < 10 minutes after leaving his burrow. The later calls also had more spread in their locations.

Appendix S6. Summarising six nights of activity that had calls very close to an ARU.

Date	Time of call (NZDT)	Close to	Peak amplitude (relative dB*)	Footsteps before or after call
31/12/19	21:37	MA4	-2	Yes
3/01/2020	22:44	MA4	0	Yes
4/01/2020	23:00	MA2	0	Yes
16/01/2020	22:08	MA4	0	Yes
20/01/2020	22:59	MA4	0	Yes
10/02/2020	22:46	MA1	-10	Yes

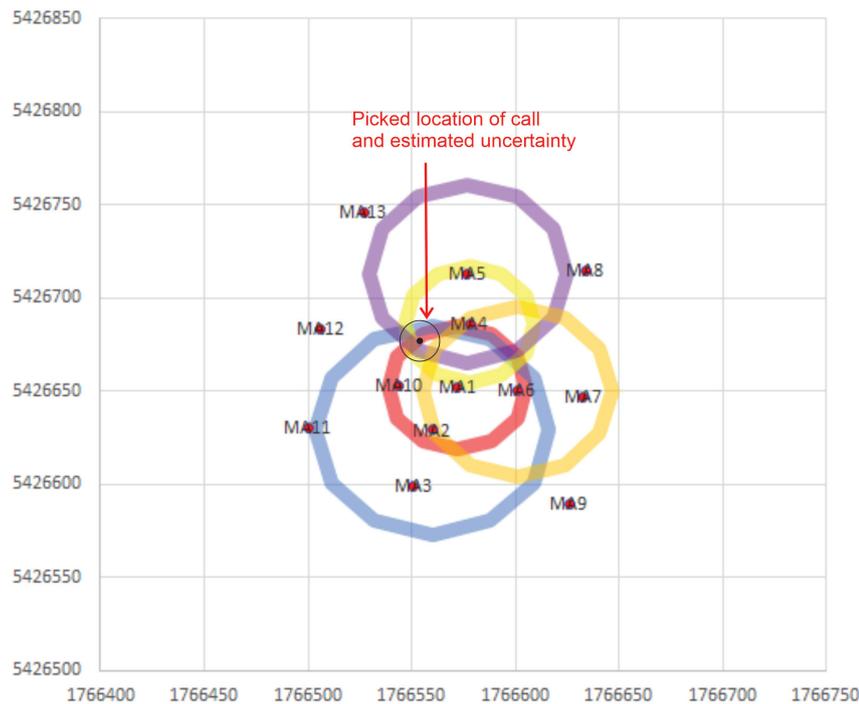
*Estimated using the Audacity software; in Audacity, decibels are measured relative to the "full scale" reading, that is the height of a track, indicated as ± 1.0 . A full-scale signal has a peak amplitude of 0 dB, and (to the human ear) sounds like the kiwi is calling right next to us. Some of the readings were so loud they were clipped. The call on the 10 February was quieter (though the bird was within 5 m of the ARU based on rustling/footsteps before and after) so was not used in the calibration.

Appendix S7. Linear fit to dB vs. distance from source based on amplitudes at each ARU station and distance from the source on the 5 nights used from Appendix S6. The best-fit linear regression had $R^2 = 0.25$ and distance = $-2.08 \times (\text{dB})$



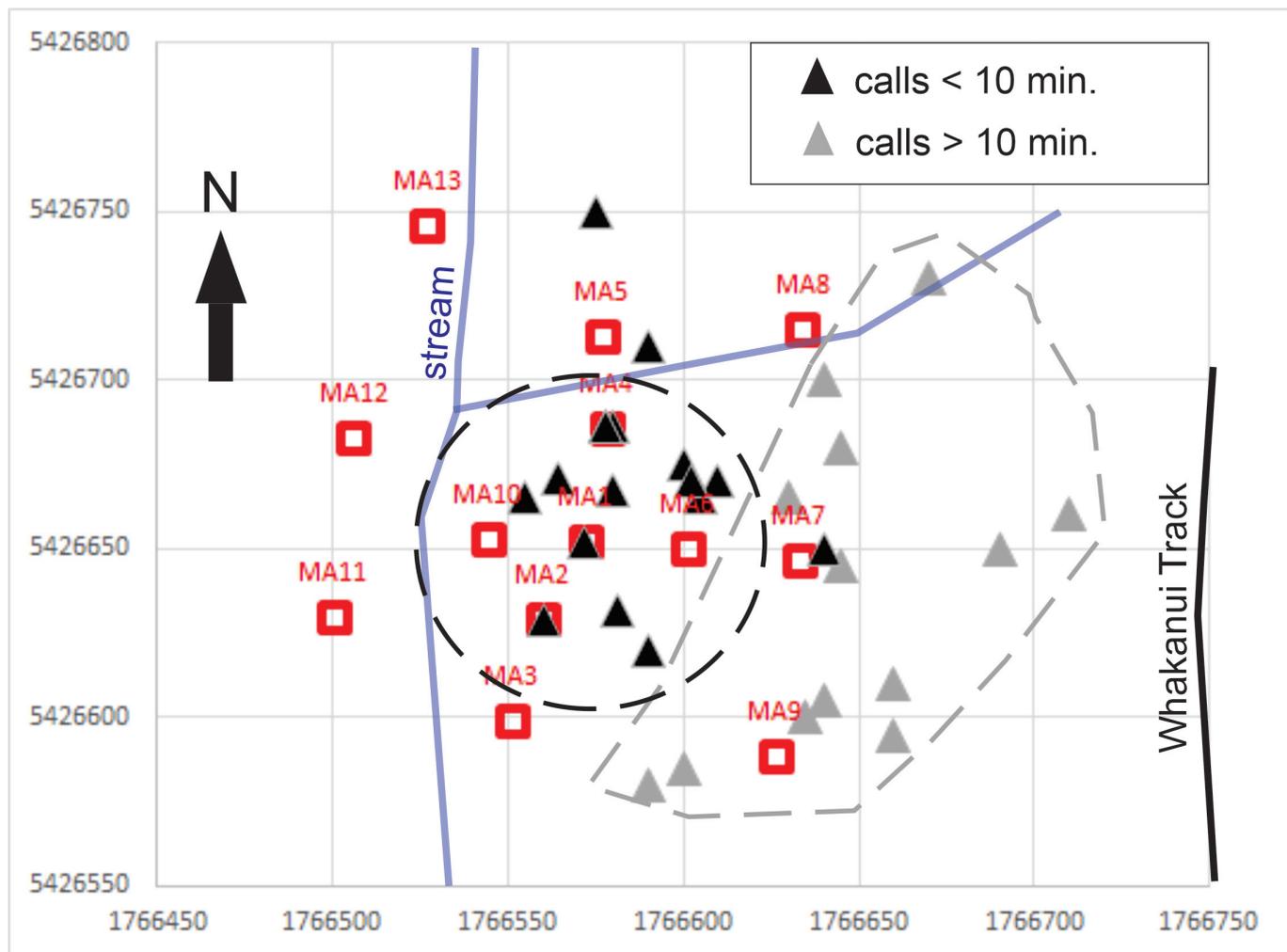
Appendix S8. Distances to source calculated for the night of 10 January 2020 from nearby ARU stations, using the linear relationship between amplitude and distance derived in Step 2 (Appendix S5).

ARU station	dB (audacity)	Calculated distance to call
MA1	-10	21
MA2	-25	52
MA4	-20	42
MA5	-26	54
MA6	-25	52

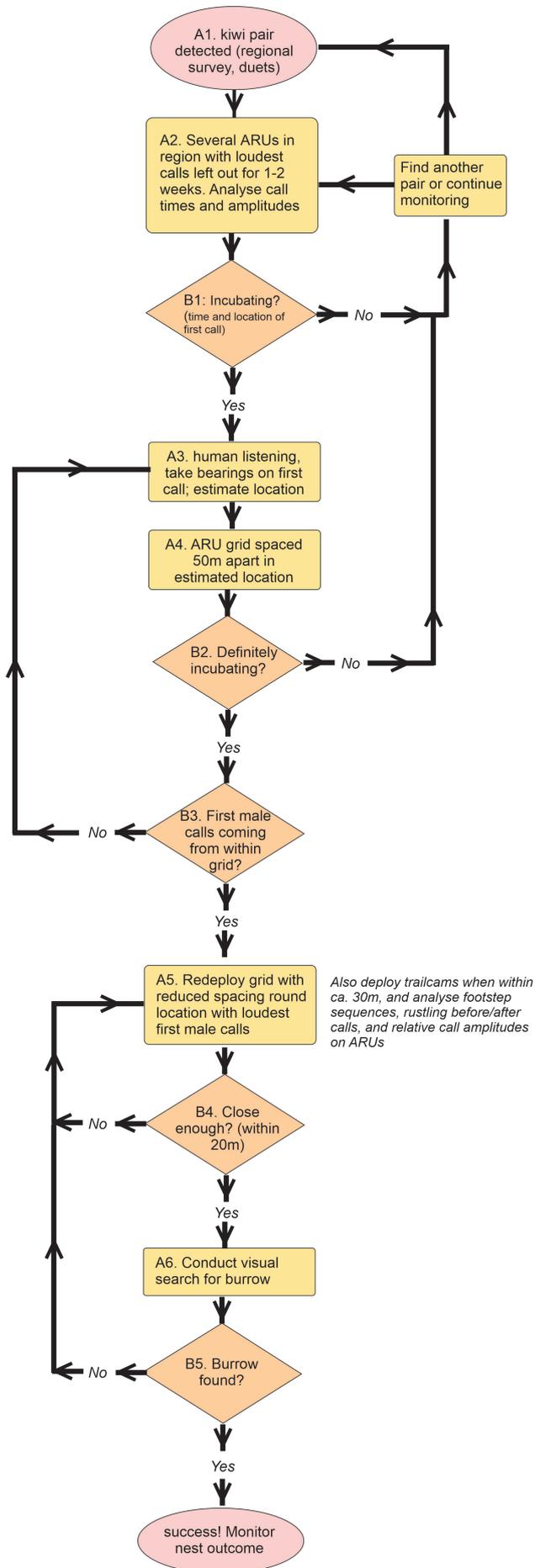


Appendix S9. Triangulation plot for the night of 10 January 2020 with coloured circles showing estimated distance to Marcel's first call of the evening from nearby ARU stations using the formula distance (metres) = $-2.08 \times$ amplitude (dB). The thin black circle with a central black dot indicates the probable location of the call and its uncertainty (for this call, ca. 15m), based on the slight mismatch between multiple intersection points.

Appendix S10. ARU stations (red labelled boxes), calls < 10 minutes after leaving burrow (black triangles; 50m radius around burrow outlined with dashed black circle) and > 10 minutes after leaving burrow (grey triangles; call area outlined with grey dashed polygon).

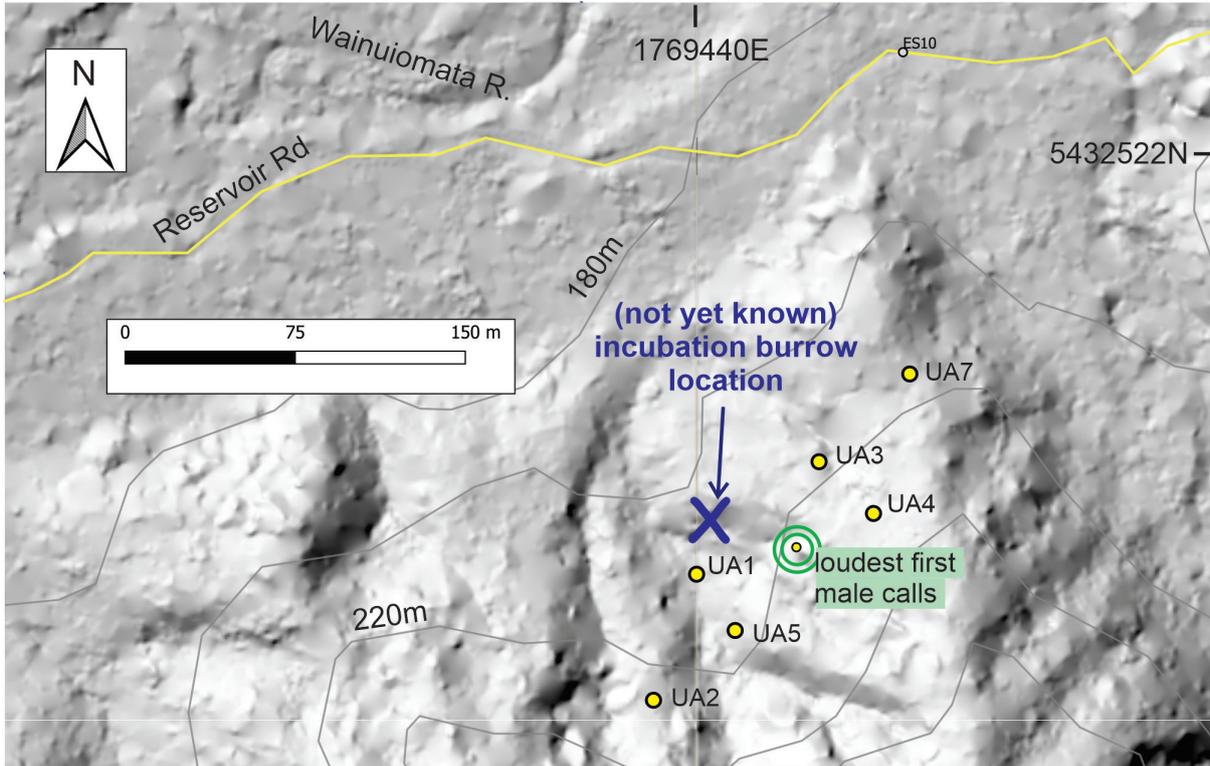


Appendix S11. Enlargement of flowchart of method to locate kiwi burrows using remote monitoring.

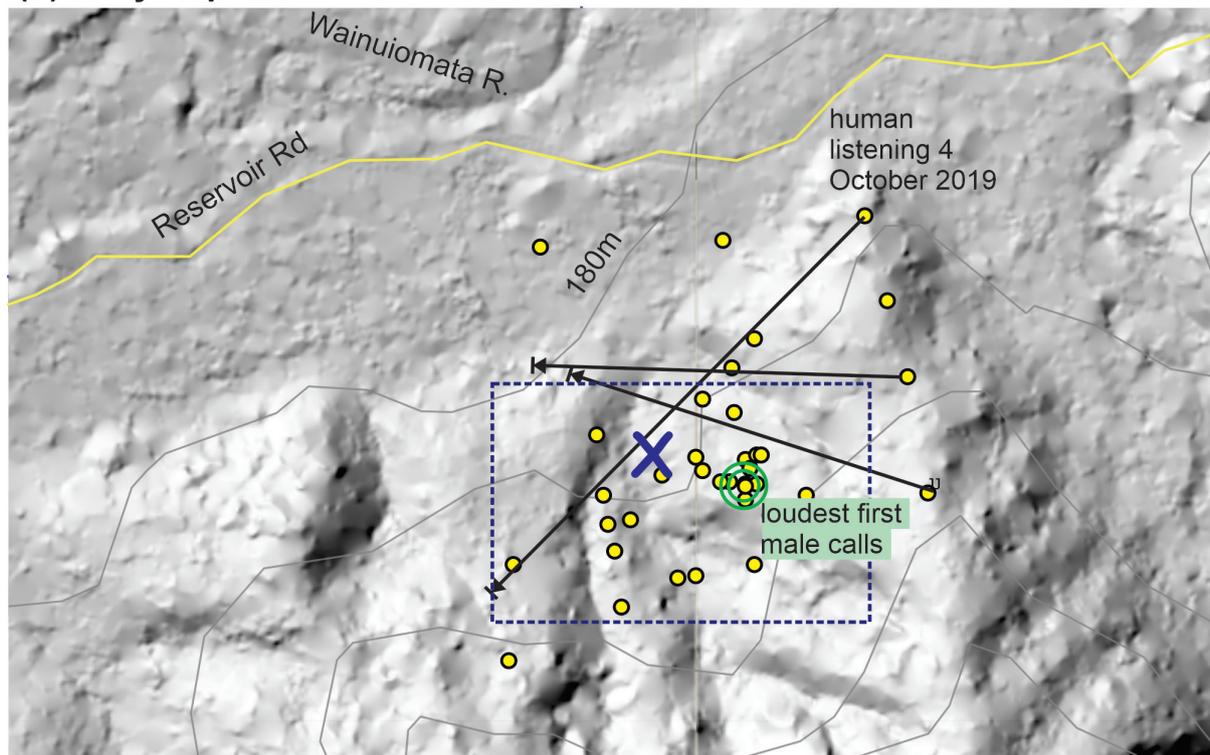


Appendix S12. Successful trial R1, Rātā’s incubation, September to November 2019. (a) Initial deployment of 7 ARUs from late August to early September 2019. Flowchart steps A2 and B1. Concentric green circles show location of loudest calls. Background hill shading from 1m DEM lidar data (<https://data.linz.govt.nz/layer/53621-wellington-lidar-1m-dem-2013-2014/>). For reference, the eventual located burrow (then unknown) is shown by the blue X. (b) Flowchart steps A3 to A5: revised and closer spacing of ARUs around location of calls plus human listening (bearings indicated by black arrows). The blue dashed box in (b) outlines the closeup in (c).

(a) late August- early September 2019

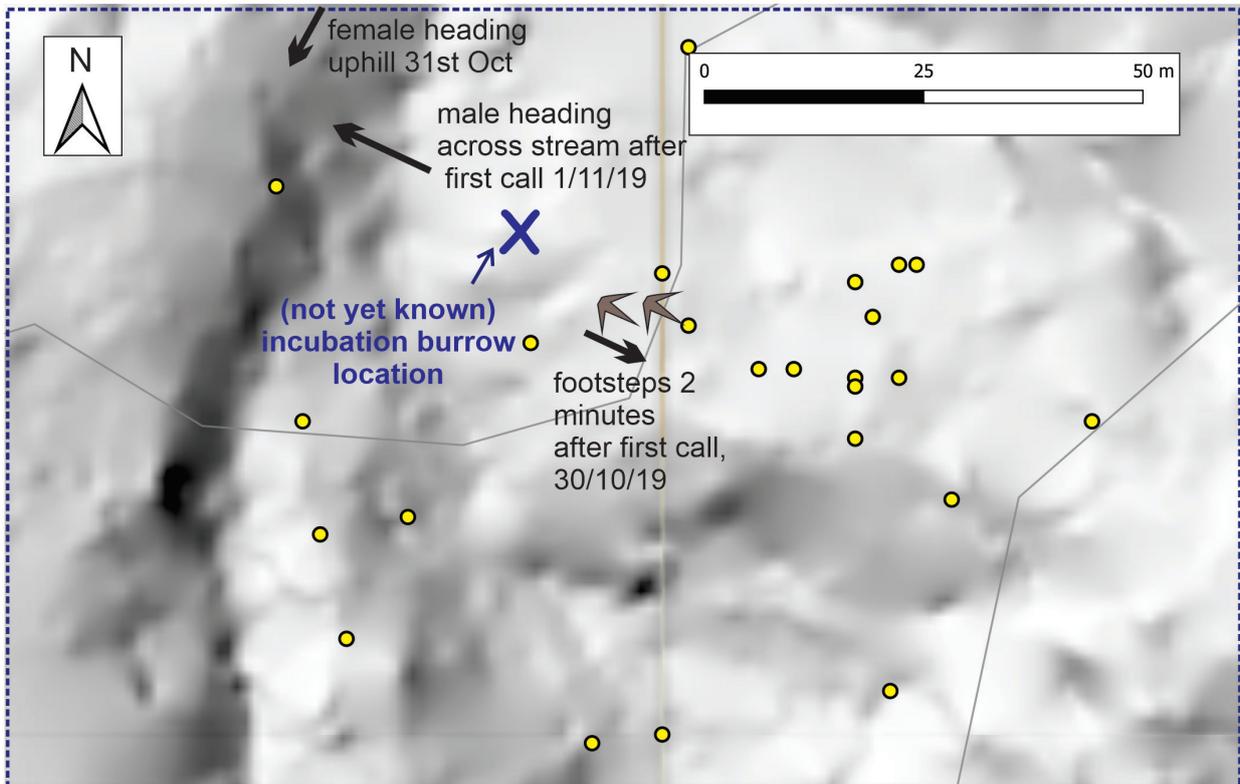


(b) early September- end October 2019

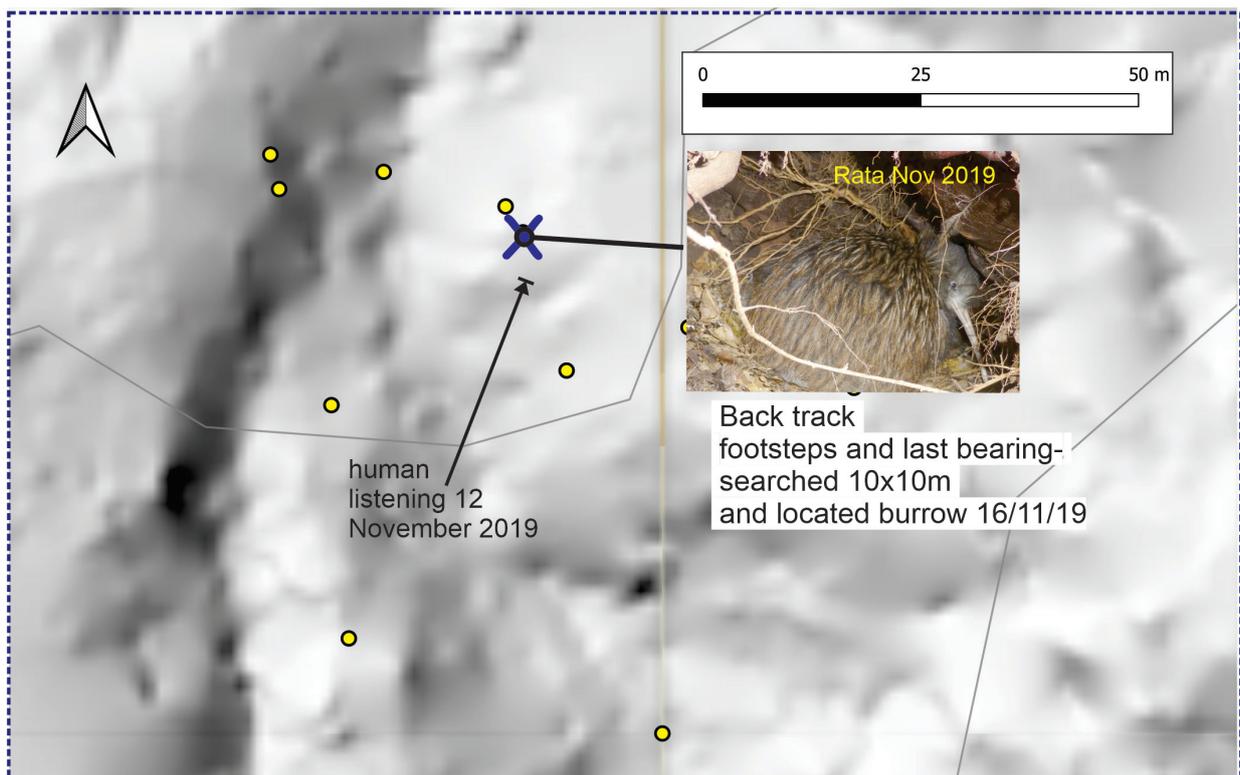


Appendix S13. Trial R1, Rātā’s incubation, September to November 2019. (c) Directions of movement of kiwi from trailcam footage (black arrows) and footsteps just after the first call in the evening (brown footprint icon). (d) The next iteration from the beginning of November 2019, with the successful location of the burrow on 16 November 2019 (steps A5 to B5 on the flowchart). One bearing from human listening was taken during this time and helped narrow the search. Photo shows a snapshot of Rātā in his burrow taken on the day of success.

(c) closeup- early September- end October 2019

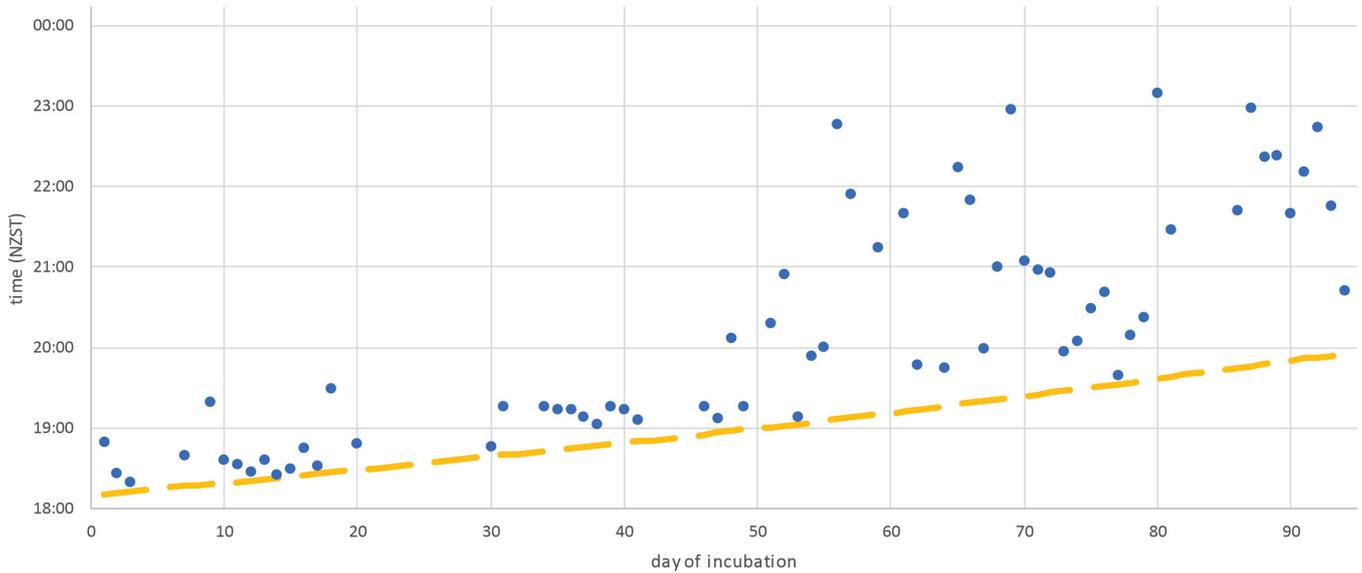


(d) start of November-16 November 2019- success!



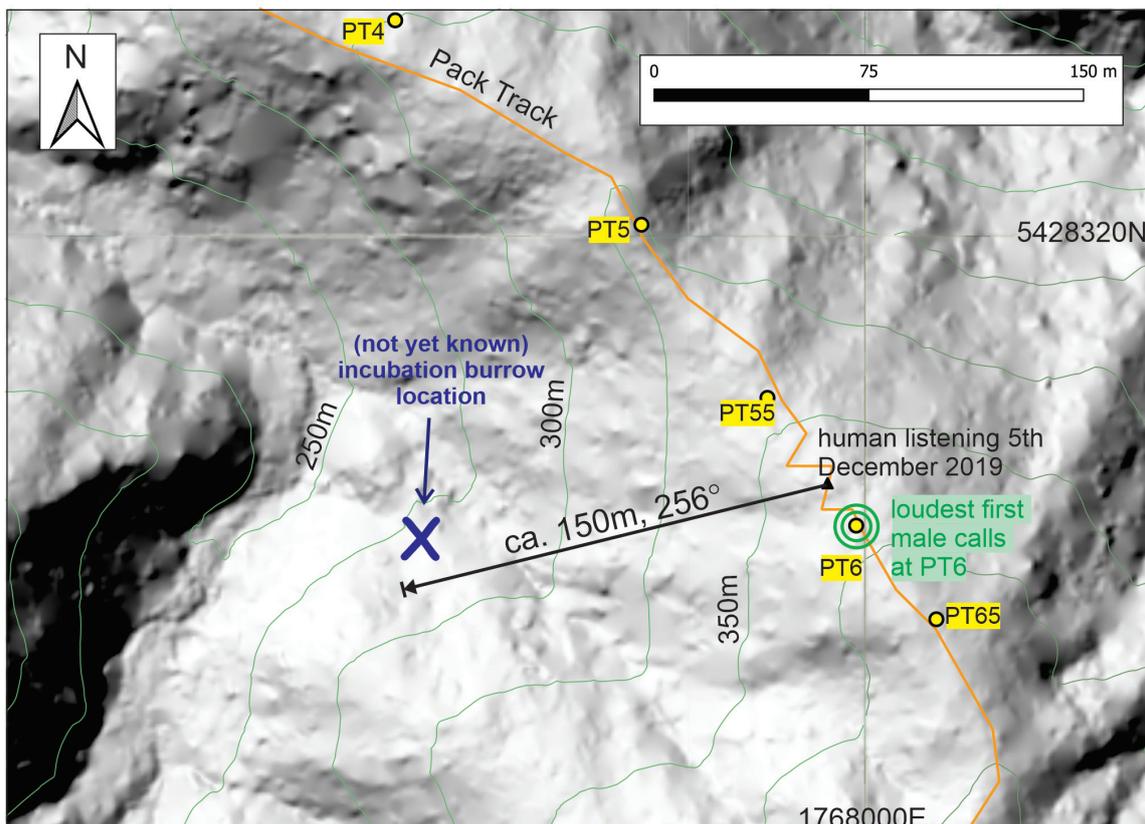
Appendix S14. First evening call times for Rātā over the course of the incubation for trial R1, compared to civil twilight. All times are in NZST. The gap from days 20–30 was owing to a faulty ARU.

Time of first call: Rata Aug-Nov 2019



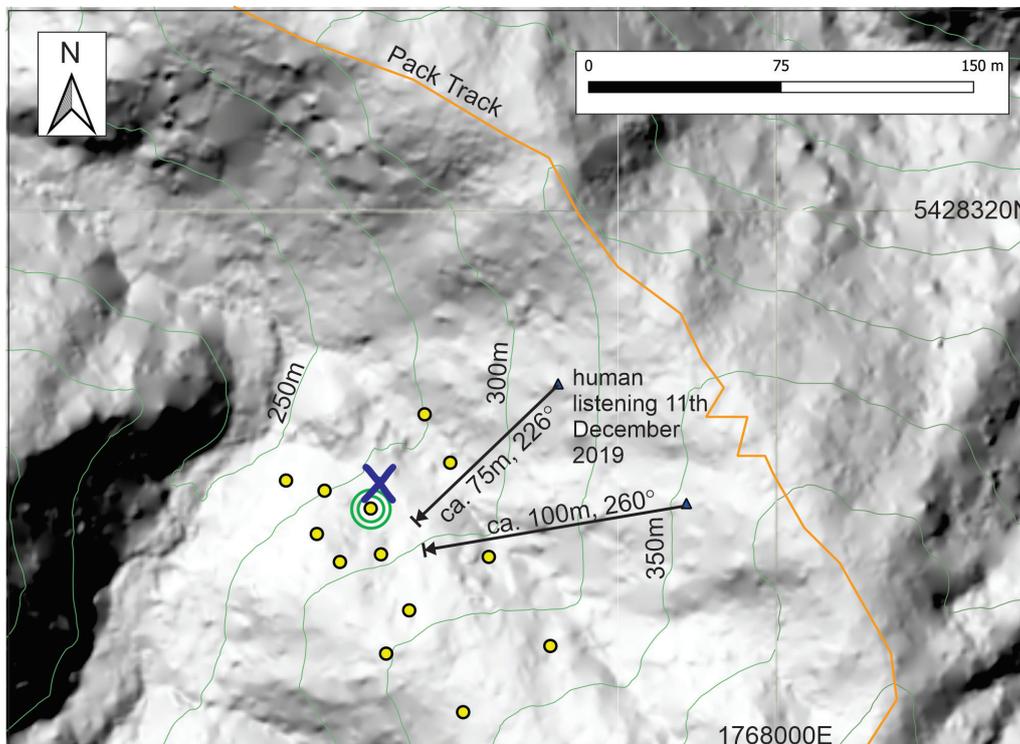
Appendix S15. Trial C2, Colin’s incubation, December 2019 to January 2020. This is an expanded version of Fig. 6 in the main paper. (a) Initial deployment of ARUs was along the Pack Track (flowchart steps A1–A3). Yellow circles are ARU locations. Black arrow shows direction and estimated distance from human listening. Concentric green circles show ARU location with loudest calls. Background hill shading from 1m DEM lidar data (<https://data.linz.govt.nz/layer/53621-wellington-lidar-1m-dem-2013-2014/>). For reference, the eventual located burrow (then unknown) is shown by the blue X.

(a) Colin, trial C2, Pack Track - 5-21 December 2019



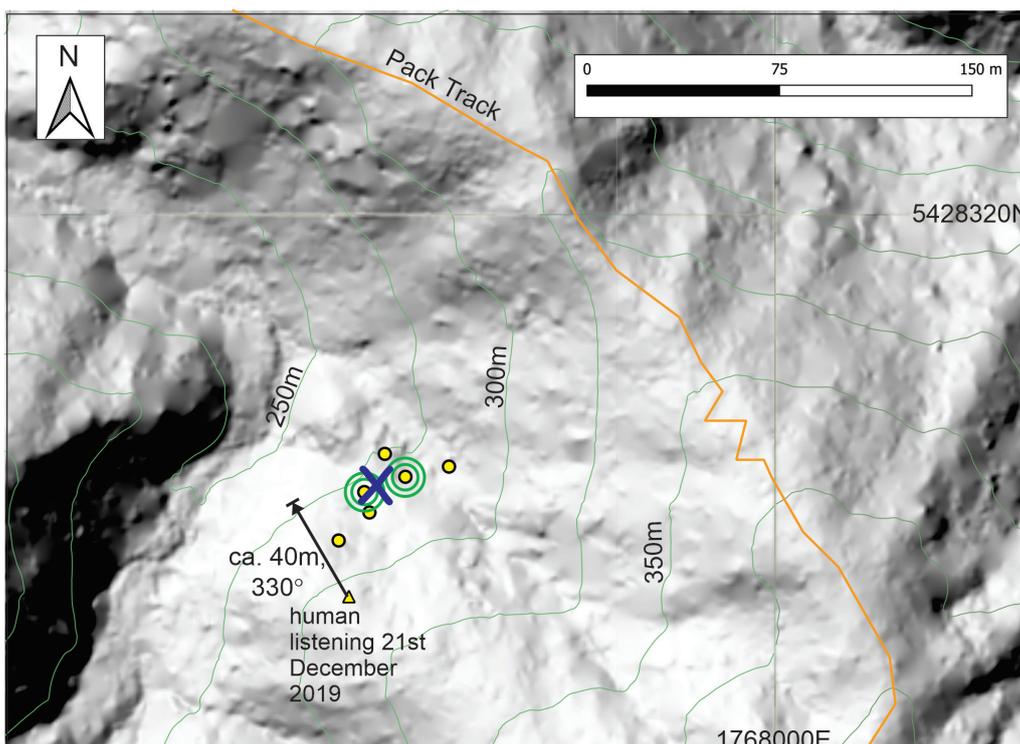
Appendix S16. Trial C2, Colin’s incubation, December 2019 to January 2020. This is an expanded version of Fig. 6 in the main paper. (b) Initial grid of ARUs around the estimated burrow location, along with some additional bearings.

(b) 21-29 December 2019



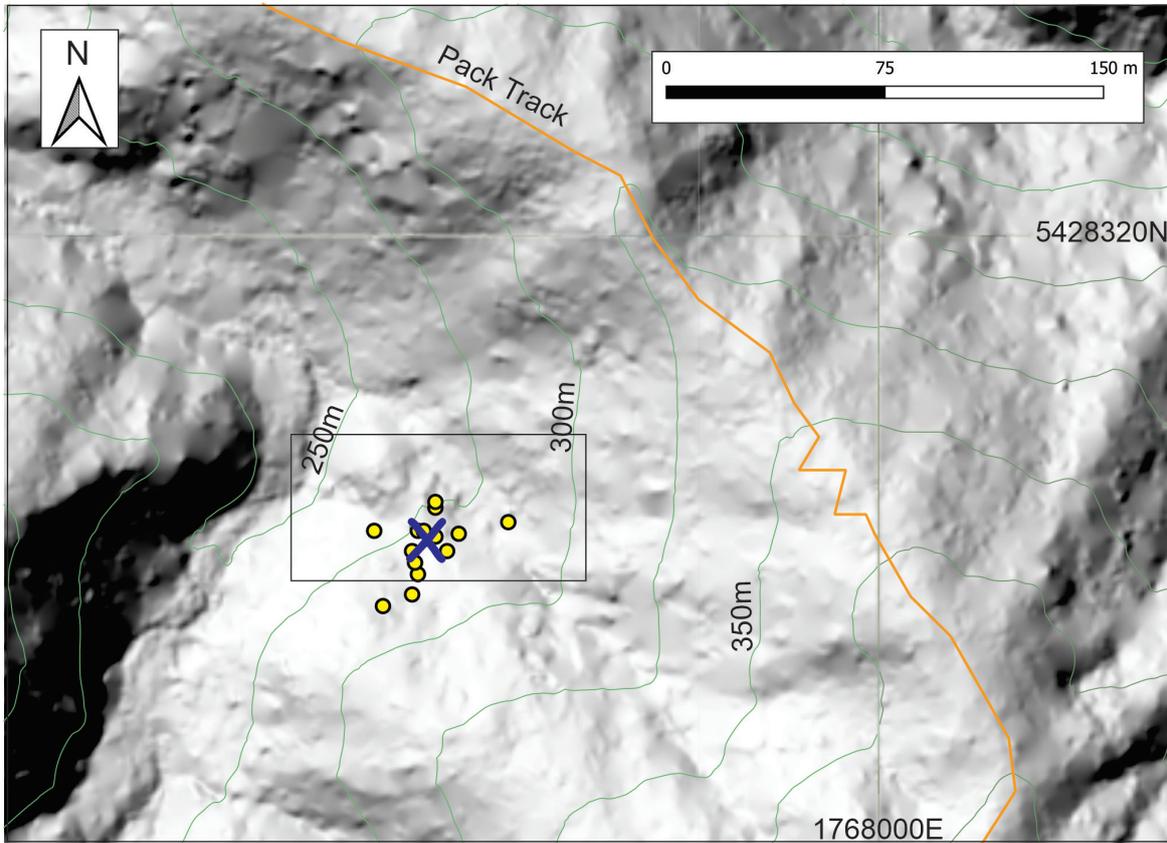
Appendix S17. Trial C2, Colin’s incubation, December 2019 to January 2020. This is an expanded version of Fig. 6 in the main paper. (c) refinement of the ARU grid with a decrease in spacing and one additional human bearing.

(c) 29 December 2019- 1 January 2020



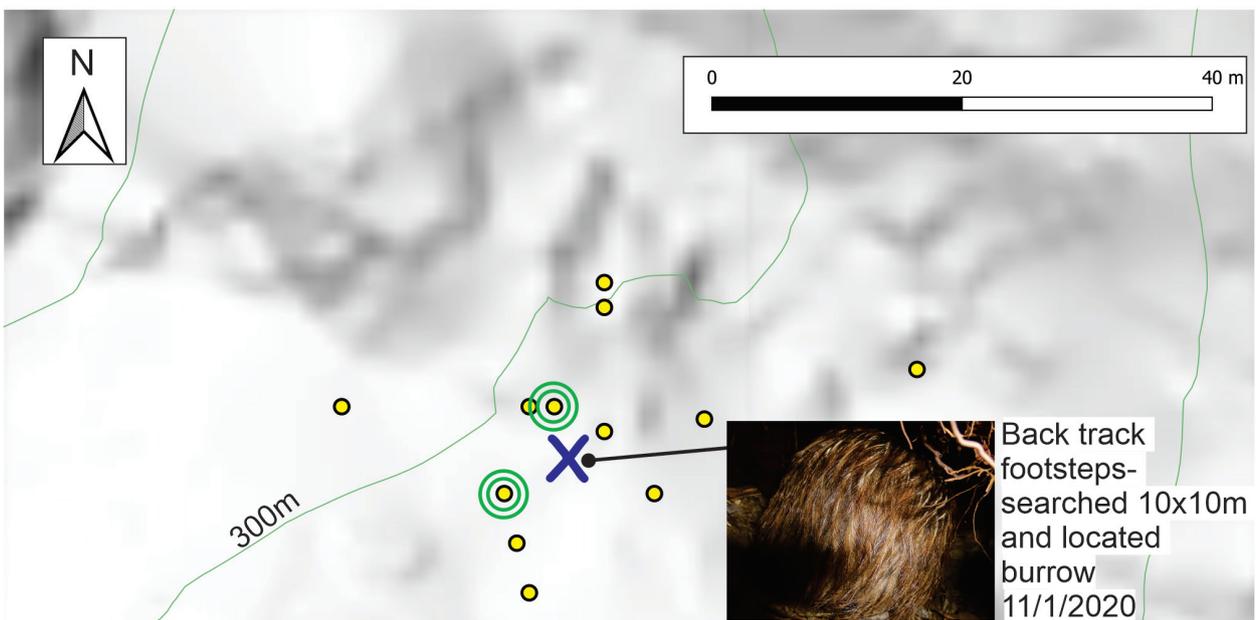
Appendix S18. Trial C2, Colin’s incubation, December 2019 to January 2020. This is an expanded version of Fig. 6 in the main paper. (d) Further refinement of ARU grid and analysis of footsteps and trailcam images (Appendix S11; step A5).

(d) 1-11 January-2020



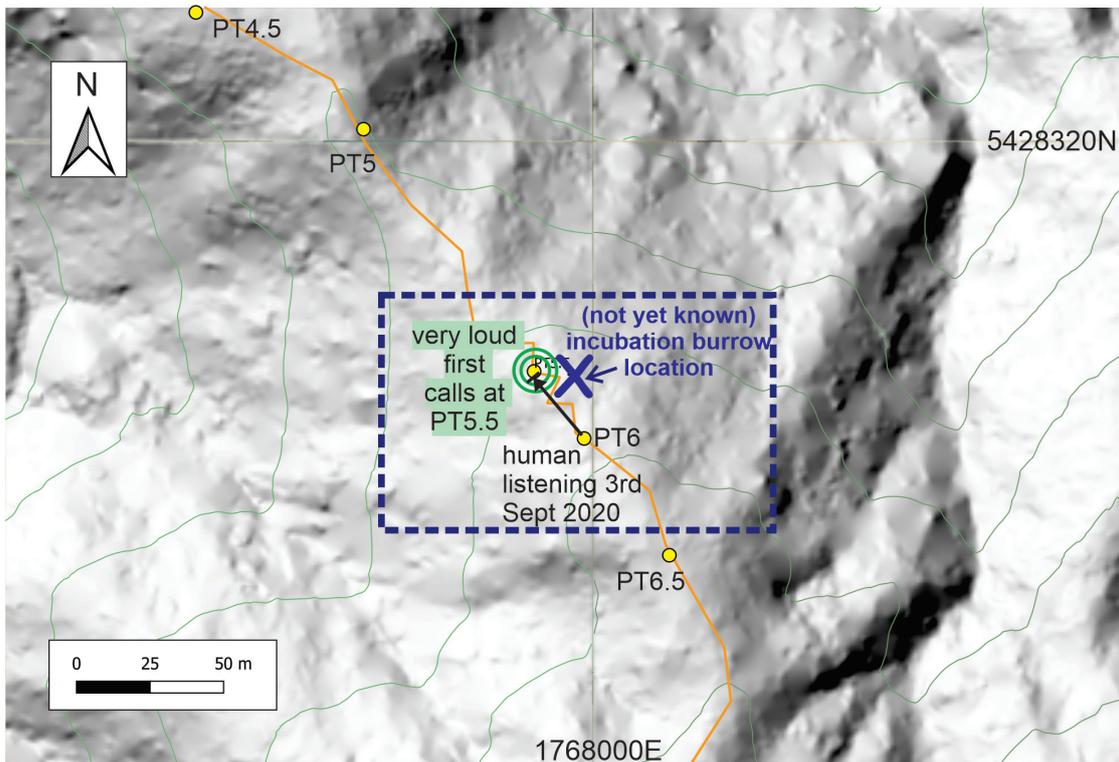
Appendix S19. Trial C2, Colin’s incubation, December 2019 to January 2020. This is an expanded version of Fig. 6 in the main paper. (e) Close up of box outlined in (Appendix S18) with location of closest calls narrowing the region of interest to 10×10 m. Visual search finally located the burrow on 11 January 2020.

(e) Closeup- calls + trailcams and footsteps (1-11 January 2020)- success!

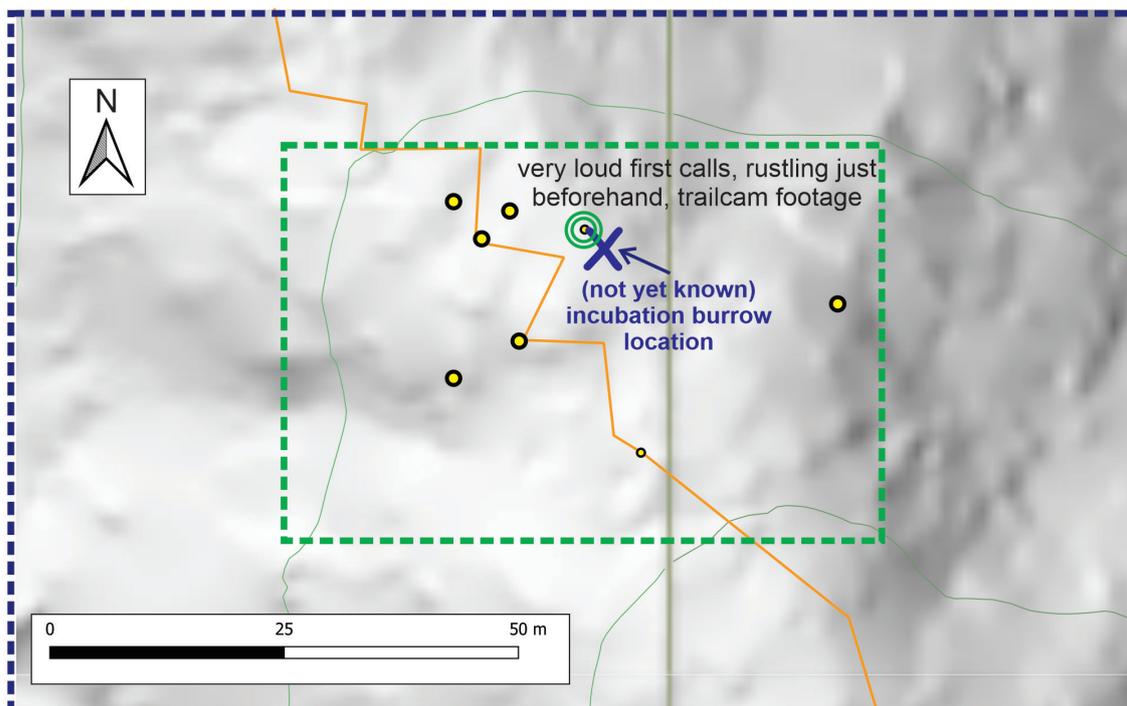


Appendix S20. Trial C3, Colin’s incubation, August to September 2020. (a) Initial deployment of ARUs along the Pack Track (flowchart steps A1–A3). Yellow circles are ARU locations. Concentric green circles show ARU location with loudest calls. Background hill shading from 1m DEM lidar data (<https://data.linz.govt.nz/layer/53621-wellington-lidar-1m-dem-2013-2014/>). For reference, the eventual located burrow (then unknown) is shown by the blue X. Human bearing (black arrow) indicated a call close and on the track. (b) Refined grid near location of loudest calls from (a). One ARU appeared to have rustling and footsteps just prior to the first call of the evening.

(a) Colin, trial C3, late August- 5 September 2020



(b) 6- 15 September 2020



Appendix S21. Trial C3, Colin's incubation, August to September 2020. (c) Closeup and further refined grid of ARUs and trailcams. Visual search of 10 × 10 m area found burrow on 26 September 2020. Photo inset shows Colin in his burrow on the day of location.

(c) 16-26 September 2020- success!

