A critical look at the use of GPS tags to study the movements of hedgehogs in a London park

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Background

Since the 1990s, GPS technology has been increasingly used in wildlife studies to investigate the movement of animals, how they use space and select resources. A variety of increasingly sophisticated wildlife tracking devices can be bought commercially, but they are prohibitively expensive for many people. Nevertheless, cheaper GPS devices are available for tracking keys, pets, luggage, vehicles and people. Here we report of the use of modified off-the-shelf, inexpensive GPS trackers for studying the movements of hedgehogs in the Regent's Park, London, UK. Since various factors (environmental and technological) can affect the accuracy of GPS receivers (e.g. Glasby & Yarnell 2013, Adams et al. 2013, Morris et al. 2017), it is normal to understand the errors in your GPS device by testing them in relation to the habitats where they will be used. We modified off-the-shelf travel trackers combined with a conventional VHF tag to study the movements of hedgehogs at The Regent's Park, London in 2014, 2015, and August 2018. We present the results of tests carried out on the accuracy of the GPS tags, and describe the advantages and disadvantages of using the two different types of tags.

The GPS and VHF tags

We used I-gotU GPS travel trackers (A41JF, Maplin, U.K.) modified by Mark Ferryman at Forest Research as described by Stevenson et al. (2013); weight 18g.* These were attached with a Biotrack TW-5 VHF transmitter in 2014 and August 2018, and with Titley LT5357 VHF transmitters in 2015 (Figure 1).

* after modification, cost £150 each (including labour).

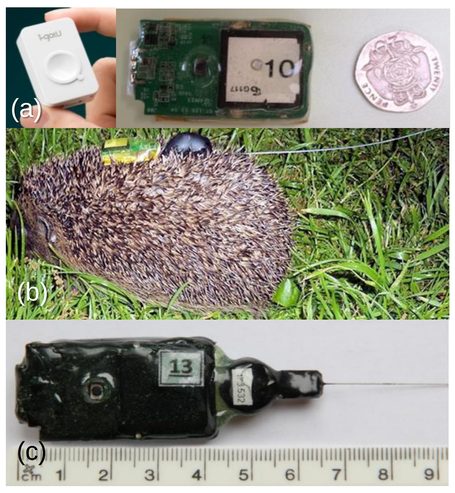


Fig.1. (a) GPS tag pre- & post- modification.
(b) GPS & Biotrack VHF tags in use.
(c) GPS tag + Titley VHF tag glued together.

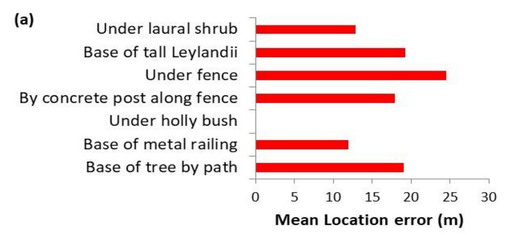
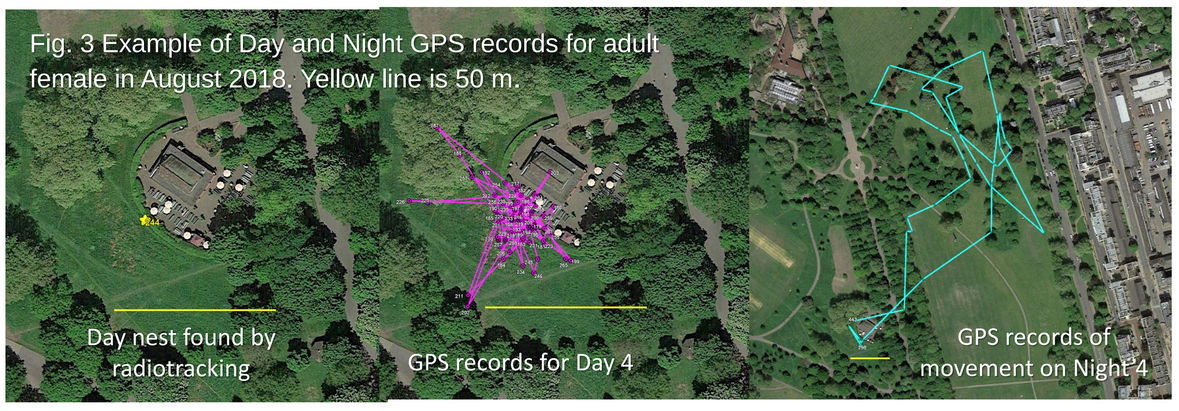


Fig.2. Static test of GPS units showing mean LE (m) & FSR (%) under different cover types.



GPS tests

We carried out static tests on GPS tags at known locations in the open at Hyde Park (location interval programmed at 5 min) and under different types of cover at The Regent's Park in 2014 (location interval programmed at 20 min). From these tests we present findings on the Fix Success Rate (FSR) and the Location Error (LE).

Tracking

We glued the GPS and VHF tags to shortened spines in the mid dorsal region of 6-10 hedgehogs with fast setting epoxy adhesive in 2014, 2015, and 2018. The location interval was programmed at 10 min. The tags were attached on a Friday night and removed the following Friday night after finding them using standard radiotracking techniques. Between the two Fridays 6-9 volunteers checked up on the hedgehogs by radiotracking them, and on certain nights followed individuals and observed their behaviour. During the day, volunteers radiotracked the hedgehogs to find their day nests.

The data from the GPS loggers was downloaded into Excel. GPS location data was then analysed using Ranges 9 software (Anatrack Ltd. http://www.anatrack.com) and viewed in Google Earth Pro. However, first we filtered the data to remove clearly inaccurate locations using unrealistic elevation (>60 m or <-10 m; most of the park is 27-37 m) and speed of movement (>60 m/min) records. Thereafter, a further filter was carried by directly inspecting the data and removing locations of hedgehogs in odd locations, e.g. the middle of buildings. The data were then divided into day (05.00-21.00 hours) and night (21.00-05.00 hours) fixes.

Results of GPS tests

Initial static tests of 7 tags in 2014, each placed in open grassland habitat at Hyde Park in the middle of the day for ~ 2 hours, produced a mean LE of 7.1 m (N = 21, SD = 4.81) and a FSR of 100%. Bearings for all except 2 of the 21 tests were random (Raleigh test). Further tests at The Regent's Park under different types of cover produced mean LEs of between 12 m and 25 m and FSRs of between 11% and 66% depending on location (Figure 2).

Accuracy of GPS tags on hedgehogs

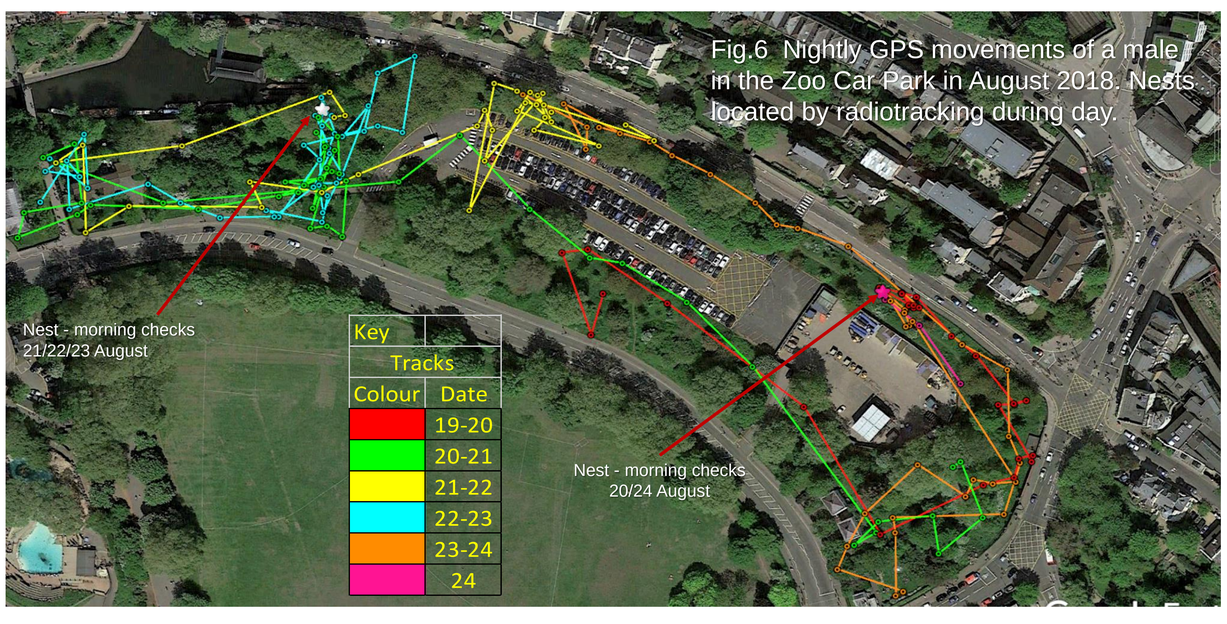
We attached GPS/VHF tags to 34 hedgehogs in 2014 and 2015. Overall, the average FSR of downloaded fixes was 49% (SD = 19%). A further 8.3% of fixes were filtered out (elevation 6.9%, speed 0.2%, direct inspection 1.3%) leaving a final FSR of 41% (SD = 16.4%).

Recorded movements of hedgehogs

Day nests were invariably situated under cover and their precise location could not be ascertained from the day GPS data because of too much noise, but they could be found by radiotracking (Figure 3). The night movements of hedgehogs could be approximated from the GPS data, bearing in mind the LE of the tags under different cover types (Figure 3). The distribution of fixes (Figure 4) was used to estimate nightly and weekly range areas (examples not shown). Radiotracking at night enabled the behaviour of selected individuals to be recorded, using Thermal Imaging cameras to observe them (Figure 5).

Discussion and Conclusion

Glasby and Yarnell (2013) carried out extensive tests on GPS Avian bugs from Biotrack Ltd. which they used on hedgehogs. In static tests they found a LE of 6.4 m (FSR 100%) in open pasture and 15.6 m (FSR 38%) in woodland. Our stationary tests gave similar results for open habitats, but were up to 10 m larger for tags under cover. FSR ranged from 100% in the open to 11% under certain types of cover. The FSRs are supported by our results from GPS tags on hedgehogs which overall was 41%. Loss of satellite connection is responsible for the loss of many records (see references) with further location errors occurring as animals moved under different types of cover. Nevertheless, there was sufficient cleaned data left to get good approximations of movement patterns, home range areas and habitats visited. Radiotracking enabled the precise locations of hedgehogs or their nests to be found and enabled observations on behaviour to be made. In contrast to GPS tracking, radiotracking is labour intensive with volunteers out in all weathers, and there is a possibility of disturbing animals when following them. For our study, we found the modestly priced GPS tags coupled with the VHF tags enabled us successfully to answer many questions about the use of space by hedgehogs in The Regents Park. It also enabled us to provide evidence of how the hedgehogs use the Zoo Car Park in consultation with developers who want to take over a large part of the car park as a lorry holding area for building a new high speed train line from Euston to Birmingham (Figure 6).



References

Stevenson, C. D., Ferryman, M., Nevin, O. T., Ramsey, A. D., Bailey, S. & Watts, K. (2013) Using GPS telemetry to validate least-cost modeling of gray squirrel (Sciurus carolinensis) movement within a fragmented landscape. *Ecology and Evolution 3: 2350-2361.*

Adams, A. L., Dickinson, K. J. M., Robertson, B. C. & van Heezik, Y. (2013) An Evaluation of the Accuracy and Performance of Lightweight GPS Collars in a Suburban Environment. *PloS one 8(7): e68496.*

Morris, G. & Conner, L. M. (2017) Assessment of accuracy, fix success rate, and use of estimated horizontal position error (EHPE) to filter inaccurate data collected by a common commercially available GPS logger. *PloS one 12(11): e0189020.*

Glasby, L. & Yarnell, R. W. (2013) Evaluation of the performance and accuracy of Global Positioning System bug transmitters deployed on a small mammal. *European Journal of Wildlife Research 59(6): 915-919.*

Acknowledgements

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