Appendix 1: The Regent's Park Hedgehog Nest box survey

October 2015 to January 2017

1. Introduction

The hedgehogs in Regent's Park are the only breeding population remaining in Central London. Since 2014, the Royal Parks Foundation, The Royal Parks, ZSL, independent wildlife experts, Dr Nigel Reeve and Prof John Gurnell and more than 100 volunteers, have carried out bi-annual detailed, systematic surveys of the hedgehogs the results from these surveys can be found in Gurnell *et al.* (2015). Research has shown that this is a small, vulnerable and isolated population.

In order to conserve this population, recommendations have been made to improve Park management techniques, habitat available and raise awareness of hedgehog conservation within the grounds team and members of the public. One recommendation was to install hedgehog nest boxes across the Park to provide a safe space for hedgehogs to build their day nests and hibernation nests. Nest boxes can help protect hedgehogs from hazards in the Park including strimmers, dogs and foxes. Their installation can also provide safe nesting spaces in areas of the Park with limited habitat suitable for nests.

In October 2015, the project team were able to install nest boxes across Regent's Park, this report provides information on the process taken and results to date.

2. Aims

- To provide additional safe nesting locations for the Regent's Park hedgehog population
- To understand if hedgehogs will use nest boxes in an urban park environment

3. Survey methods

3.1 Nest box design

After research into different types of nest boxes, the design thought to be most suitable was from the RSPB, see images below. Two chambers were needed in the box, an initial chamber for the hedgehog to enter through and one for the nest itself. The first chamber prevents other animals such as foxes or dogs putting their noses into the nest.

These boxes were designed for garden us, so to improve security of the nest box within the Park, a hole was drilled through the base of the box so a large metal peg could be placed through and secure the box to the ground. The wing nut on top of the box, securing the lid to the base, was replaced with a bolt of the same diameter and tightened in place using a spanner or wrench, this meant people can't easily open the box to look inside.

Image 1: Internal and external view of the hedgehog nest box

Image 2: Internal and external view of the hedgehog nest box in situ

3.2 Locations

In total, 50 nest boxes have been deployed. Nest box locations were chosen based on areas of the Park hedgehogs are known to use, security of the nest box when in situ, access to the nest box during summer when vegetation has grown up and areas of the Park lacking suitable nest sites. A full map of the nest box locations can be found in Figure 3.1 and Appendix 1 and a list of locations with their grid references in Appendix 2.

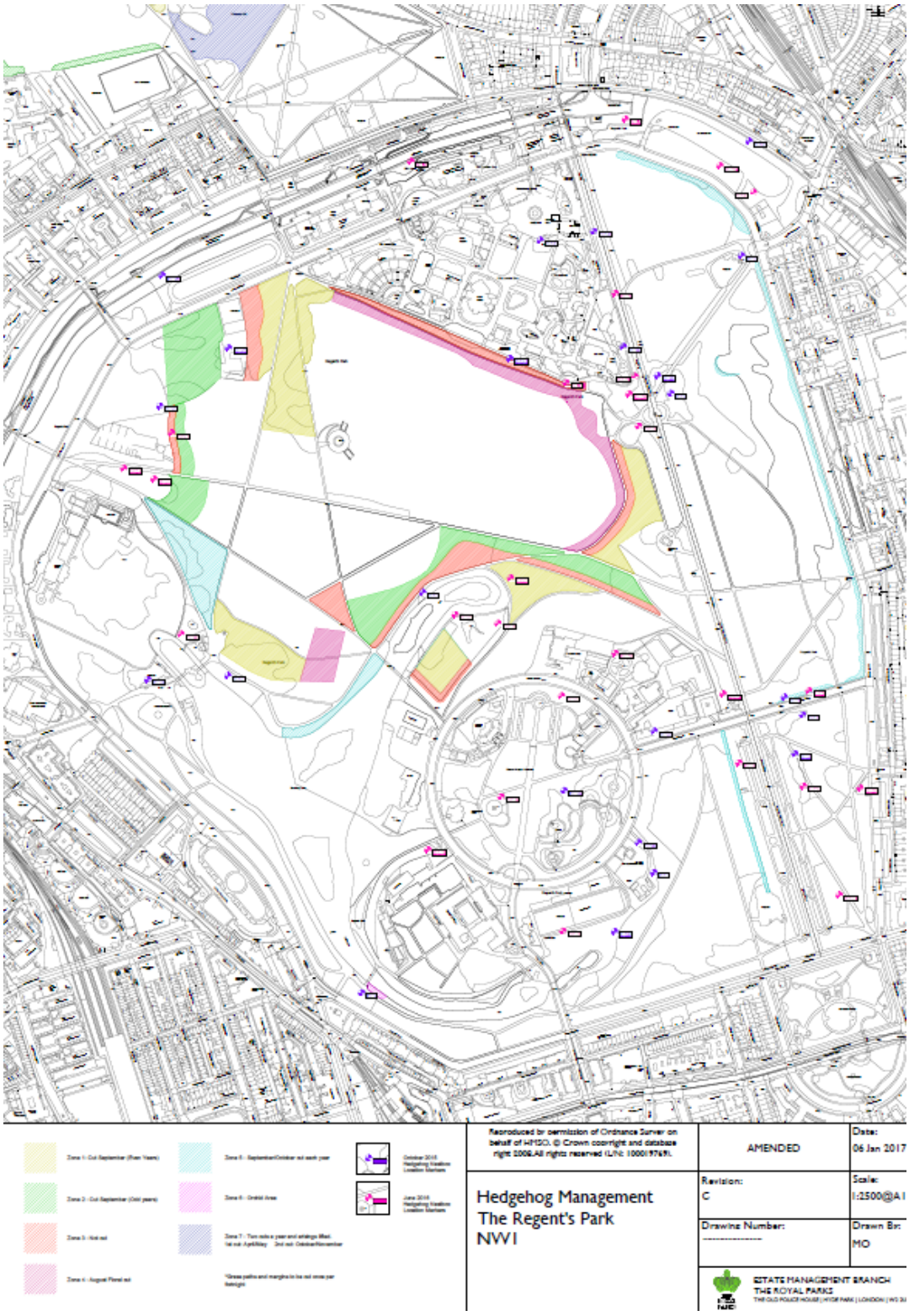


Figure 3.1: Hedgehog nest box locations in The Regent's Park (a full sized version can be found in Appendix 1)

3.3 Nest box installation

3.3.1 How the nest boxes were installed

Each nest box was given a number and a name before being installed, the numbers run from 1 to 50, the names reflect key people who have worked or volunteered on the Regent's Park Hedgehog programme, e.g. Number 37, Name 'Belinda'.

Three teams of two or three people installed the nest boxes. Each team was given a kit bag and a list of locations to install, the full installation kit list can be found in Appendix 3. The process for installing each nest box was as follows:

1. Choose a specific location within the area the nest box is to be placed
2. Attach a security label to the side of the box, with the name, number and RPF contact details on
3. Open the nest box and, using a mallet, place the large peg through the hole at the bottom
4. Place some leaves in the main chamber of the box to being the nest
5. Place some hedgehog food in the first entrance chamber
6. Close the lid and bolt down, tightening with a wrench
7. If the nest box is particularly visible to members of the public, cover over with leaves, branches or foliage
8. Take a GPS reading of the location and complete a nest box installation proforma (a copy can be found in Appendix 4)

Image 3 & 4: Security label on the side of the nest box with name, number, saying it is part of a scientific survey and contact details for the Royal Parks Foundation

Image 5: The metal peg used to secure the box in place (not pushed down in this picture!)

Image 6: The team installing the first hedgehog nest box

3.3.2 When the nest boxes were installed

Date	How many boxes installed	By whom?	Notes
2 December 2013	3	ZSL	One in the zoo car park, two within the zoo grounds, all different styles of nest box
8 October 2015	27	RPF, TRP & ZSL	
26 April 2016	20	RPF & TRP	At the same time, 3 nest boxes from October were relocated as their original location wasn't suitable or had been damaged
TOTAL	50		

Table 3.1: Number of nest boxes and date of installation across the Regent's Park

3.4 Nest box checking

There are two key times of the year nest boxes need to be checked for use in, firstly as a day nest from spring to autumn, secondly as a hibernation nest during winter. To check for these nests, and cause as little disturbance to the hedgehogs as possible, it was agreed to check the boxes three times a year, once during the winter hibernation period, once in the early summer before the main breeding period and once in the late summer after the main breeding season. To date, the boxes have been checked four times:

	Date	Hedgehog life cycle
1	22 March 2016	Hibernation
2	6 June, 9 June and 9 July 2016	Pre breeding
3	30 Aug, 20 Oct and 2 Nov 2016	Post breeding
4	7 Dec and 5 Jan 2017	Hibernation

Table 3.2: Nest box checks to date.

To ensure all nest boxes were checked and the process didn't take too much time, the 50 nest boxes were divided into 'zones' based on their location in the Park. Members from the Royal Parks Foundation, The Royal Parks, ZSL, our scientific advisors and some volunteers have taken responsibility for a zone so they know where to find their nest boxes, particularly important during the summer months when vegetation is at full growth, it takes between 2-3 hours to check a zone. See Appendix 5 for a map of the zones.

When each zone is being checked, the team are provided with a kit bag (see Appendix 6 for equipment list) and a set of checking proformas (see Appendix 7 for the pro forma template). The process for checking is as follows:

1. Find the nest box and check it's still in position and hasn't been disturbed
2. Unscrew the bolt to open the lid and check inside
3. If there is no nest present, check for signs of other animal use, e.g. insects or mice
4. If a nest is present, carefully check inside to see if a hedgehog is present

5. If no hedgehog is present, check for signs of hedgehog use, e.g. spines
6. If a hedgehog is present, check if there are any nestlings and follow the nestling procedure (see Appendix 8), check if it has been tagged up with a number, if yes, make a note, if not, mark it up with a new number
7. If a hedgehog is found in a state of hibernation, do not disturb it or the nest and simply record its presence
8. Clear out the tunnel of leaves and debris so that if it has leaves in it when you check it nest, there is evidence of it being used.
9. After everything has been checked, close up the box and screw back in place
10. Take a photograph of anything interesting
11. If the nest box has been disturbed, then re-position and move if necessary to a more secure location, make sure to take a new GPS reading if put in a new location.




Images 7,8,9 and 10: Woodmouse in one nest box, hedgehog in a nest box, fully formed nest, plastic in the first chamber of a box

3.5 Camera traps

When the first set of nest boxes were installed, five camera traps were installed in secure locations positioned facing five nest boxes. The aim was to capture footage of which animals were using the nest boxes. No hedgehog footage was found but lots of foxes, mice and squirrels. These cameras were up for eight weeks and brought down over the winter.

Image 11: Fox sniffing a nest box in Queen Mary's Garden

4. Results

By October 2015, 30 nest boxes had been installed in the Park and this was increased to 50 in April 2016; the locations of the boxes are shown in Figure 6.13. One nest box contained a hedgehog at the time of box inspections in spring (March 2016), one in summer (June 2016 and August 2016 data pooled) and one in winter (December2016). Overall, however, the number of boxes that showed signs of hedgehogs having visited the box since the previous survey increased throughout the survey period (Figures 6.13, 6.14). In winter 2016, apart from one box in the southwest and one in the centre of the Park (Figure 6.13c), most signs of presence occurred in and around the southeast corner of the Zoo grounds, Gloucester Green and the Zoo Car park. Overall, the distribution of visited boxes reflects the distribution of hedgehog captured in the September 2016 spotlighting survey (Figure 6.15).

(a) Spring 2016

(b) Summer 2016

(c) Winter 2016

Figure 4.1 Boxes containing signs that hedgehogs had used them since the previous survey. Red=hedgehog signs, lime = no signs.

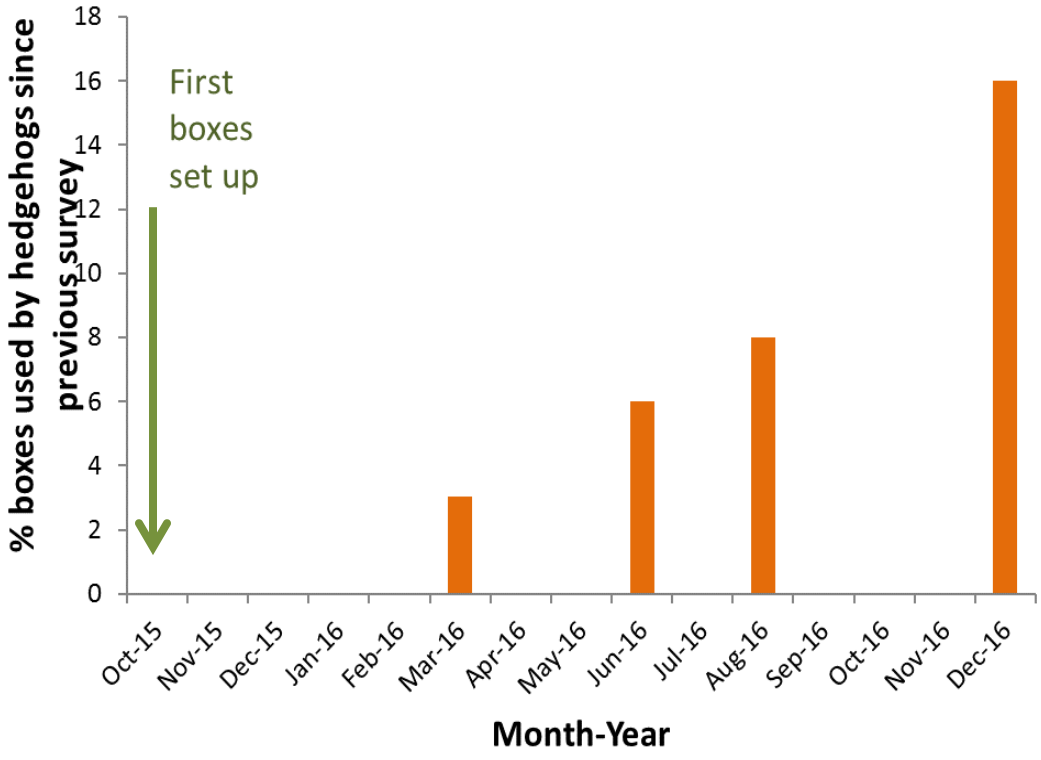


Figure 4.2 Per cent of boxes visited by hedgehogs since previous inspection.

Figure 4.3 Boxes containing signs that hedgehogs had used them since the previous survey at the times of the summer and winter 2016 surveys and hedgehog captures during the September 2016 spotlighting survey. Red=hedgehog signs, lime = no signs, blue = capture.

5. Discussion

Although few hedgehogs were found in nest boxes at the times of inspection, there were an increasing number of signs during the year that boxes had been visited by hedgehogs. This was mostly within the north east of the Park where most hedgehogs were captured; it should be noted that many boxes were located outside the areas used by hedgehogs in 2016 (Figure 6.15). So far it appears that boxes should be left *in situ* for a period of 3 - 6 months or longer before they are used by hedgehogs, but thereafter it is possible that boxes could provide useful information on hedgehog distribution. One of the original aims at trialling nest boxes was to see whether they provide safe nesting sites for breeding females, for example, by avoiding disturbance from dogs and foxes. Further studies in 2017 will provide valuable information about whether more boxes are used, whether some females use them to raise young, and whether a network of boxes can be used as an indirect monitoring tool.

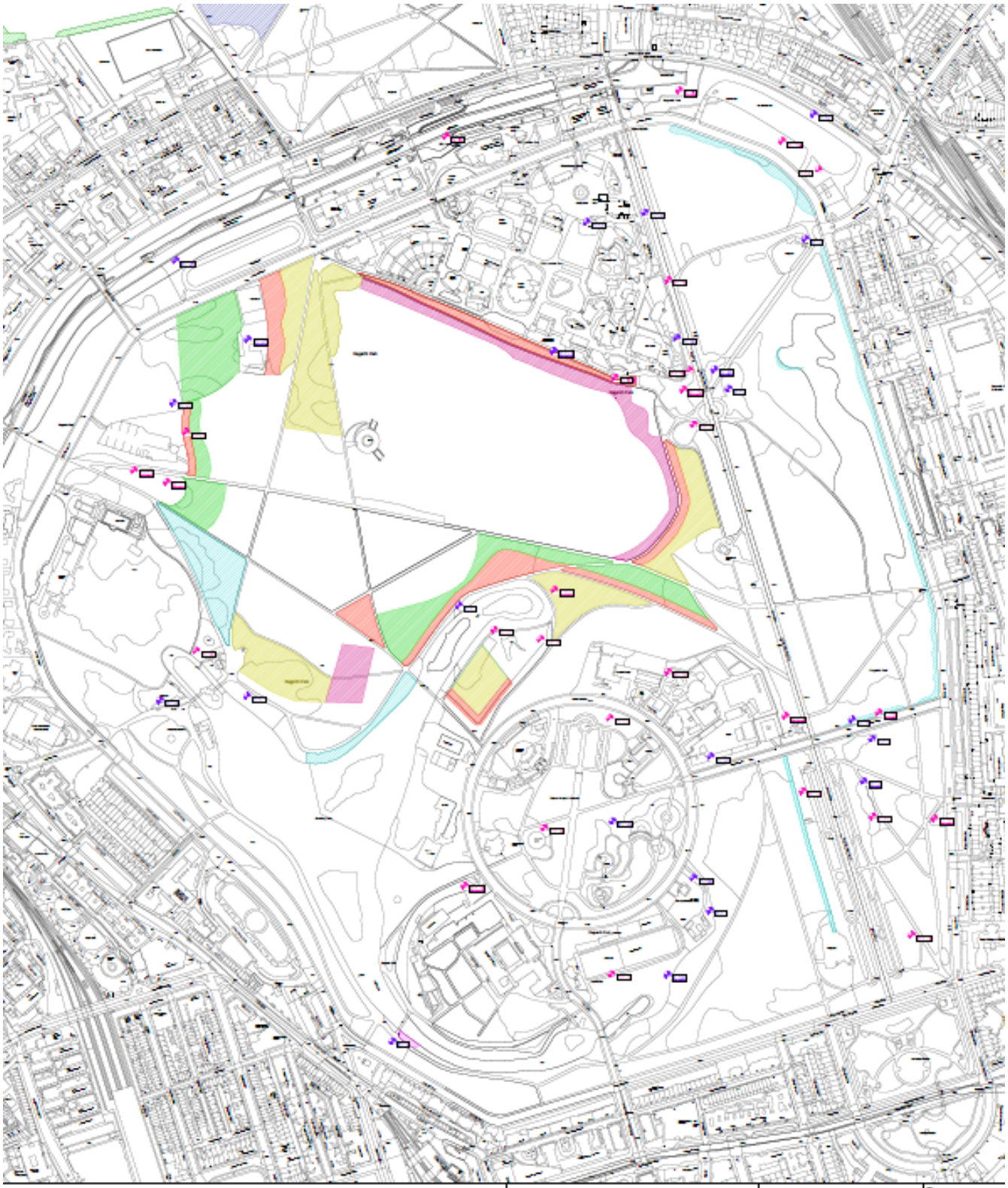
6. Conclusion and recommendation

Fifty hedgehog nest boxes had been established across the Park by March 2016 and were inspected in March, June, August and December. Although few hedgehogs were found in boxes at the times they were inspected, there was an increase in the number of boxes that appeared to be visited by hedgehogs over the year and these boxes were in areas where hedgehogs were known to be present. Nest box studies will continue in 2017.

Spotlighting surveys and nest box monitoring studies should continue in 2017 and through to 2021 to establish whether the hedgehog population in Regent's Park is viable in the long-term, and, if not, to activate conservation management interventions if it is thought they are needed.

Appendices

Nest box report Appendix 1: Map of nest box locations



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AMENDED

Date: 06 Jan 2017

Hedgehog Management
The Regent's Park
NW1

Revision: C

Scale: 1:2500@A1

Drawing Number: ----------

Drawn By: MO

ESTATE MANAGEMENT BRANCH
THE ROYAL PARKS
THE OLD POLICE HOUSE | HYDE PARK | LONDON | W2 2UH

Hedgehog Nest Box Installation Proforma – April 2016

Nest Box Name & Number Insert name & number of the nest box	Name: _____ Number: _____
Date Date day nest box was placed in the field: DD/MM/YYYY	26 / 04 / 2016 D D / MM / YYYY
Time Time day nest box was placed in the field: e.g.17:40	___ ___: ___ ___
Location: was the nest box marked on a map?	Yes / No
Location: 10 digit NGR code Location of nest box. 10-digit NGR, e.g. TQ12345 12345	TQ _ _ _ _ _ _ _ _ _ _
Survey Zone Number Survey zone in which the nest box was placed (1- 8)	
Aspect (If known) The way in which the nest box is facing e.g North, East, South, West	KNOWN? Y / N ASPECT: _____

Habitat where nest box was placed:	Select one location which best describes where the nest box was found: ☐ Grass < 10cm tall (excluding sports pitches) ☐ Grass - cut but > 10 cm tall ☐ Tussocky rough grassland > 10cm tall ☐ Sports pitches ☐ Planted shrubberies/flower beds with mulch ☐ Planted shrubberies/flower beds without mulch ☐ Scrub (bramble/bracken, neglected overgrown shrubbery) ☐ Recent plant-colonised disturbed site ☐ Tall herbs but not scrub (e.g. willow herbs, dog's mercury, stinging nettle, hogweed, red campion, ferns) ☐ Reedbeds and marginals ☐ Hedgerow (under or within 50 cm of base) ☐ Woodland floor ☐ Bare soil (not in woodland/flower bed /shrubbery) ☐ Bare artificial habitat (e.g. tarmac, paved, hardstanding) ☐ Other (please describe in left panel ←))

Notes E.g. details of type of vegetation, any nearby landmarks, anything unusual about the location, how accessible it is to a dog / human	
Camera Trap placed? If a camera trap has been placed, please state the number of the camera	Yes / No If yes, state number: _____
Photograph taken? Please take a photo of the nest box location, using the label provided to record the location and date	Yes / No *If yes, who took the photo:* _____

Proforma completed by:	Name:	Date: __ __ / 04 / 2016
Proforma checked by supervisor:	Name:	Date: __ __ / 04 / 2016

Nest box report Appendix 3: Nest box checking zones

Hedgehog Management
The Regent's Park
NW1
200 ÷ 6 to check
KEPC = 1 to check

AMENDED

Revision:

Drawing Number:

Date:
29 Jan 2016

Scale:
1:2500@A1

Drawn By:
MO

ESTATE MANAGEMENT BRANCH
THE ROYAL PARKS

Hedgehog Nest Box Checking Proforma

Nest Box Name & Number Insert name & number of the nest box	Name: _____ Number: _____
Date checked Date day nest box was placed in the field: DD/MM/YYYY	____/____ / 2016 DD / MM / YYYY
Time checked Use 24 hour clock format	___ :___
Is the nest box still present?	Yes / No
Has the nest box been disturbed? Please provide as much detail as possible, e.g. is the box in the same location, are there any signs of it being tampered with, is it still in good condition etc.	Yes / No *If yes, please provide details…*
Is there a hedgehog present in the box? If it is a new hedgehog without a tag, please tag it up and mark down the following details: Number, circumference, weight, sex, injuries, parasites	Yes / No *If yes, please provide any details…*
Are there any signs a hedgehog has used this box? Please provide as much detail as possible	Yes / No *If yes, please provide details…*
Are there signs of any other animals using this box? Please provide as much detail as possible, e.g. squirrels, foxes, mice, rats, birds etc	Yes / No *If yes, please provide any details…*
Notes E.g. details of the surrounding area, vegetation cover, if the box had to be moved or replaced, etc	
Sample taken? E.g. shed hairs, spines, faecal sample, animal remains etc. Provide details.	
Photograph taken? Please take a photo of the nest box in location and of any interesting features for our records.	Yes / No *If yes, who took the photo:* _____

Proforma completed by:	Name:	Date: ___ / ___ / 2016
Proforma checked by supervisor:	Name:	Date: ___ / ___ / 2016

Hedgehog Nestlings ID information

If you accidentally disturb babies it is a shame, but if the female is presenting her ID mark obviously and you can see the nestlings, describing their stage of development and counting them would be useful additional date.

Obviously exacerbating the disturbance to get data (especially if the nestlings are every young) is not acceptable, but if such information is there before your eyes it might as well be gathered.

Descriptions of what nestlings might look like:

1. **Under 1 week old:** Pink skin / no fur, white spines with only short tips of brown spines growing through, eyes closed – NB: This is the most vulnerable age and could be abandoned / eaten after any disturbance

2. **Up to 2 weeks old:** Pink skin / no or very little fur with brown spines having grown through the white spines, eyes usually closed – NB: Still vulnerable but less likely to be abandoned / eaten after mild disturbance

3. **2-3 weeks old:** Fur covering body (short at first) and well developed brown spines, eyes usually open

4. **4 weeks old and over:** Fully furred and brown spines, looks like a small adult with a relatively big head

Camera survey of hedgehogs in Regent's Park

Marcus Rowcliffe, Liam Nash & Chris Carbone, & Royal Parks & ZSL
April 2017
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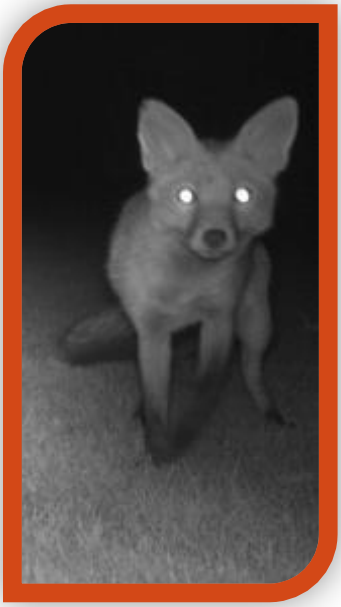
Executive Summary



Hedgehogs have historically been an important element of urban biodiversity in the UK, but appear to have declined dramatically in recent years. London exemplifies this decline, with parks like, Regent's Park now holding the only known population left in inner London.

A critical component of monitoring and understanding the causes for wildlife declines is the ability to measure their abundance and distribution. An emerging method for estimating the abundance of hedgehogs is the camera-trapping method, the random encounter model (REM), where animal density is estimated from the rate of encounter, controlling for confounding factors.

This method has an important advantage in that multiple species can be monitored in the same survey. Thus, species like foxes or badgers – potentially competing species or actual predators of hedgehogs, can be monitored using this approach - allowing us to look for linkages in their abundance and distribution trends.

The survey was conducted from 3 October to 1 November 2016 across two 14 day periods. We used 39 camera-traps (25 Reconyx & 14 Bushnells) placed in 68 locations, selected from an initial randomly placed systematic grid, but placed on the nearest secure site (base of a tree or fence post) with similar habitat conditions. After 14 days, the cameras were moved to a second location. Most cameras (except those in secluded areas) were active only at night, to minimize impacts on park visitors and workload for processing images.

We collected data across a total of 927 trap nights, collecting 988 sequences of mammals and birds (6237 images). We obtained 73 sequences of hedgehogs and 744 sequences of foxes. Despite ten-fold more fox records than hedgehogs, slightly larger camera detection zones for foxes and, more markedly, higher speeds of movement in foxes suggested around six-fold greater detectability for this species. Estimated densities in Regent's Park were therefore much more similar between the species than their raw trap rates suggested: fox 25.2 km^{-2} (SE 6.3); hedgehog 16.2 km^{-2} (SE 8.2). Both these estimates are within the range of densities estimated elsewhere for these species. In a total area of 1.56 km^2, these results suggest populations of c. 40 foxes and c. 25 hedgehogs within Regent's Park.

Contents

Methodology

We base our survey on sixty camera locations obtained by overlaying a regular square grid of points, with 150 m (or more/less depending on the size of the park) spacing and a randomised starting location. The distribution of camera-trap sites in Regent's Park is presented in (Fig 1). A complete square array was initially overlaid, and any inaccessible points removed (in water, Winfield House grounds, outside park boundary fence). Deploying 33 cameras for 15 days per location, cameras will each be deployed at two locations, giving a total survey duration of 33 days. Where possible, cameras will be programmed to operate only between park closing and opening times – or in the evenings for parks open all night. We will remove and erase all photos of people, except those unrecognisable representing backgrounds of wildlife photos – which sometimes happen for daytime photos.

Setting up Cameras

Starting from the precise point position indicated on the map, cameras will be placed on the nearest suitable fixing point, where suitability depends on:

- Having a solid fixing point, whenever possible an existing tree or post, with the possibility of installing a new post when there is no other option and this is considered safe and feasible;
- Being within about 30 m of the map point;
- Ideally being relatively inconspicuous to the public;
- Having reasonably clear ground in the camera view; where the point falls in an unmown meadow, minimal vegetation clearing can be used to provide an adequate sight line.

Cameras will be fixed at about 20-30 cm above the ground, pointing as near as possible parallel to the ground. Cameras in locations considered more at risk of theft will be placed in security boxes and locked to the fixing point.

All cameras will be labelled with a small sticker requesting that they are not disturbed, explaining why they are there and that they are not operational by day, and giving a contact for more information.

When placing and removing cameras, a series of calibration images will be taken, photographing a standard object in order to parameterise a ground surface model, enabling us convert animal positions from digital image position to real world position (separate protocol to be provided).

Downloaded images will first be tagged with species and number identifiers. Images containing hedgehogs or foxes will then be processed to extract digital positions of animals, combining these data with calibrated ground surface models to estimate real world animal positions and movement speeds, which will then be used to parameterise random encounter model density estimates (separate protocols to be provided for these analyses).

Staff and Volunteers

The deployment and recover of the cameras involved the use of three sets of 10-12 volunteers who worked in pairs when deploying or recovering cameras. Volunteers were needed for three phases - the deployment of the first round of camera locations, then moving to the second round of locations and final collection.

The project will be steered by Marcus Rowcliffe (ZSL) and Chris Carbone (ZSL) and Ben Collen (UCL). Day to day field work and image management/processing will be carried out by volunteers recruited through ZSL or by the relevant parks staff. The surveys require (ideally):

1) One full-time volunteer (2 months) to oversee the site survey (camera placement, status and help store and process the images
2) 5-6 teams of day volunteers (10-12 in total) to set or take down the camera grid. Each survey requires three sets of these volunteers. On the first day to set up the initial locations, then to move the cameras to new locations, and the last day to collect the cameras.

Results

Distribution of Camera-trap sites in Regent's Park

Cameras were deployed in 63 locations, in two phases, each approximately 12-14 days in duration. Two of the Bushnell cameras were stolen or destroyed.

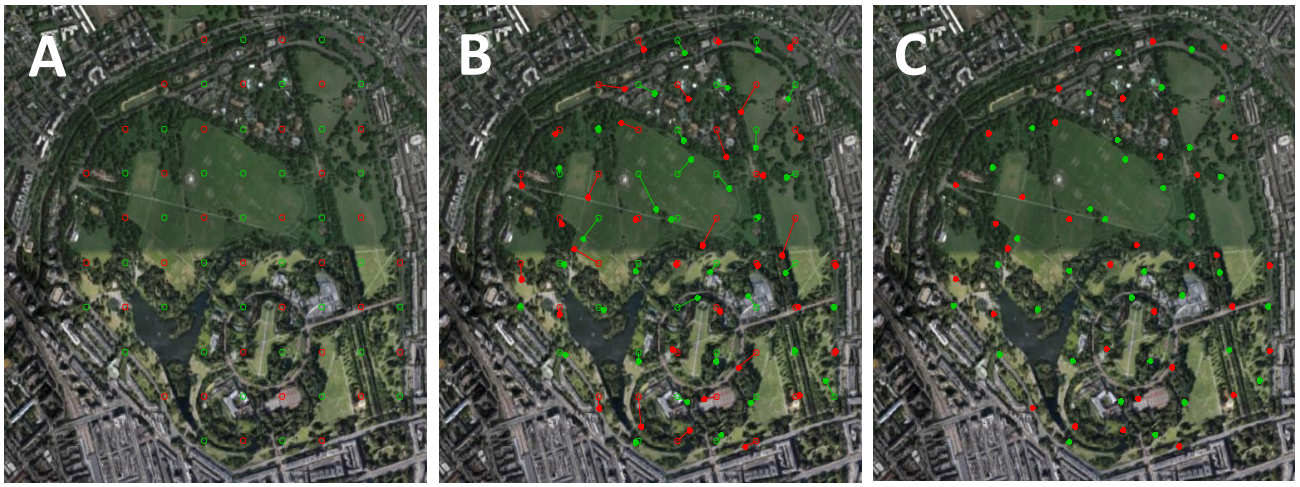


Figure 1. Camera trap locations originating from a uniform grid (A) to the nearest secure location (C).

Camera-trap records

We obtained over 100,000 images in total, though many of these were not usable. We obtained over 6000 images of mammals and birds (including dogs), and 73 and 744 sequences of hedgehogs and foxes (respectively). Foxes were far more abundance in the record both in terms of coverage and frequency.

Table 1. Camera-trap record.

	Images	Contacts
Calibration	5886	-
Fox	4385	744
Hedgehog	814	73
Rodent	766	115
Cat	139	26
Dog	124	28
Bird	9	2
Unidentified	51	-
TOTAL	6288	988

Activity of hedgehogs and foxes

In October 2017, the hedgehogs in Regent's Park showed a clear peak in nocturnal activity at around 1:00 AM but were recorded between 19:00-6:00 AM the following day (Fig. 2). Foxes were active throughout the evening. Estimated levels of activity using previously published methods (Rowcliffe et al 2015) varied between the two species, hedgehogs were estimated to be active 64% of the day, compared to 84% for foxes. There was some indication fox activity may have declined across the month, but there was no such trend found in hedgehogs (Fig. 3). The result for foxes suggest they may move out of the park periodically to feed.

In a recently reseeded field there was an abundance of fox activity and evidence that they were regularly eating earthworms there (Fig 4).

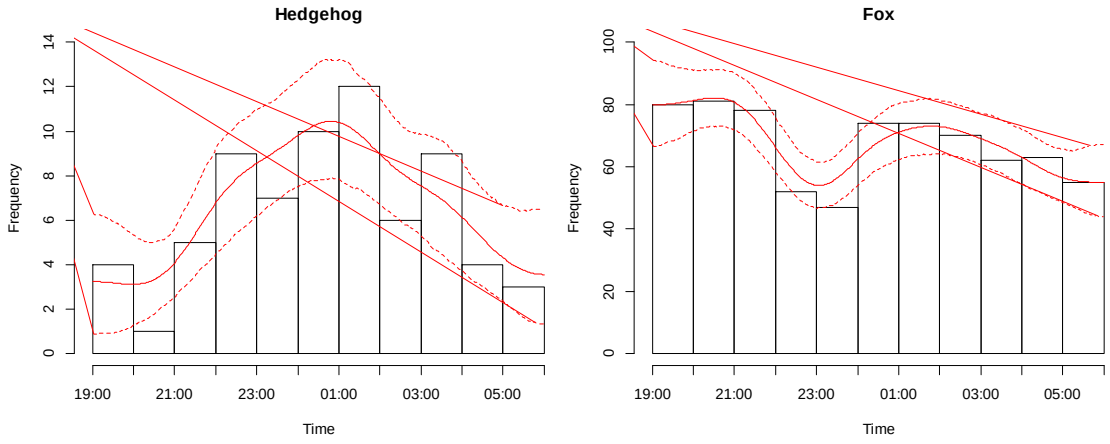


Figure 2. Activity patterns of hedgehogs and foxes derived from the camera-trap record.

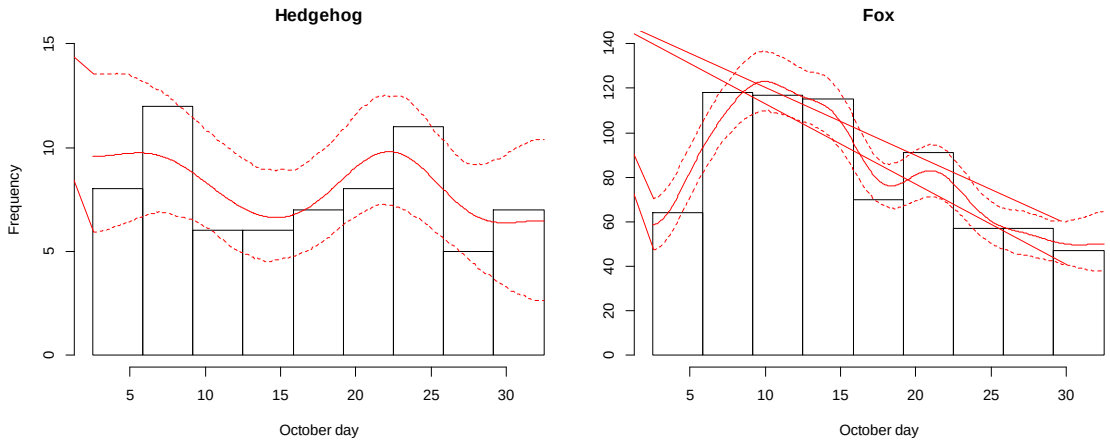


Figure 3. Variation in sighting rates across the study period.

Figure 4. Photos of foxes feeding on earthworms in a recently reseeded field.

Table 2. Estimated activity and movement parameters for hedgehog and fox. Activity level is the percentage of the night spent active. Active speed is the average speed of movement while active. Night range is the average distance covered per night. Standard errors are given in brackets.

Species	Activity level, %	Active speed, m/s	Night range, km
Hedgehog	60.6 (9.2)	0.041 (0.015)	11.9 (2.5)
Fox	82.0 (4.3)	0.172 (0.027)	2.1 (1.1)

The Distributions of foxes and hedgehogs

Foxes were widely distributed across the park, with sightings at virtually all camera locations, whereas hedgehogs were found in roughly ¼ of the sites.

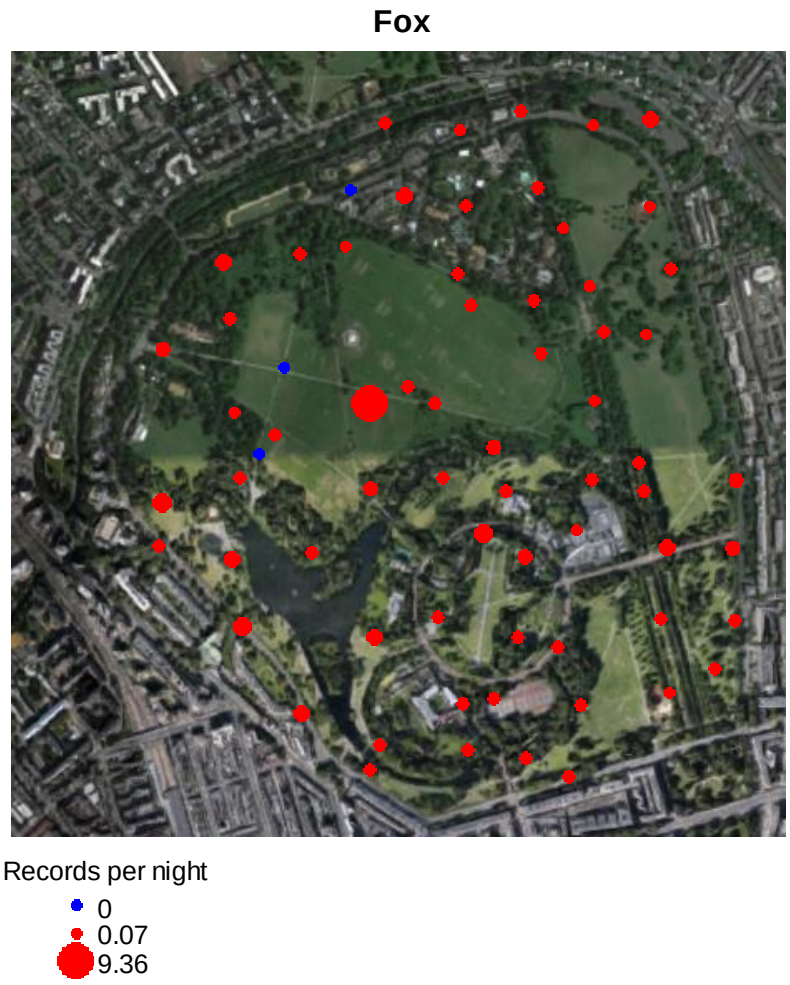


Figure 5. The distribution of fox sightings across camera-trap locations in Regent's Park.

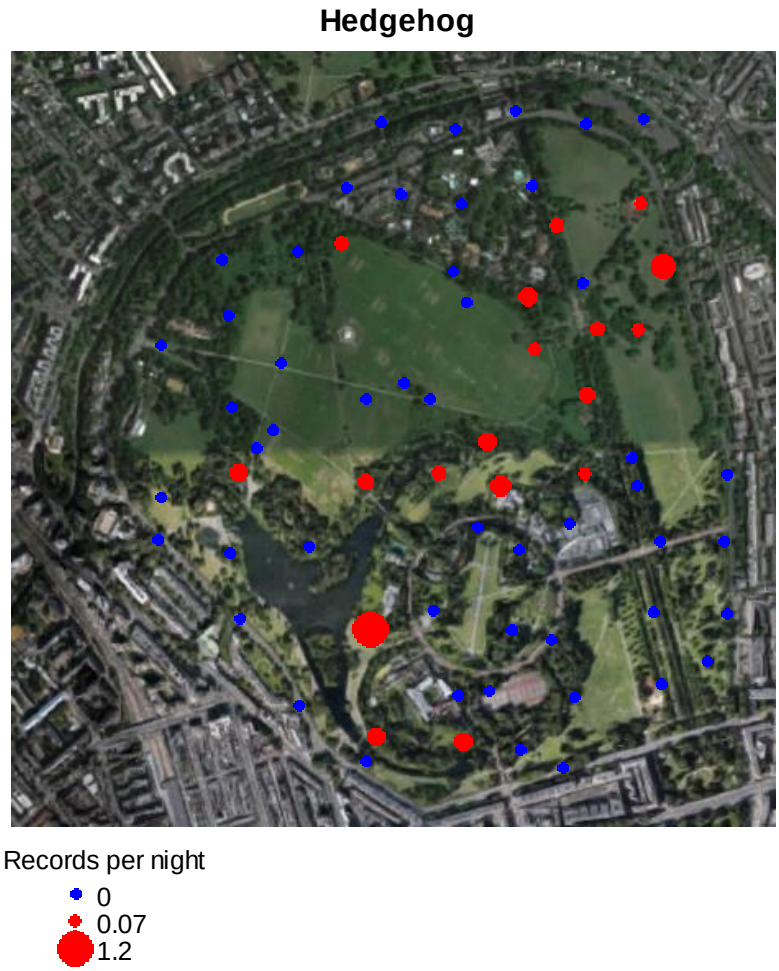


Figure 6. The distribution of hedgehog sightings across camera-trap locations in Regent's Park.

Camera trap detection zones

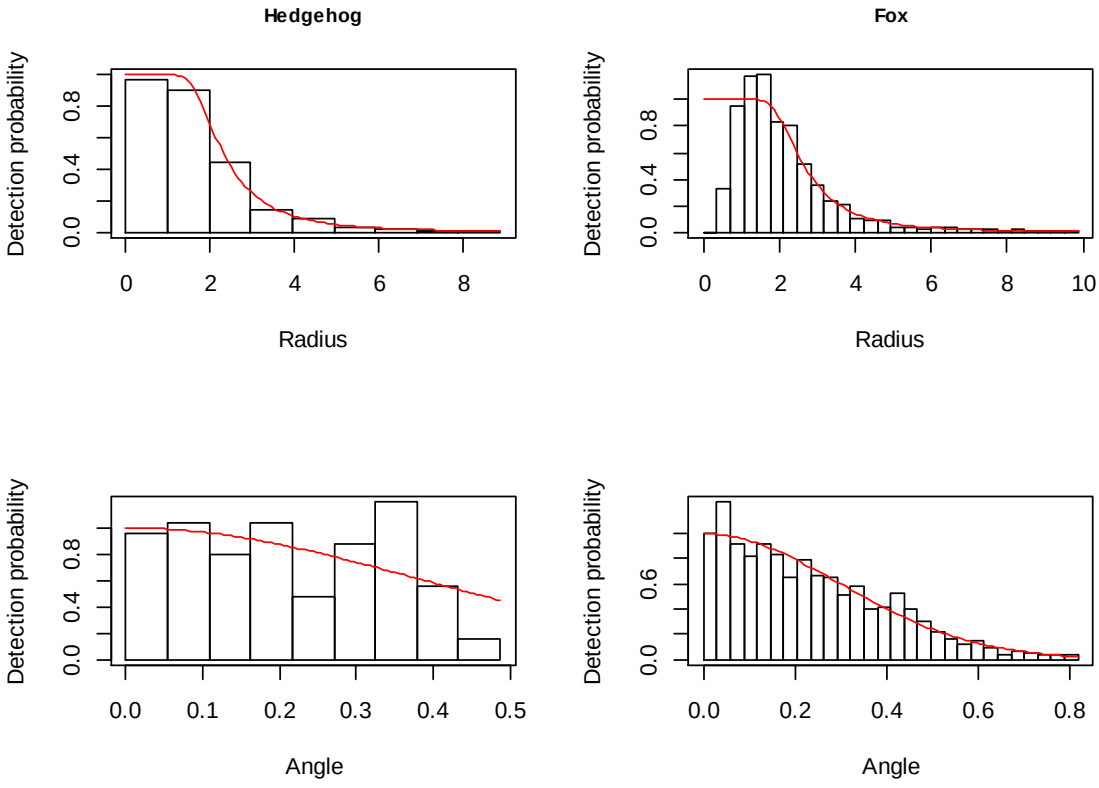


Figure 7. Distributions and fitted detection functions for radii (top) and angles (bottom) of positions on first detection for hedgehogs (left) and foxes (right).

Table 3. Estimated effective detection radii and angles (standard errors in brackets).

Species	Detection radius, m	Detection angle, degrees
Hedgehog	2.91 (0.19)	36.4 (1.0)
Fox	3.23 (0.06)	42.3 (0.3)

Density estimates of foxes and hedgehogs

Figure 8. Regent's park boundary from which population size extrapolated. Area within boundary is 1.56 km^2.

Table 4. Estimated densities and population sizes for Regent's Park, assuming an area of 1.56 km^2.

Species	**Density, km^{-2}**	**Population**
Hedgehog	16.2 (8.2)	25.3 (12.8)
Fox	25.2 (6.3)	39.3 (9.9)

Appendix 3a Spotlighting Proforma

Spotlighting Proforma – Sep 2016

(Don't forget to hand this proforma into Hedgehog HQ when you leave!)

Date: Date the survey data were collected in the field. Note: the date will change after midnight.	___ ___ / 09 / 2016 D D / MM / YYYY
Time Time the survey data were collected in the field: 00:00	___ ___ : ___ ___
Survey Zone Number Survey zone in which the hedgehog was found (1- 7)	
Hedgehog location on map. Mark the position of the hedgehog on a map & label it with hog number/zone/sex/date-time	*Staple map to this pro forma*
GPS reference: 10 digit NGR code using GPS Enter the hedgehog location e.g. TQ12345 12345	TQ _ _ _ _ _ _ _ _ _ _
How did you find the hedgehog?	Torch/Thermal Imaging Camera/Sound/Other *If other, please state…* *If found by thermal imaging camera, approx. how far away was the hedgehog in metres?* ____ m
Is there any evidence this hedgehog was marked in 2014? *If yes, state colour and location of marks or cut spines….provide photograph if possible (see below)*	Yes / No
Is the hedgehog already marked with yellow number tag(s) from the 2015 survey?	Yes / No *If yes, state number:* *If yes, how many tags left:* *Have you topped up the tags to 6? Yes/No*
If the hedgehog is <u>not</u> already marked with yellow number tag(s), enter the new number you mark it with.	
Hedgehog details	
Sex You should specify a sex	Male / Female / Unknown *If unknown, state reason why…*
Weight: Enter weight in grams (g) <u>minus</u> the weight of bag	
Circumference Specify a circumference in centimetres (cm) from the nose to the bottom of a <u>tightly</u> rolled up hedgehog. If hedgehog is not tightly rolled up, don't measure it.	
Ectoparasites Externally visible parasites	None / Ticks / Fleas / Mange / Maggots/ Other *Describe in detail location + type…*

Injuries Check eyes / ears / limbs / body	Yes/No *If yes, describe in detail location + type…*
Action taken with injured hedgehog? Provide details if necessary	Not applicable / Hedgehog left in field / Taken to vet / Other

Habitat

Habitat where hedgehog was found:	Select one location which best describes where hedgehog was found: □ Grass < 10cm tall (excluding sports pitches) □ Grass - cut but > 10 cm tall □ Tussocky rough grassland > 10cm tall □ Sports pitches □ Planted shrubberies/flower beds with mulch □ Planted shrubberies/flower beds without mulch □ Scrub (bramble/bracken, neglected overgrown shrubbery) □ Recent plant-colonised disturbed site □ Tall herbs but not scrub (e.g. willow herbs, dog's mercury, stinging nettle, hogweed, red campion, ferns) □ Reedbeds and marginals □ Hedgerow (under or within 50 cm of base) □ Woodland floor □ Bare soil (not in woodland/flower bed /shrubbery) □ Bare artificial habitat (e.g. tarmac, paved, hardstanding) □ Other (please describe in left panel ←)

Samples and photographs

Spine Sample Taken? If Yes, remember to mark the sample tube with: hog number /zone /sex/date-time	Yes / No
Photograph taken? If you take a photo, place a piece of paper next to the hedgehog stating: hog number/zone/sex/date-time	Yes / No *If yes, who took the photo…*
Comments – *Anything of interest, e.g.:* Breeding: Sexually active male / Lactating female / Recent copulation / Sexually inactive Unusual colour: Nose / Pad / Fur or spines Surroundings: Anything unusual? Behaviour: Was the hedgehog doing anything unusual?	

Proforma completed by:	Name:	Date: __ __ / 09 / 2016
Proforma checked by supervisor:	Name:	Date: __ __ / 09 / 2016
Data inputted into Cartographer by:	Name:	Date: __ __ / __ __ / 2016

Appendix 3b Fox Sighting Proforma

Fox Sighting Proforma – Sep 2016 (Don't forget to hand this proforma into Hedgehog HQ when you leave!)

Date (DD/MM/YYYY)	___ ___ / 09 / 2016 D D / MM / YYYY

Sightings

	Time of fox sighting in field HH:MM	Number of foxes seen	How did you see the fox? Torch / Thermal Imaging Camera / Sound / Other (please state)	Location marked? Mark on paper map	Location of fox sighting: 10 digit NGR code e.g. TQ 12345 12345	Survey zone number	Notes Free text
1				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
2				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
3				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
4				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
5				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
6				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
7				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
8				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
9				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
10				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
11				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		
12				Yes/No	TQ _ _ _ _ _ _ _ _ _ _		

Proforma completed by:	Name:	Date: ___ ___ / 09 / 2016
Proforma checked by supervisor:	Name:	Date: ___ ___ / 09 / 2016
Data inputted into Cartographer by:	Name:	Date: ___ ___ /___ ___ / 2016

Appendix 4 Equipment List

Item	Quantity
Survey equipment	
GPS Garmin	8
Superglue	10
Steret wipes	100
Sample pots. *NB, only needed if collecting spine samples*	50
Small canvas bags	11
Laminated supervisor packs	9
Numbering system and small plastic bags	1
Per fix spray	1
AAA batteries	283 (will vary)
AA batteries	391 (will vary)
LED torches	24
Headtorches	14
Spring balance	9
Fine pointed tweezers	9
Sprung side cutters	9
Tape measures	9
Scissors	9
Nail scissors	2
Hand sanitizer bottles	9
Tool rolls	9
Landing mats	9
Weigh bags	9
Mizuno Bags	12
Clip Boards	9
Goggles	18
Gloves	18
Thermal imaging cameras	8 if possible
Dry wipe pens	10
Volunteer welfare	
Personal torches	40
Waitrose Lanyards	50
Hi viz jackets	40
Hedgehog HQ	
Staplers	2
Pens & pencils	20
Pencils	15
Rubbers	10
Spare paper	1
Small white sticky labels for the numbering system	1 sheet
Whiteboard marker pen	2
Sandwich bag roll	1
Bin bags	1 roll
Tea	Lots
Coffee	2

Milk	8 pints a night
Sugar	1
Cardboard cups	400
Tea spoons	5
Biscuits	200
Crisps	200
Bowls for biscuits & fruit	3
Plastic cups for water	100
Tea urns	2
Kettle	1
Money box (to store keys in)	1
Kitchen roll	3
Toilet roll	8
Hand wash for toilets	2
Paper towels for toilets	4 wadges
Bleach	1
Air freshener	1
Cleaning spray	1
J cloths	8
Laptop	1
Projector	1
Extension lead	1

THE ROYAL PARKS FOUNDATION

A STUDY OF HEDGEHOGS IN THE REGENT'S PARK

Photo by Matt Haworth

VOLUNTEER SURVEY GUIDE SEPTEMBER 2016

Working in partnership with

THE ROYAL PARKS

ZSL LET'S WORK FOR WILDLIFE

Contents

1. Project Summary

What We're Doing

Following successful surveys in 2014 and 2015, we have gained a good understanding of the small and vulnerable hedgehog population in The Regent's Park. We have gathered comprehensive data about the movements, behaviours, home ranges, habitat preferences and isolated nature of the hedgehogs in the Park.

We are now carrying out a third year of our Hedgehog Study, this time with a focus on establishing overall hedgehog numbers, rather than finding out more about their behaviour, in order to monitor the population trend.

We will share our findings in a report in spring 2017 and will use this to continue to make recommendations for enhancing hedgehog habitat within Regent's Park and further afield.

Who's Involved?

This project is a fantastic partnership that brings together the Royal Parks Foundation, The Royal Parks, the Zoological Society of London (ZSL), and expert wildlife biologists Dr Nigel Reeve and Professor John Gurnell, along with support and guidance from The Garden Wildlife Health Project, The People's Trust for Endangered Species and Central Royal Parks Wildlife Group. It has been funded by a generous neighbour, passionate about hedgehog conservation. The fieldwork will be made possible thanks to a team of volunteers, ecology students and local neighbours with a keen interest in wildlife and conservation.

What else we hope to achieve

Through community engagement and a communications campaign, we hope to inspire local people to take a greater, active interest in urban wildlife conservation. We'll be hosting hedgehog themed Discovery Days from our Education Centre in Hyde Park over the summer and hopefully reprinting our hedgehog family activity sheets for use in the cafes in Regent's Park.

2. About hedgehogs

Hedgehogs were once common and familiar animals in rural and suburban British landscapes but there is evidence from a number of sources of a significant and general decline in numbers in recent years. Several factors have been put forward as reasons for this decline, including:

- Predation, especially by badgers in areas with high badger densities
- Death from traffic on roads or being killed in bonfires
- Changes in agricultural practice and a reduction in invertebrate food availability
- Fragmentation of habitat
- In gardens, the absence of garden compost/wood piles/leaf litter for hibernation sites and the use of fences (rather than hedges) without movement gaps at ground level to allow hedgehog movements. Also drowning in garden ponds without escape ramps, injuries from garden tools and other hazards.
- Becoming trapped in cattle grids or becoming caught in discarded cans, and other debris

The presence of hedgehogs in London's central Royal Parks mirrors this national decline; in the early 1970s they were found in all the central Parks, but since then they have disappeared from all except The Regent's Park.

However, explanations for the loss of hedgehogs are circumstantial and there is a lack of direct scientific evidence about the true extent, scale and causes of the hedgehog decline. This applies as much to London's Parks as to the wider countryside. So, why are hedgehogs able to persist in The Regent's Park and not elsewhere, and what can be done to ensure they survive into the future? This project directly addresses these questions and, from the findings, will draw up habitat management recommendations for The Regent's Park that may also be applied to other urban open spaces.

Since 2007 hedgehogs have been a UK Biodiversity Action Plan (BAP) priority species and also a Westminster BAP species for which The Royal Parks is a lead partner.

Developing habitat management recommendations

Since 2014, this study has provided a more detailed understanding of which features and areas of the Park (and its surroundings) are used by hedgehogs and, for example, whether they are used for nesting or foraging for food. This information has been reviewed in light of our existing understanding of hedgehog habitat requirements to develop detailed recommendations for conserving hedgehogs in the Park and its surroundings. We hope the results will also help inform managers of other urban open spaces on managing habitats sympathetically for hedgehogs.

3. Survey Activities Overview

A. Spotlighting

This is a general nocturnal survey carried out by teams of volunteers to help provide hedgehog population estimates in the Park. Volunteers will be tasked to find active hedgehogs by torchlight and with the use of a thermal imaging camera, make notes on their health and condition, then mark them with plastic markers on the spines so we can identify each hedgehog for the rest of the survey.

How do I do it?

As well as spotlighting the animals using a torch, looking for hedgehogs involves listening for the rustle as they move through the undergrowth, or the noises made during courtship or fighting. While following your designated route, you need to be quiet, avoid talking, and wear rustle-free clothing. Noise from wind or traffic or walking on loose gravel paths can reduce your searching efficiency. Walk on the grass or bound surfaces where possible. Hedgehogs freeze when they hear something coming.

Walk your route at a steady slow rate, pausing briefly roughly every 20 metres or so to listen for sounds. Hedgehogs are not called hedgehogs for nothing – studies have shown that they spend 80% or more of their time within five metres of hedges and other edge features. However, they may also forage in open grassland where they are easy to spot when the grass is short. So walk close to the edges of hedgerows or borders, keep listening and use your torch systematically to scan the open ground as well as checking the edge habitat. If there are two of you, then one can search the open ground while the other concentrates on the denser habitat. Where light pollution from street lighting is enough, you can sometimes see animals moving in open ground without a torch. Try to keep your night vision by avoiding shining the torch, especially head torches, in people's eyes. Using red light can help, especially while taking notes.

When you spotlight an animal it may freeze or run. Try to 'pin it down' with the light, but you may need to be quick on your feet. If you hear an animal, try to locate it as precisely as possible before trying to spotlight it. In undergrowth, if you alert it too early and make it freeze, you may never find it. If you heard snorting, then look for two animals.

Use of the thermal imaging cameras

Each group will have access to a Flir E60 thermal imaging camera. These are worth about £7,000 each so please look after them carefully! They proved useful in detecting hedgehog presence in the field last year, particularly in areas of open areas of short grassland. The battery life is 4 hours and it can be used during your entire shift. The best mode is the 'Above Alarm' setting where you can adjust the temperature threshold above which the hedgehog would be displayed in red against a grey background. Don't forget to manually focus the lens as this makes a big difference.

It's best to stand still and scan the surrounding area slowly using the camera and then walk 50m or so, stop and scan again - the screen does affect your night vision and you may be prone to tripping in the Park if you walk and use the camera at the same time! If the hedeghog is displaying interesting or unusual behaviour, then you can take a video or a still image with this camera - just press and depress the trigger under your index finger.

B. Records of fox sightings

Whilst in the field, we will record any fox sightings within the Park to help monitor their distribution and activity. Volunteers will complete fox proformas with their supervisors and mark on a map where the fox was sighted, what habitat type it was using and what its activity was.

4. Hedgehog Sep Survey 2016 – Activity Schedule

Spotlighting Schedule

	Friday 2 Sep	Saturday 3 Sep	Friday 9 Sep	Saturday 10 Sep
Timing	8pm – 12.00am	12.30am – 4.30am	8pm – 12.00am	12.30am – 4.30am
Groups	7 groups of 4 or 5	7 groups of 4 or 5	7 groups of 4 or 5	7 groups of 4 or 5
Supervisors	9	10	9	10
Volunteers	30	30	30	30

5. The Regent's Park Zones

We have divided The Regent's Park into eight zones, as follows:

Zone 1a	Marylebone Green, Community Wildlife Gardens, Tennis courts, Regent's University
Zone 1b	Avenue Gardens, English Gardens and Park Square Gardens
Zone 2a	Gloucester Green, Zoo car park
Zone 2b	Cumberland Green and the Broadwalk up to Ready Money Fountain
Zone 3	Sports pitches and southern border of the Zoo
Zone 4	Back of nursery, St John's Lodge garden, Wetland area, Long Bridge
Zone 5	Hanover Green, water side, Holme Green, Queen Mary's Gardens
Zone 6	Edge of lake, Winter Gardens, Running track, Leafyard Wood
Zone 7	ZSL (London Zoo)

You can see these zones clearly marked in the Visitor's Map provided in your pack. Detailed maps of each area will be located at Hedgehog HQ and given to each group supervisor for each session.

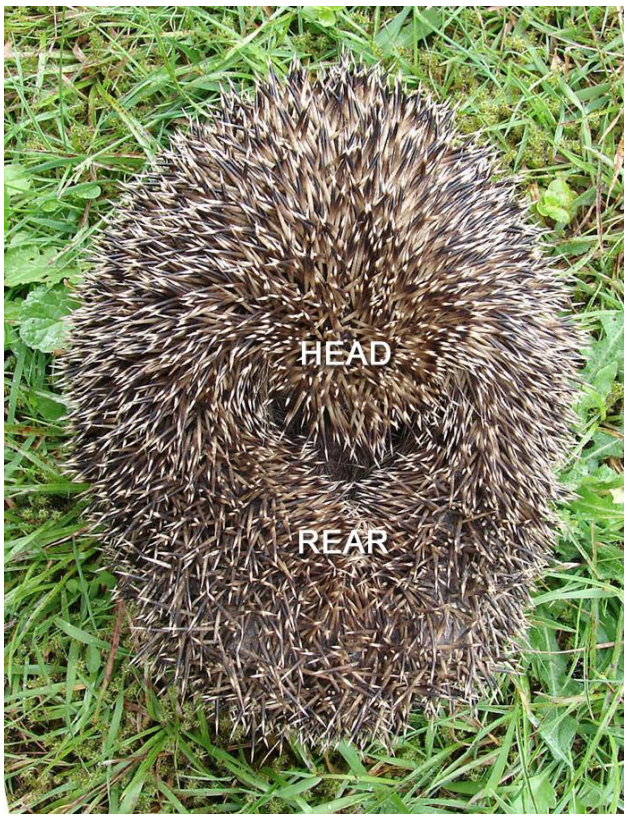
6. How to Handle a Hedgehog

As part of the survey activities, we are hoping we will come into contact with hedgehogs in the Park. If you are happy and confident to, there may be the opportunity to handle a hedgehog. Your project supervisor will be able to assist you.

Always wear gloves. Hedgehogs rarely bite but are prickly and normally very dirty. During handling, be quiet and avoid rustling or clicking noises, don't make what you might think of as reassuring noises like tutting or shushing. Ensure any open wounds, cuts or grazes you may have are covered with a plaster and use hand-sanitizing gel or wash your hands after handling them.

When you pick up a wild hedgehog it will usually roll-up into a ball. To examine it, you need to get it to unroll. Various methods exist but this one is relatively easily taught and usually successful. Some individuals are very reluctant to unroll and it can take many minutes just to determine the sex of the animal. The technique (for a right handed person) is as follows:

Gently pick up the hedgehog and hold it face down so that its rear-end is in your right palm and your left hand is under its front end (nose pointing away from you). Gently bounce it up and down in your hands, with luck it will gradually put out its feet and untuck its snout - now you have a crouching hedgehog. Without hurrying, keep bouncing it gently and allow the snout to poke between the thumb and index finger of the left hand and, using gentle but firm pressure, place the thumb on the back of its neck. Now it cannot tuck its head back down. Gently gripping the underside at the rear of the animal with your right fingers, put your right thumb in the small of its back and gently open out the animal by flexing it backwards; keep all movements smooth and slow.

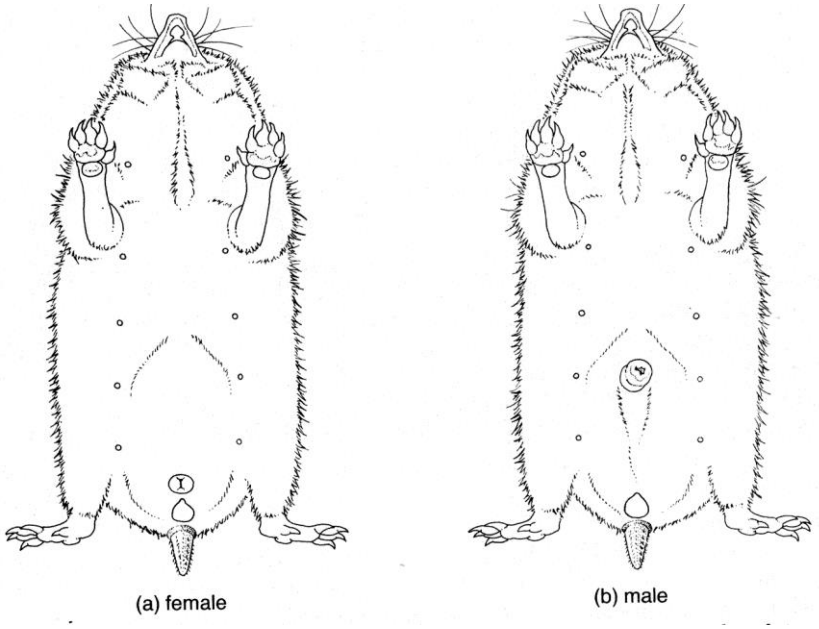


A rolled-up hedgehog on its back.

A wild-caught hedgehog unrolled in the hand.

The sexes can only be told apart by inspecting their genitalia. Luckily the differences are obvious. The male has a conspicuous penis sheath opening well forward on the belly (roughly where one might expect to see the navel), whereas the vulva of the female is very close to the anus. Although the male's testes are abdominal, there is a visible bulge in mature animals. Up to 10 nipples are visible in both sexes, but in pregnant or lactating females they may be more prominent.

If an animal will not unroll in the hand, lay it on its back on the ground. Wait quietly until it begins to unroll. Just as the animal rights itself (as if to run away) it will open up and you stand a good chance of seeing the underside. Because the penis sheath is usually obvious, you can usually determine the sex.



Drawing and photograph of the undersides of the two sexes.
Drawing Source: p. 42 in Reeve N. J. (1994) Hedgehogs, Poyser. Photograph Source: N.J.Reeve

7. Hedgehog Marking System

During the spotlighting activity we will capture and mark the hedgehogs we encounter. We'll use Nigel Reeve's new marking system which worked well when we trialled it last year. This involves short lengths of yellow coloured plastic tubing printed with a three digit number preceded by a '#'. Six duplicate numbers will be attached to the spines of the hedgehog on the crown of its head using superglue and tweezers.

This can be done even with the animal still rolled up. Your project supervisor will advise you on which number to use, then follow these steps:

- Take a short (5 to 10mm) piece of the appropriate numbered yellow plastic tubing.
- Hold one end, (by hand or with tweezers) fit the other to the nozzle of the tube of glue (e.g. UHU, Bostic multi-purpose glue) and pump a small bead of glue inside the tubing.
- Then quickly slip the piece of plastic tubing over a spine in the chosen location.
- The glue will bond it to the spine. Ensure the sharp tip of the spine protrudes from the tubing.
- In this study we are marking six spines on the crest of the head so that even if some spines are moulted at least one should remain for the duration of the study.

LOCATION OF YELLOW NUMBERING SYSTEM

Example of 2015 numbering system on a hedgehog

Example of plastic tubing marking system used in 2014 – in case you spot any different colours of tubing, blue, red, white or yellow

8. Hedgehog First Aid

Nic Masters, Head of Veterinary Services at ZSL, has provided a veterinary first aid plan for the Hedgehog survey, in case any hedgehogs found require veterinary attention. The plan is based on three scenarios. Your project supervisor will be able to help you if a hedgehog does need veterinary attention:

1. Moribund or severely injured hedgehog (e.g. Road Traffic Accident or dog attack) requiring euthanasia.
2. Hedgehog with minor issue (e.g. constriction injury to limb) that can be treated effectively with immediate first aid and then released at exactly the same site.
3. Hedgehog with more serious issue that requires temporary hospitalisation followed by either release within a few days at exactly the same site, or rehoming in a rescue centre (agreed beforehand) within a few days.

Types of injuries you may encounter:

- Missing or injured eyes from contact with thorns etc.
- Torn ears
- Bites or grazes on the hedgehog's side flanks
- Missing or damaged limbs
- Skin diseases
- 'Fly blown' wounds (an infected wound, looks like little grains of rice which are fly eggs)

What to do if you come across an injured hedgehog:

- Keep the hedgehog safe, calm and still, making sure the group is as quiet as possible.

- Contact the project coordinator at HQ who will arrange for the animal to be collected and taken to the ZSL vets for examination.

- While you wait, complete a spotlighting proforma with as much information as possible. Record the animal number if previously tagged. Do not try to sex the animal if you think that it will cause it further discomfort.

- If the animal is not tagged, add a new set of yellow tags to the crown of its head so that it can be identified in future.

- Make a detailed note of the injuries on the proforma and take photos if it is possible to do so without distressing the animal.

9. Data Management

A. COLLECTING AND STORING DATA

Data is an essential part of this project and it's critical we record and store results accurately so they can be analysed to meet the objectives of this project.

For every survey activity, your group will be asked to complete a pro forma to collect data and information. These proformas will be introduced to you at the volunteer training workshop and you will be instructed on how to fill these in. Don't worry, the supervisor on each activity will also be able to remind you how to fill these in and will sign them off after they've been completed.

Once we have all the data collected from the survey, the Project Team will upload this data to Cartographer and Dropbox. We use two online platforms that make it easy for us to view and analyse the data.

B. STORING PHOTOS ON DROPBOX

WHAT IS IT?

Dropbox is an online service that lets you share photos and videos. We are using it as it has the capacity to store lots of large files, such as videos and photos which will be taken in the field. All volunteers will use Dropbox to upload photos and / or videos from any of the surveys; they will not use Dropbox to enter any data from the survey.

HOW TO TAKE THE FIRST PHOTO OF A HEDGEHOG

When taking the first photo of a new hedgehog – it is very important to remember to use the photo label template provided. Complete the label and place it beside the newly marked hedgehog so that it is legible and clear in the photo. Your Supervisor will have a copy of the labels for you.

HOW TO UPLOAD PHOTOS & VIDEOS

So that we all know who took each photo / video, when and where, we will ask you to save all files as follows:

Date_Hog#_Notable Features_Zone(s)_Your Name

An example would look like this:

Fri02Sep_#155_damagedleg_Zone1_JohnSmith

FRI02SEP is Friday 02 September (as per the folder title)
HOG # if known, insert the hedgehog number
NOTABLE FEATURES if there's anything we need to know about the hedgehog, e.g. damaged leg, torn ear etc
ZONE1 relates to the zone(s) of the park your photo was taken from
YOUR NAME, well it's your name!
Thank you in advance for following these instructions. This way, it will be much easier for us to organise all the data and media collected for the survey, and also easier to acknowledge you if we use your photo in the future. If you have any questions about the above, please get in touch with the Hedgehog Project Team.

10. Volunteer Kit List

VOLUNTEERS WILL NEED TO BRING THE FOLLOWING ITEMS WITH THEM TO EACH SESSION:

- Appropriate clothing for the activity:
    - Stout walking shoes
    - Warm clothing for nocturnal activities
    - Wet weather gear if needed
    - Change of clothes if wet *(particularly a change of socks!)*
    - Where possible, please wear non 'rustly' clothing as hedgehogs don't like this noise

- Mobile phone *(fully charged)*

- Water bottle *(you can fill it with tap water at HQ)*

- Snacks if you feel you might need them *(light refreshments will be available at Hedgehog HQ)*

- Camera *(if possible, particularly if it has night vision)*

- Volunteer kit you will be provided with:
    - Personal torch for nocturnal work
    - High viz jacket for nocturnal work
    - Lanyard & volunteer ID card
    - Stationery and survey equipment as needed

11. Risk Assessment

A Risk Assessment for the Hedgehog Survey can be found in the back of your pack. Please ensure you read this ahead of your first volunteer session.

12. Hedgehog Headquarters (HQ)

Location

Hedgehog HQ is at the Old Ironworks building on the Inner Circle, Regent's Park *(see map in your pack)*.

Security & Access

Hedgehog HQ will be accessible during the times and dates of all survey activities. Hedgehog HQ will be locked at all other times.

Facilities

Hedgehog HQ will have:

- Toilets
- Access to running water
- Tea, coffee and light refreshments
- First aid and welfare items
- Location to store your personal belongings whilst out on your survey activity *(although we recommend you don't bring anything too expensive or sentimental with you)*

Bicycle Parking

Hedgehog HQ will have space available for you to lock up any bicycles. Please bring a bike lock with you.

13. Emergency Procedure

A. In the case of an emergency requiring Regent's Park to be evacuated:

- You will be contacted by your supervisor and updated on the situation
- Please follow instructions from your supervisor for next steps

B. In the event you/your group gets lost or separated from your supervisor:

- Please head towards Hedgehog HQ on the Inner Circle to meet up with your supervisor
- If you need directions, please phone Clare Bowen on 07785 318717
- Before you start an activity, please make a note of your supervisor's mobile phone number in your field notebook or store it on your phone.

C. In the case of accident or injury to you/a team member:

- Please phone 999 if serious
- Then phone Clare Bowen on 07785 318717 to update them on the situation

D. If you encounter antisocial behaviour from a member of the public

- Do not confront them. Get yourself into a safe position. Call 999 if you feel threatened. Inform your supervisor. Make your way back to Hedgehog HQ.

14. Travel

Modes of Transport

- Where possible and safe to do so, we would appreciate people use environmentally friendly modes of transport (e.g. walk, cycling or public transport) to get to The Regent's Park.
- If required, parking will be available for the survey period. Please get in touch with Tess Pettinger on tpettinger@royalparksfoundation.org if you would like to drive and require a parking permit for Regent's Park. She will need the make of car, colour and registration number.

Reimbursements

- We are happy to reimburse any reasonable travel expenses incurred during the Hedgehog Survey
- Please ensure you keep any receipts and we will ask you to submit these at the end of the survey period
- If your travel cost will be over £10 please could you let us know before purchasing so we can confirm the cost with you
- We would also ask that any travel which can be covered by a pre-purchased travel card you already own does not get submitted for reimbursement
- We will reimburse you by cheque, this should be sent out to you within 6 weeks of the end of the survey

Late night exit from the Regent's Park

In September, The Regent's Park will close to the public at 8pm. During our nocturnal surveys (Spotlighting) which will finish after 8pm, the exits from the Park will be:

Pedestrian:

- Chester Gate
- Gloucester Gate
- Hanover Gate
- Clarence Gate
- Park Square East and West

Car:

- Chester Gate (in)
- Clarence Gate (out)
- Hanover Gate (in/out)

Please see these marked on the map in the back of your pack.

15. Key Contact Details

Hedgehog Project team

Clare Bowen: Head of Programmes: Royal Parks Foundation
cbowen@royalparksfoundation.org
07785 318717

Tess Pettinger: Programmes Manager: Royal Parks Foundation *(available on Friday 2 and Saturday 3 September only)*
tpettinger@royalparksfoundation.org
07801 260740

General Royal Parks Foundation Office Number (weekdays, 9am – 5.30pm): 020 7036 8040

On call The Royal Parks Officer: The Regent's Park + Primrose Hill: 07969 726083

16. A Partnership Project

Project Lead

- Royal Parks Foundation, the charity for London's eight amazing Royal Parks. Registered charity number, 1097545.

Project Partners

- The Royal Parks
- Zoological Society of London

Independent advisors

- Dr Nigel Reeve
- Emeritus Professor of Ecology John Gurnell

Support and Guidance from

- Garden Wildlife Health Project
- People's Trust for Endangered Species
- Central Royal Parks Wildlife Group

Appendix 6 Risk Assessment

Royal Parks Foundation
Regent's Park Hedgehog Survey Risk Assessment
Friday 2 Sep – Saturday 10 Sep 2016

Action	Hazard	Who is at risk?	Existing Controls	Risk Rating			Additional Controls Required
				L[1]	C[2]	R[3]	
Using equipment and hand tools	*Repetitive movements, sharp edges*	Hedgehog Project team and volunteers	Demonstration on how to use the equipment and hand tools at the volunteer training session. Gloves to be worn when appropriate. All tools are well maintained.	3	1	3	First Aid kit and first aiders available.
Handling a hedgehog	*Sharp spines, bites and germs*	Hedgehog Project team and volunteers	All participants and Hedgehog Project team to wear thick gardening gloves when handling a Hedgehog, all gloves to be sprayed with dettox when returned.	3	2	6	First Aid kit and first aiders available.
Working outdoors in the Park	*Bending down, repetitive movements causing repetitive strain injuries*	Hedgehog Project team and volunteers	At the training workshop and at start of each activity session participants to be reminded to work within their personal capabilities and to take regular breaks. Project supervisors to monitor.	2	2	4	

Working near roads in Regent's Park	*Vehicles, bikes, horses and other Park users*	Hedgehog Project team and volunteers	Volunteers briefed to be aware of the roads in Regent's Park and their users at the training workshop and at start of each session. Project supervisors to monitor the roads and volunteers throughout the session and be aware of any concerns. Hedgehog Project team and volunteers to all wear hi-viz jackets when on site and carrying out survey activities.	2	2	4	
Nocturnal working	*Working in the dark – limited vision causing trips and falls*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team to each carry a personal torch at all times. Volunteers not to work by themselves and be with another person at all times when working in the Parks. Volunteers have access to the emergency procedure for any problems. First aider to be on site on each shift.	4	2	8	
Nocturnal working	*Working in the dark – being separated from the group*	Hedgehog Project team and volunteers	Volunteers and Hedgehog project team to each wear a high viz jacket when working at night. Volunteers to take their team supervisors mobile phone number before they head into the field. Volunteers to be issued with a lanyard with key contact information for the Hedgehog project team they can call if they become separated. Group supervisors briefed to regularly check on the location of all members of their team.	3	2	6	
Nocturnal working	*Violent or aggressive behaviour*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team to be aware of other Park users. If come across any violent or aggressive Park user, make yourself safe, move to a safe distance away, then 999 to be called immediately in case of any violent or aggressive behaviour. Volunteers must not work alone during any survey activity. Additionally at night time, volunteers to be provided with clear routes in and out of the Park and encouraged to leave in pairs or more. Taxis arranged for anyone travelling further afield after the tube finishes.	3	2	6	

Working near Regent's Park lake	*Proximity of water - falling in*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team briefed not to go near the Regent's Park Lake at the training workshop and at start of each activity session. Hedgehog Project team to monitor the volunteers and direct any away from the lake if necessary. Survey teams not to go close to the lake particularly during nocturnal activities.	1	3	3	
Working outdoors in the Park	*Park fabric + uneven ground causing slips, trips or falls*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team advised at the training workshop and at start of each activity session not to run on gravel paths or across Park land as the ground can be uneven and there may be potholes. Walking routes will be clearly defined and appropriate, stout, footwear to be worn by all.	3	1	3	First Aid kit and first aiders available.
Working outdoors in the Park	*Heat or cold related illness e.g. Sunburn, sunstroke, chilblains, hypothermia*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team advised at training workshop to wear weather-appropriate clothing. Activities to be stopped if volunteers clothing unsuitable for conditions. Spare clothing to be stored at Hedgehog HQ if required.	3	1	3	
Working outdoors in the Park	*Coming into contact with the hazardous plants, e.g. Nettle stings, allergic reaction, poisoning if eaten*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team to be aware of nettles and other stinging plants and advised to avoid them. Volunteers advised not to eat any plants found in the Park. Hand-washing facilities available at Hedgehog HQ.	3	1	3	
Working in the Park	*Bird faeces, bacterial infections*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team advised at the training workshop and at start of each activity session not to put hands in their mouths, hand-washing facilities available. Any open wounds, cuts or grazes to be covered with plasters. Project supervisors and/or volunteers to carry hand sanitizing gel. Volunteers instructed to wash hands before eating/ at end of session.	3	2	6	

Working in the Park	*Presence of dog faeces, Toxocariasis*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team briefed at the training workshop and at start of each activity session on possible presence of dog faeces and not to touch it.	2	1	2	
Working under and near trees	*Falling branches*	Hedgehog Project team and volunteers	Regular tree inspections from Park staff. Avoid working under trees in strong wind. Park to close in event of extremely high winds, hedgehog session to be re-scheduled on an alternative day.	1	3	3	
Working near other park users	*Violent or aggressive behaviour*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team to be aware of other Park users. If come across any violent or aggressive Park user, make yourself safe, move to a safe distance away, then 999 to be called immediately in case of any violent or aggressive behaviour. Volunteers must not work alone during any survey activity.	1	3	3	
Coming into contact with wildlife	*Grazes, bites, infection.*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team advised to not touch wildlife (except Hedgehogs where appropriate) within the Park whilst working on their activity. Particularly waterfowl and dogs. Any open wounds, cuts or grazes to be covered with plasters.	3	2	6	
Working in park land	*Coming into contact with small litter in project site.*	Hedgehog Project team and volunteers	Regent's Park litter picked daily. Volunteers and Hedgehog Project team must not touch or pick-up used litter, needles or syringes found during a project. Gardening gloves to be worn where appropriate whilst carrying out activities. Charity supervisor to pick up any sharps using gloves and place in hard Tupperware box. Box to then be disposed of in normal rubbish.	1	3	3	Report any needles or syringes found at the project site immediately to the charity supervisor.
Working outdoors in spring and summer	*High pollen count*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team advised pre-visit if pollen count is forecast to be high so that people with severe allergies may take/bring appropriate medication. In case of severe reaction, phone 999.	2	2	4	First Aid kit and first aiders available.

Working outdoors in spring and summer	*Bee, hornet and wasp stings*	Hedgehog Project team and volunteers	Remove bee sting as quickly as possible. Watch closely for symptoms. In event of sudden swelling, breathlessness or increased heart rate, ambulance to be called immediately by phoning 999.	1	3	3	
Working near the Wildfowl collection	*Intimidation and pecking*	Hedgehog Project team and volunteers	Volunteers and Hedgehog Project team to monitor the area throughout the activity time and be aware of any wildfowl encroaching on the space and warn others in their team if coming nearby.	1	3	3	

Add in site specific detail that may affect the risk rating as stated above (include the date, time and weather conditions).

[1]Likelihood of Occurrence	[2]Likely Consequences	[3]Risk Rating R = L x C
1. Improbable: probability is close to zero	1. Negligible: Trivial injury (requiring minor first aid)	1-5 Tolerable: No additional controls required
2. Remote: Unlikely though conceivable	2. Minor: Minor injury/short term issue	6-10 Low Risk: Probably requiring written guidelines
3. Occasional: Could occur some time	3. Serious: Single severe injury and/or multiple minor injuries	11-15 Medium Risk: Written guidelines required until risk is designed out
4. Probable: Occurs repeatedly/an event to be expected	4. Critical: Single fatality and/or multiple severe injuries	16-20 High Risk: Consider need for activity and additional control methods
5. Frequent: Not surprised if event occurs/will occur several times	5. Catastrophic: Multiple fatalities	21-25 Intolerable Risk: Cease activity

Project Site: Various sites around Regent's Park	
Assessor(s): Sara Harrison	Date: 18.08.2016
Signature(s):	Date for Review: Ongoing during Hedgehog Survey, Fri 2 Sep to Sat 10 Sep 2016

Appendix 7 Summary of reported Regent's Park hedgehog casualties in 2016

23 March 2016 Male #153
This was an adult male, found on Chester Road. Highly suspect road traffic accident- sadly it was completely eviscerated. No post-mortem examination
18 August 2016 – no markings Sex – unknown
A ZSL member of staff found a dead hedgehog along Prince Albert Road at c7.30am. The animal was road kill and didn't have any obvious markings. When he returned about an hour later (ca. 08:30h) to collect the carcass, it had been removed, possibly by a street cleaner. No post-mortem examination
20 May 2016 # 197 Sex – unknown
Found by survey volunteers. The volunteer saw a fox drop the dead hedgehog from its jaws. The hedgehog was in advanced state of decomposition No post-mortem examination
May 2016 #199
Awaiting post-mortem report
14 April 2016 Female #192 – Hedgehog euthanased
ZSL Vet report
Conscious examination. Can curl up but does not do so normally. Spine is laterally deviated to the left as move caudally, with both hind legs still tucked under the animal. Not able to stand, propriocept and walk normally, although motor function is clearly intact to hind legs. Odd repetitive 'scratching' behaviour of left hind leg. Review of radiographs show previous bony injury to right hock, possible dislocation of left elbow, fractures of left ribs and left scapula - presumably as the result of severe physical trauma. Grossly, these lesions are not apparent externally and there is no evidence of ongoing infection. Agreed with Royal Parks that animal could move to rehabilitator, but with poor prognosis. If unable to locomote and eat due to neurological signs then PTS is advised.
Post mortem examination 0f #192 produced by the Garden Wildlife Health Project **Gross exam - XT708-16**
Examined is the carcass of an adult female European hedgehog (*Erinaceus europaeus*) in thin body condition and with moderate autolysis (decomposition). There is no visible subcutaneous fat. There is a moderate amount of dark brown/black sticky thick material over the spines on dorsum and head and the spines appear fractured in this area. There is an area of alopecia within this region (10 x 8 cm). There are multiple areas of alopecia over the ventrum and the ventral skin appears diffusely covered in tan brown crust. The muscles of the left thigh appear dark red in colour. There is evidence of an old healed fracture of the right tibiotarsus. The left elbow is luxated and the left scapula has a closed simple fracture with no significant changes in the soft tissues surrounding. The stomach is empty. In the small intestine are moderate amount of light brown mucoid material. In the large intestine are moderate amounts of dark green-brown mucoid material. The lungs are mottled dark red in colour.

Other tests
Approximately a dozen fleas are seen on the carcass. *Staphylococcus* spp. is isolated from a sample of the skin. No dermatophytes (ringworm) were isolated from a sample of the skin. No significant bacteria are cultured from the liver or small intestine. No parasites are seen on wet preparations of the intestinal contents and lung. **Comment**
This hedgehog was euthanized due to observed hindlimb paralysis. The left elbow was luxated and there was a fracture of the left scapula however no soft tissue reaction was seen with these lesions. There was an area of alopecia on the dorsum associated with blunting of the spines and a black sticky substance was adhered to the spines. These lesions could be associated with trauma due to road traffic accident. The hedgehog was in thin body condition and had very little fat reserves, indicating that the wounds she suffered were likely making walking and finding food difficult. In addition, we detected evidence of superficial pyoderma of the ventral skin associated with bacterial infection.

Appendix 8 Post-mortem analysis of hedgehog liver tissue samples for second-generation rodenticides

Rodenticides, including second generation anticoagulant rodenticides (SGARs) are in widespread and common use to control rodents (rats and mice) and are in current use in The Regent's Park. SGARs are toxic to all mammals and birds and are persistent. Among many non-target wildlife species potentially at risk from rodenticides are hedgehogs which, though principally predators of macroinvertebrates, include carrion in their diet (Reeve, 1981). Rodents typically die of internal bleeding several days after ingesting the bait, giving them time to disperse well away from baiting sites; spreading the rodenticide widely. Inadvertent exposure of hedgehogs to SGARs may therefore be either by: 1) direct consumption of bait, 2) via secondary consumption i.e. eating poisoned rodents either alive or as carrion, and/or 3) eating invertebrates that may have also become contaminated. The exposure of hedgehogs was confirmed in a study by Dowding *et al.* (2010) when rodenticide residues (both first and second generation compounds) were found in 66.7% of 120 dead hedgehogs provided by rescue centres.

In order to investigate whether or not the Regent's Park hedgehog population was potentially affected by rodenticides, we used hedgehogs that had either been found dead (e.g. road kill) or had died after having been found sick or injured. Samples of frozen liver tissue (stored at -20°C) were taken *post-mortem* from 12 hedgehog casualties by Dr. Becki Lawson (Garden Wildlife Health project, Institute of Zoology) and sent for analysis to Dr. Gloria Pereira (Centre for Ecology & Hydrology, Lancaster) in June 2016. The report from CEH was received in October 2016. Four samples were from hedgehogs that died in 2014, seven in 2015 and one in 2016 (Table 1).

Table 1. Data for individual hedgehog casualties providing liver samples.

Sample reference	Sample wt. (g)	ID Nº in bold & summary of markers found	Date	Carcass condition	Sex	Age: **S**ubadult **A**dult	Cause of death	Body condition
XT0568-14	11.0	None - **#4**	May 2014	Freshly dead	F	A	Euthanasia	Normal
XT0618-14	4.5	2 blue markers on neck, clipped spines dorsum	May 2014	Moderate decomposition	M	A	Trauma	Normal
XT0600-14	13.0	None	May 2014	Freshly dead	F	S/A	Undeter-mined	Fat
XT0599-14	6.9	**#54**	May 2014	Freshly dead	M	S	Euthanasia	Normal
XT422-15	11.9	**#159**	May 2015	Mild autolysis	M	A	Infectious disease	Normal
XT486-15	39.6	**#230** 3 white + 2 yellow markers	May 2015	Advanced decomposition	M	A	Undeter-mined	Unknown
XT627-15	18.0	**#176**	June 2015	Advanced decomposition	F	A	Undeter-mined	Normal
XT678-15	17.4	**#150** 3 yellow markers head region	June 2015	Mild autolysis	M	A	Trauma	Thin
XT738-15	18.0	**#151** 3 white on left back of cranial section: 2 blue + 1 white	July 2015	Mild autolysis	F	A	Trauma + euthanasia	Thin
XT830-15	28.0	**#169** 4 yellow markers on head	July 2015	Freshly dead	M	S/A	Trauma + euthanasia	Normal
XT831-15	25.8	**#161** 3 yellow markers on head + 1 yellow right hip without Nº	July2015	Mild autolysis	F	A	Trauma	Normal
XT709-16	26.5	**#199**	May 2016	Mild autolysis	--	A	--	--

The analyses were carried out using Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS), see Dowding *et al.* (2010), to detect and quantify the five second generation rodenticides (SGARs) currently licensed for use in the UK: Bromadiolone, Difenacoum, Flocoumafen, Brodifacoum, Difethialone. First Generation Rodenticides (FGARs) such as coumatetralyl and warfarin were not included in the analyses. The results are summarised in Table 2 below.

Table 2. Concentrations (nanograms per gram wet weight) of rodenticide compounds found in hedgehog liver samples using LC-MS/MS. The data are not recovery corrected so as to provide figures comparable to most of those in the literature. Note: 1µg= 1000ng

Sample reference	**Compound concentration** (ng/g wet weight; -- below detectable level)					No. SGARs found	Total SGARs (ng/g)
	Bromadiolone	Difenacoum	Flocoumafen	Brodifacoum	Difethialone		
XT0568-14	--	--	--	--	--	0	0
XT0618-14	851.1	30.4	--	--	--	2	881.5
XT0600-14	59.7	23.2	--	--	--	2	83
XT0599-14	41.2	42.1	--	5.5	--	3	88.8
XT422-15	--	--	--	--	--	0	0
XT486-15	12.3	2.7	--	--	--	2	15
XT627-15	--	2.4	--	--	--	1	2.4
XT678-15	35.7	--	--	--	1.7	2	37.4
XT738-15	--	--	--	--	--	0	0
XT830-15	--	2.9	--	--	--	1	2.9
XT831-15	--	--	--	--	--	0	0
XT709-16	48.2	15.9	--	--	--	2	64.1
Total no.	6	7	0	1	1		

One or more SGAR compound residues were detectable in 8 out of 12 samples (67%) and 6/8 (75% of those detectable) had more than one SGAR detected. Five of them had residues of two SGARs and one had three SGARs. Albeit a small sample, this prevalence is comparable to that found in a sample of 120 hedgehog livers analysed using LC-MS by Dowding *et al.* (2010) which were 57.5% positive for one or more SGARs. Looking at FGARs and SGARs combined, Dowding *et al.* (2010) found 66.7% of hedgehogs tested positive and 27% had residues of more than one rodenticide. Their hedgehog samples were obtained from hedgehog rescue centres and animals may have originated from either urban or rural sites.

Most previous studies (of other species) have used less sensitive High Performance Liquid Chromatography (HPLC) with detection by fluorescence spectroscopy. Dowding *et al.* (2010) found only 23% of 120 hedgehogs to be positive using fluorescence detection, less than half the prevalence of 57% revealed using the more sensitive LC-MS/MS method on the same individuals.

A review of studies using HPLC and fluorescence spectroscopy by Dowding *et al.* (2010) (Table 3) indicates that, using this method, the prevalence of hedgehogs having detectable levels of rodenticide appears roughly similar to certain other non-target predators such as stoats, weasels and polecats but at lower risk than predatory birds such as owls and raptors (Table 3). More recent work (Walker *et al.*, 2016) using LC-MS/MS has shown 100% prevalence of rodenticide residues in 24 red kites (*Milvus milvus*) and 96% contained residues of more than one SGAR. Concentrations of >100ng/g wet weight were found in 75% of birds. Similarly, 94% of a sample of 100 barn owls in

2015 had detectable liver residues of one or more SGAR and almost three quarters had liver residues of more than one compound (Shore *et al.* 2016).

Table 3. Percentage occurrence of residues of a first-generation anticoagulant rodenticide coumatetralyl (coum), and second-generation anticoagulant rodenticides brodifacoum (brod), bromadiolone (brom), difenacoum (difen) and flocoumafen (floc) in the livers of British predatory birds and mammals as identified using high performance liquid chromatography. ND indicates residue not detected; - indicates chemical was not investigated. Source: Dowding *et al.* (2010).

Species	n	Coum	Brod	Brom	Difen	Floc	Total[a]	Ref[b]
Hedgehog (*Erinaceus europaeus*)	120	-	3.3	10.8	13.3	ND	22.5	1
Polecat (*Mustela putorius*)	100	-	3.0	12.0	22.0	ND	36.0	2
Stoat (*Mustela erminea*)	40	15.0	2.5	6.7	-	-	22.5	3
Weasel (*Mustela nivalis*)	10	30.0	-	10.0	-	-	30.0	3
Red fox (*Vulpes vulpes*)	92	7.6	5.4	26.1	16.3	-	45.7	4
Barn owl (*Tyto alba*)	717	-	3.9	11.0	16.7	1.1	26.1	5
Barn owl (*Tyto alba*)	52	-	5.8	28.8	30.8	ND	42.3	6
Buzzard (*Buteo buteo*)	40	-	2.5	5.0	32.5	2.5	37.5	6
Tawny owl (*Strix aluco*)	172	-	4.7	11.6	5.8	ND	19.2	7
Red kite (*Milvus milvus*)	20	-	-	-	-	-	70.0	8
Kestrel (*Falco tinnunculus*)	36	-	-	-	-	-	67.0	8
Kestrel (*Falco tinnunculus*)	40	-	15.0	40.0	72.5	ND	84.6	9

[a] Total percentage of individuals positive for one or more chemicals.
[b] Reference: 1 - present study; 2 - Shore et al. (2003a); 3- McDonald et al. (1998); 4 - Shore et al. (2003b); 5 - Newton et al. (1999b); 6 - Shore et al. (2006a); 7 - Walker et al. (2008), 8 - Shore et al. (2000); 9 - Shore et al. (2006b).

The two most prevalent compounds detected in Regent's Park hedgehogs were difenacoum (7 individuals) and bromadiolone (6 individuals), with only one detection each of brodifacoum and difethialone, and none of flocoumafen. Difenacoum and bromadialone were also the most prevalent SGAR compounds in hedgehogs and most other species cited by Dowding *et al.* (2010), Walker *et al.* (2016) and Shore *et al.* (2016). These two SGARs are the least acutely toxic of the five SGARs currently licensed for use in the UK and, at the time these Regent's Park animals were collected, were the only SGARs licensed for outdoor use[1].

Known uses of rodenticide in the park include Bromadiolone in the form of 'Contrac All-weather Blox' (Bell Laboratories) and difenacoum as 'Sakarat D Wax bait' (Killgerm) or Neosorexa (BASF). Brodifacoum in the form of 'Talon Soft' (Syngenta) was used at one catering outlet, and is claimed to require less than 25% of the bait consumption to kill rats compared to difenacoum, and typically 80% less than bromadiolone[2]. As yet we have no information on the possible source of Difethialone detected in hedgehog #150 (sample XT678-15).

The interpretation of these results in terms of their significance for hedgehog health is difficult. SGARs are persistent and therefore pose a real risk of secondary poisoning to predators or

[1] Having reviewed all five SGARs the Health & Safety Executive (2012) found them to be indistinguishable in terms of environmental toxicity. Hence, since 2016, all five SGARs are now potentially eligible for similar authorisations (Shore *et al.*, 2016) which could include 'open area' use of Brodifacoum, Difethialone and Flocoumafen. However, there is a new stewardship scheme designed to enhance best practice to reduce risk to non-target species (http://www.hse.gov.uk/biocides/eu-bpr/rodenticides.htm).

[2] http://www.pestmagazine.co.uk/en/news/posts/2012/nov/news-from-syngenta

scavengers. However, clear evidence of illness or death of hedgehogs from poisoning by SGARs (e.g. haemorrhaging) is lacking from the *post-mortem* results in this study, as it was in the Dowding *et al.* (2010) study. See Table 1 for a summary of causes of death.

Dowding *et al.* (2010) noted that there is no precise liver concentration diagnostic of lethal poisoning in hedgehogs or other species. This remains so, but in a large multi-species study of predatory birds using LC-MS/MS on liver samples, Thomas et al. (2011) calculated that for barn owls with SGAR residue levels in the range of 0.1-0.2mg/kg (100-200ng/g) there was an associated toxicity probability of over 10-20%. That is about one in ten owls with levels of 100ng/g might die as a result of their exposure, or about one in five at 200ng/g). Researchers in this field, including Thomas et al. (2011) are at pains to point out that liver SGAR concentrations associated with toxicity vary greatly among species. Nevertheless, where no data exist for species such as hedgehogs, studies of other species provide our only reference points.

Regarding the feasibility that the localised use of anticoagulant rodenticides in and around buildings could result in the widespread exposure of non-target species, a model developed by Topping & Elmeros (2016) provides strong evidence that rodent-mediated dispersal of anticoagulant rodenticides in household and urban use might be enough in itself to explain the almost universal exposure observed in Denmark of non-target mustelid predators of rodents.

Of the 12 Regent's Park hedgehogs examined, one adult male (XT0618-14) received on 31/05/14 had a particularly elevated total SGAR level (881.5 ng/g) and two others (subadults) had levels of 83.0 ng/g and 88.8 ng/g. Post-mortem examination of the adult male (XT618-14) identified the cause of death likely to be a secondary consequence of a traumatic injury. A chronic open fracture of the tibia with local infection and tissue necrosis associated with lymph node enlargement was present. No evidence of macroscopic haemorrhage was detected on routine inspection of body systems. Microscopic examination of a suite of tissues (comprising adrenal gland, bladder, brain, heart, liver, intestine, skin and spleen), similarly detected no evidence of significant internal bleeding that may have occurred secondary to SGAR exposure.

The subadult female (XT0600-14) received on 29/05/14 was found unable to move, clearly unwell and covered in fleas. Post-mortem examination revealed it was in normal body condition with a parasitic pulmonary infection, blood in its urine and haemorrhage / muscle damage in the tissues around the neck possibly indicating trauma, although it was difficult to associate this trauma with the cause of death, which was undetermined.

The subadult male (XT0599-14) received on 30/05/14 was in normal body condition and was euthanased because of chronic tissue infection with no evidence of haemorrhage detected. To what extent SGARs in the concentrations found in these hedgehogs may cause sub-lethal physiological impacts or exacerbate the impacts of injury is currently unknown.

Although a small sample, our Regent's Park data indicate that hedgehogs are commonly exposed to SGARs, and our results are broadly consistent with those of Dowding *et al.* (2010). We cannot be sure of how hedgehogs are being exposed to SGARs; whether via direct consumption of bait, the consumption of rodent carcases, or the consumption of invertebrates such as molluscs that may have consumed bait, the faeces or carcases of poisoned rodents or ingested soil-bound residues (Hernandez-Moreno *et al.* 2013).

We conclude that our study, although small, provides clear evidence that SGARs are a potentially negative impact on the Regent's Park hedgehogs and that steps should be taken to minimise further

risk. That five of our sample of 12 animals had residues of more than one SGAR suggests that exposure to rodenticides from multiple sources is common.

While recognising that a diverse group of organisations, companies and residents may at various times need to implement rodent control within The Regent's Park, we recommend that all rodent control methods and rodenticide use within the park is audited and regularly reappraised with the aim of minimising the use of poison bait.

In order to lower the risk of secondary poisoning of hedgehogs, the first line of defence against rodent pests should be to clear away food sources that may attract them, exclusion and trapping. Having followed the Campaign for Responsible Rodenticide Use (CRRU) code (http://www.thinkwildlife.org/about-crru/) and considered where and when the use of a rodenticide may be essential, hedgehogs and other wildlife (such as avian predators of small mammals) should be factored into the risk assessment process and care should be taken to avoid access to the bait by hedgehogs or their invertebrate prey.

As is already current practice in the park, dead rodents should be cleared away, bagged, and properly disposed of. Slugs and snails found in the vicinity of the bait should also be cleared in the same way. Physiological differences from mammals and birds will mean that such invertebrates are less susceptible to these anti-coagulant toxins (Hernandez-Moreno *et al.* 2013) but they may have ingested toxic bait. A key problem is that, even with due diligence, only a proportion of poisoned animals may be found, leaving contaminated invertebrates and rodent corpses to be scavenged by hedgehogs.

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References:

(*Asterisk denotes secondary citations from Dowding* et al. *(2010) included as sources in Table 3.*)

Dowding, Claire V.; Shore, Richard F.; Worgan, Andrew; Baker, Philip J.; Harris, Stephen (2010) Accumulation of Anticoagulant Rodenticides in a Non-target Insectivore, the European hedgehog (*Erinaceus europaeus*). *Environmental Pollution*, **158** (1), 161-166.

Hernandez-Moreno D., I. de la Casa-Resino, A. Lopez-Beceiro, L.E. Fidalgo, F. Soler, M. Perez-Lopez (2013) Secondary poisoning of non-target animals in an Ornithological Zoo in Galicia (NW Spain) with anticoagulant rodenticides: a case report. *Veterinarni Medicina* **58**, 2013 (10): 553–559

* McDonald, R.A., Harris, S., Turnbull, G., Brown, P., Fletcher, M. (1998) Anticoagulant rodenticides in stoats (*Mustela erminea*) and weasels (*Mustela nivalis*) in England. *Environmental Pollution* **103**, 17-23.

* Newton, I., Dale, L., Finnie, J.K., Freestone, P., Wright, J., Wyatt, C., Wyllie, I. (1999b) *Wildlife and pollution: 1997/98 annual report*. Joint Nature Conservation Committee Report No. 285, Peterborough, UK.

Reeve, N.J. (1994) *Hedgehogs*. T. & A. D. Poyser, 313pp.

* Shore, R.F., Birks, J.D.S., Afsar, A., Wienburg, C.L., Kitchener, A.C. (2003a). Spatialand temporal analysis of second-generation anticoagulant rodenticide residues in polecats (*Mustela putorius*) from throughout their range in Britain, 1992-1999. *Environmental Pollution* **122**, 183-193.

*Shore, R.F., Fletcher, M.R., Walker, L.A. (2003b). Agricultural pesticides and mammals in Britain. In: Tattersall, F., Manley, W. (Eds.), *Conservation and conflict: mammals and farming in Britain.* Westbury Publishing, Otley, UK, pp. 37-50.

* Shore, R.F., Malcom, H.M., McLennan, D., Turk, A., Walker, L.A., Wienburg, C.L., Burn, A.J. (2006a) Did foot-and-mouth disease-control operations affect rodenticide exposure in raptors*? Journal of Wildlife Management* **70**, 588-593.

* Shore, R.F., Walker, L.A., Turk, A., Wienburg, C.L., Wright, J., Murk, A., Wanless, S. (2006b). Wildlife and pollution: 2003/04 annual report. Joint Nature Conservation Committee Report No. 391, Peterborough, UK.

Shore, R.F, Walker, L.A., Potter ED and Pereira, G. 2016. Second generation anticoagulant rodenticide residues in barn owls 2015. CEH contract report to the Campaign for Responsible Rodenticide Use (CRRU) UK, 17 pp.
http://pbms.ceh.ac.uk/sites/pbms.ceh.ac.uk/files/stewardship-2015-owls.pdf

Thomas, P. J., Mineau, P., Shore, R. F., Champoux, L., Martin, P. A., Wilson, L. K., Fitzgerald, G. & Elliott, J. E. 2012. Second generation anticoagulant rodenticides in predatory birds: Probabilistic characterisation of toxic liver concentrations and implications for predatory bird populations in Canada (vol 37, pg 914, 2011). *Environment International,* 40**,** 256-256.

Topping C J and Elmeros M (2016) Modeling Exposure of Mammalian Predators to Anticoagulant Rodenticides. *Front. Environ. Sci. 4:80. doi: 10.3389/fenvs.2016.00080*

*Walker, L. A., Turk, A., Long, S. M., Wienburg, C. L., Best, J. & Shore, R. F. 2008b. Second generation anticoagulant rodenticides in tawny owls (Strix aluco) from Great Britain. Science of the Total Environment, 392, 93-98.

Walker L.A., J.S. Chaplow, C. Moeckel, M. G. Pereira, E.D. Potter, A.W. Sainsbury, R.F. Shore. (2016). Anticoagulant rodenticides in red kites (Milvus milvus) in Britain 2010 to 2015: a Predatory Bird Monitoring Scheme (PBMS) report. Centre for Ecology & Hydrology, Lancaster, UK.14 pp
http://pbms.ceh.ac.uk/sites/pbms.ceh.ac.uk/files/PBMS_Rodenticide_Red_Kite_2016_FINAL.pdf

Appendix 9 FLIR E-60 User Guide

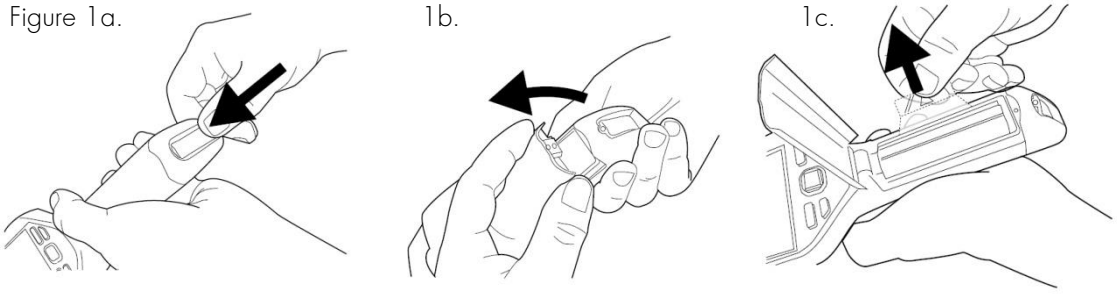
REGENT'S PARK HEDGEHOG SURVEY 2015:
BRIEF INSTRUCTIONS FOR FLIR E60 (doc.v.2)

The Thermal Imaging camera will already be set up for field work and with an SD card. You should not have to change image modes or other menu settings. However, you will need to adjust the threshold temperature (above which objects are shown as red) according to ambient temperatures in the field.
WARNING: The laser pointer must not be shone into eyes (people or animals).

1) Start work with a fully charged battery. If the battery expires, press the silver button in the base of the handle to open the battery compartment (part of the handle) and replace the battery. Make sure batteries are put on charge after each session.

Removing/replacing the battery
a. Ensure the camera is turned off. Push the latch (Fig.1a.) on the battery compartment.
b. Open the battery cover gently (Fig.1b.).
c. Pull the transparent tape to lift out the battery (Fig.1c.). Check carefully to see how it fits. Insert replacement battery in same orientation as the one removed. Gently snap cover closed.

Figure 1a. 1b. 1c.



2) Using the Thermal Imaging camera.

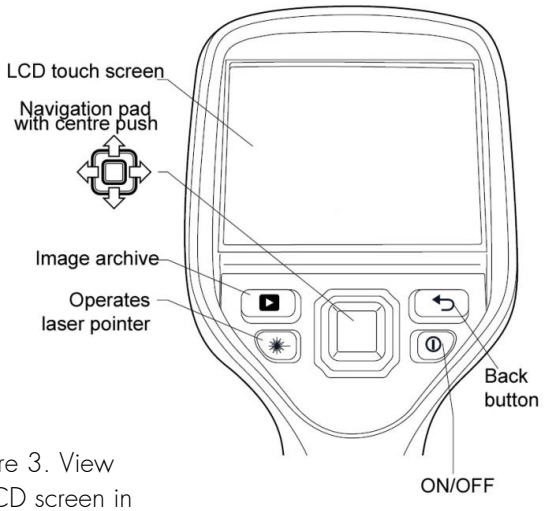
a. Remove the rubber lens cover from the front of the camera. Press the On-off button briefly and let the camera power-up.

b. Point it to the general area you plan to observe. The camera self-calibrates to match the ambient range (vertical scale right side of LCD screen image). Focus the image (rotate the lens).

c. We are using the 'Above alarm' image mode. The display should be mostly grey with only objects above of the set threshold temperature (shown centre bottom of screen) showing as red.

Figure 3. View of LCD screen in 'Above alarm' mode

Figure 2. View of LCD screen & control



d. If necessary adjust the threshold temperature using the up/down function of the Navigation pad. To start with observe the hand of a nearby person (red hand against entirely grey background). Then fine-tune when you can observe a hedgehog. You'll need different settings on warm and cold nights or on paved or natural ground. Fig.3 was a very cold night, using an unusually low threshold of 7 C.

NOTE: The 'Above alarm' mode is just one of several colour modes which can be selected via the Navigation pad centre button and selecting Color from the menu. During behavioural observation, if desired, alternative colour modes *may* give more detail e.g. 'Rainbow high contrast'.

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3) Zooming the image.

Scanning for hedgehogs and behavioural observation may benefit from different digital zoom settings. You may need to re-check focus if the image seems blurred.

a. Tap and hold your finger down on the LCD touch screen. This displays a zoom toolbar.
b. Select the required zoom factor (none, 2x, 4x). The selected zoom factor is displayed in the top right corner of the screen (see image above).

4) Saving still images (JPEG) and video (MPEG4).

a. Push Navigation pad centre button to display the menu system. Navigate to Recording mode icon (camera)
b. Push Navigation pad centre button to display options and then select Still image or Video option (as required)
c. Push the Navigation pad centre button.
d. To capture a still image, simply squeeze the trigger at the front of the handle. To capture video, squeeze the trigger to start the recording. A red icon at the top of the LCD image blinks during the recording. Squeeze the trigger again to stop the recording

5) Viewing & Deleting a saved image

a. Push Image archive button and use navigation pad to select the image you want to view.
b. Push the navigation pad centre button to open the image.

To Delete:

a. Push the Navigation pad centre button to display a toolbar
b. On the toolbar, select Delete (dustbin symbol) and push the Navigation pad centre button.
c. Push Image archive button or Back button to leave the image archive.

6) Transferring saved images or videos to a computer.

This is best done by removing the SD card from the E60 and using a USB card reader.

a. Turn the camera off. Face the LCD screen & open the rubber flap on the left side of the camera.
b. The SD card is in the centre slot. Push-in and release the card to disengage the spring catch and remove the card.
c. Insert the SD into a built-in or plug-in USB card reader and transfer the files to the computer.

Reference notes on setup/settings of E60 for hedgehog field work:

- Auto calibration option selected on the 'Temperature Scale' menu options
- Photo as separate JPEG: Off (Used in picture-in-picture mode. Determines if a digital photo will be saved as a separate file with a full field of view. If this setting is disabled, the digital photo will be saved with the same field of view as the infrared image.)
- Preview image before saving: Off
- Camera temperature range: -10-120
- Auto orientation: ON
- Display Intensity: LOW (better for night viewing and lower battery consumption and)
- Auto Power Off: Off
- Video output format: PAL
- Level span mode: level/max/min
- WiFi: Off
- Bluetooth: Off

Parameter settings:

- Emissivity setting: set to a custom setting of 0.98 on a scale of 0-1 (human skin is 0.97-0.98, a polished mirror about 0.1)
- Distance: set at 15 metres (the atmosphere absorbs IR)

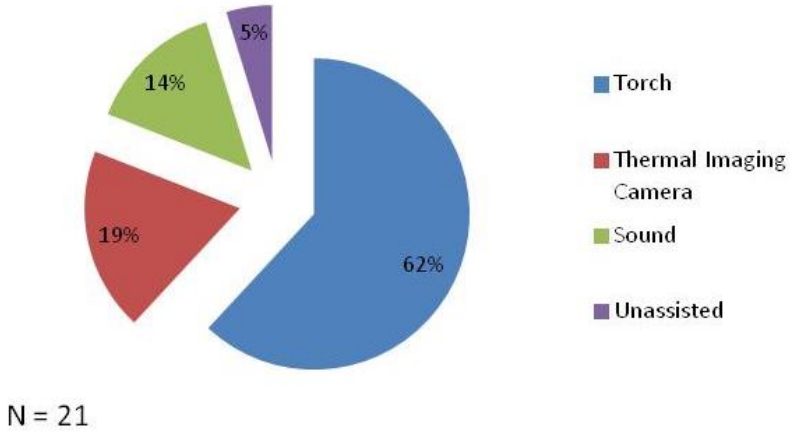
REGENT'S PARK HEDGEHOG SURVEY 2015:
BRIEF INSTRUCTIONS FOR FLIR E60 (doc.v.2)

- Relative humidity: Default value is 50% setting. (may need to be set higher if wet weather).
- Atmospheric temp: 16 C (may need to be changed according to weather).
- Window compensation: Off (irrelevant to field work)

Appendix 10 Method of detection during spotlighting surveys

(a) May 2016

During the September 2016 survey, surveyors were asked to record by which method they first detected a hedgehog, and if it was by using the Thermal Imaging Camera, approximately how far away the hedgehog was. Using the torch was the most successful method in both surveys (Figure A.2.1), although the Thermal Imaging Camera performed well, and was only slightly behind the torch method in the September survey. Some animals were detected by sound, mostly in the May survey. Detection distances using the Thermal Imaging Camera in September 2016 ranged from 3 m to 60 m with a mean of 23.3 m (stdev = 15.98 m, N = 18).



(b) September 2016

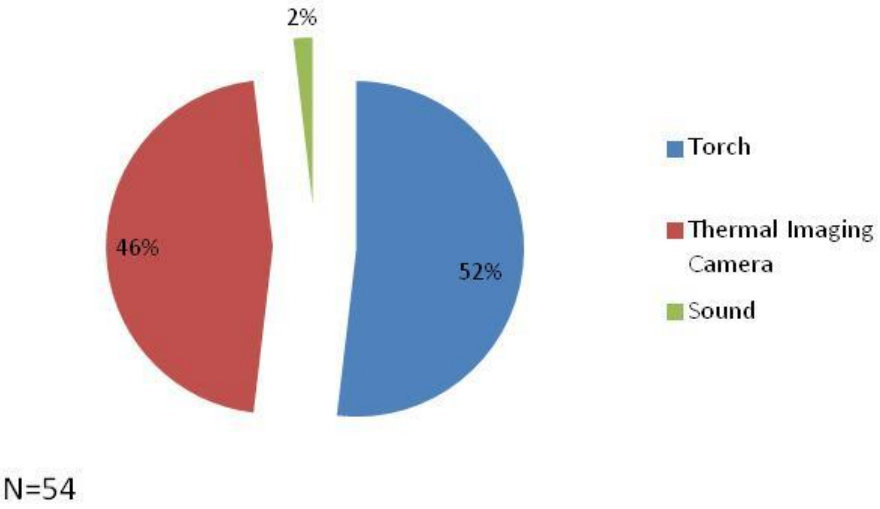


Figure A.10.1 Method of detection of hedgehogs during the 2016 spotlighting surveys

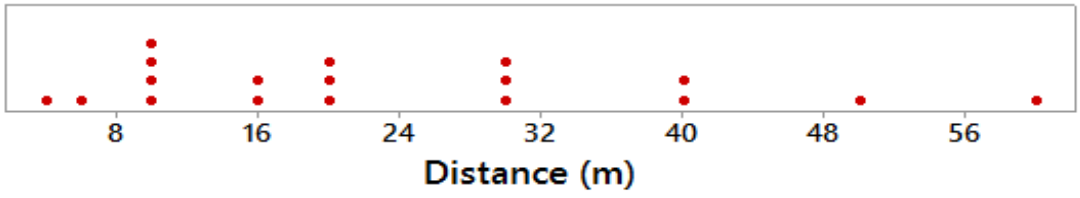


Figure A.10.2 Thermal Imaging Camera detection distances in September 2016.
(mean - 23.3 m, stdev = 15.98 m, N = 18).

Appendix 11 Hedgehog markers

From 2015, captured hedgehogs were individually marked using numbered yellow plastic sleeves or markers (see Gurnell *at al.* 2016). Six markers, each bearing the same identification number, were glued to spines on the crown of the head. In 2016, in order to monitor the survival of these markers and assess the effectiveness of the marking system, surveyors were asked to record the number of markers remaining on recaptured hedgehogs. In both the May and the September surveys, the mean numbers of markers found on recaptured hedgehogs were similar (May: mean 3.4, stdev 1.74, N=9; September: mean 3.8, stdev1.31, N=10) (Figure A1.1).

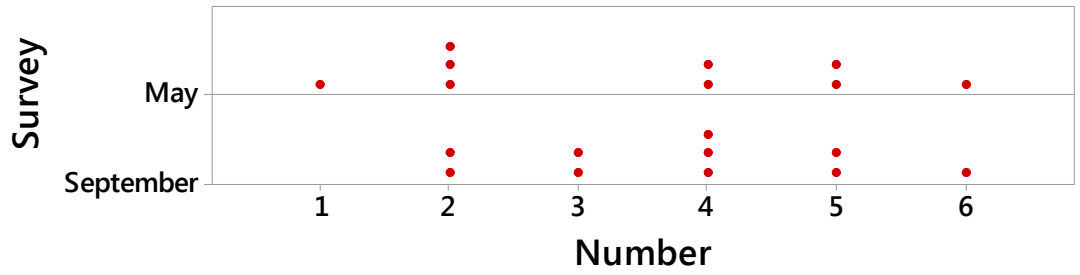


Figure A.11.1 Dotplots of numbers of yellow numbered markers remaining on hedgehogs in May and September 2016.

Appendix 12 Weather issues potentially affecting hedgehogs in Regent's Park

Data from http://www.metoffice.gov.uk/climate/uk/summaries
Data are for the South East and Central South England region, in which the monthly and seasonal figures are compared to the 1981-2010 mean figures – for brevity referred to as 'normal' below.

Most animals were in good body condition although in May 2015 both male and female mean weights were respectively 17% and15% less than in May 2014. This suggests a lean period over Winter or Spring. Met office data indicate a very wet and warm winter in 2013/14 with January and February 2014 having respectively 256% and 268% of normal rainfall and a mean temperature of 1.6°C and 2.2°C above normal. March 2014 was drier (66% of mean) but April and May 2014 were wetter with respectively 140% and 136% of the mean. Winter 2014-15, was wet with 110% of average rainfall, well above average (125%) sunshine and a mean temperature of 3.9°C ; only 0.2°C above average. However, Spring 2015 was exceptionally dry with March and April having only 43% and 36% of normal rainfall and above-average sunshine 124-135%). In contrast, May was wetter (113% of normal) with less sunshine (97% of normal) and slightly cool conditions (0.2°C below normal). Assuming that such data can be broadly applied to the Park, such dry Spring conditions, in contrast to the warm wet conditions in May 2014, may well have adversely affected the supply of invertebrate prey; particularly earthworms and gastropods. Consistent with this idea is that relatively few worm casts were evident in the park's grasslands during Spring 2015 (Mark Rowe pers. comm.). Autumn 2015 was mild with a temperature of 0.5°C above normal and 3.8 fewer days of air frost and generally drier than normal with 84% of rainfall.

The first half of 2016 has been close to normal with monthly mean temperatures ranging from 0.7°C below normal to 1.1 °C above and rainfall overall moderately above normal with monthly figures ranging from 101% to 188% of normal. Somewhat wet but otherwise normal weather would be expected to provide good conditions for hedgehogs. However, July was particularly dry with only 41% of normal rainfall, despite mean temperature and sunshine hours being close to normal. August was changeable with a wet start but overall with only 70% of average rainfall and mean temperature 0.9°C above average. Temperatures peaked in the S.E. at 34°C in some places on 23rd. Nevertheless, most hedgehogs caught in September 2015 were in good body condition, with subadults weighing upwards of 460g. All adults weighed in the range 800-1450g. Assuming mainly natural sources of food, this suggests that the dry period in July-August did not have a big negative impact on prey availability. October 2016 was exceptionally dry (36% of normal rainfall) although the mean temperature was close to normal (0.1°C above average), but November was wetter (118% of normal) and cooler with a mean temperature 1.0°C below average. December was very dry indeed (22% of average rainfall) and warm (1.1°C above average). The dry conditions in October could have had impacts on prey availability in the run-up to hibernation but the consequences of the wet cold November and dry December are difficult to predict.

TABLES SHOWING MORE DETAIL

Values are for SE & Central England showing actual figures (Act) and size of anomaly (Anom) from 1981-2010 mean. Source: http://www.metoffice.gov.uk/climate/uk/summaries/2014/march/regional-values

2014	Max T°C		Min T°C		Mean °C		Sunshine Hrs		Rainfall (mm)		Days rain ≥1 mm		Days air frost	
	Act	Anom	Act	Anom	Act	Anom	Act	Anom %	Act	Anom %	Act days	Anom days	Act days	Anom days
January	9.4	2.0	3.0	1.3	6.2	1.6	63.7	108	205.2	256	23.7	11.1	5.1	-5.0
February	9.8	2.0	3.7	2.4	6.7	2.2	96.6	123	147.7	268	21.2	11.5	0.7	-9.7
March	12.8	2.3	3.4	0.4	8.1	1.4	159.7	140	37.9	66	7.5	-3.1	4.4	-1.8
April	15.1	1.9	6.1	1.8	10.6	1.9	167.5	99	75.1	140	10.9	1.1	0.7	-2.7
May	16.8	0.2	8.2	0.9	12.5	0.6	201.6	100	74.1	136	13.5	4.2	0.3	-0.3
June	20.9	1.3	10.7	0.6	15.8	0.9	241.7	120	37.8	74	6.8	-1.6	0.0	-0.0
July	24.0	2.0	13.2	0.9	18.6	1.5	269.2	125	46.2	89	7.2	-0.8	0.0	-0.0
August	20.6	-1.3	11.2	-0.9	15.9	-1.1	199.4	98	102.0	178	13.2	4.8	0.0	0.0
Sept	20.8	1.9	10.9	0.8	15.8	1.3	144.8	97	14.8	24	2.9	-6.0	0.0	-0.0
Oct	16.7	1.9	9.9	2.5	13.3	2.2	106.9	94	111.4	120	16.4	4.6	0.1	-1.3
Nov	12.0	1.3	6.1	2.0	9.0	1.6	58.3	82	135.6	155	18.2	6.1	2.4	-2.7
Dec	8.8	0.9	2.2	0.2	5.5	0.5	75.0	147	53.9	64	8.3	-3.7	10.6	0.7

Seasonal summary data for Central and South East England 2015 show for **winter** a mean temperature of 1.7 ° above the 1981-2010 mean, 235% of mean rainfall with 27.8 additional days of rain and -20.2 days below the mean number of days with air frost. An exceptionally wet and warm period.

Spring: a mean temperature of 1.3°C above the 1981-2010 mean, with 113% of rainfall, +2.2 days of rain and -4.7 days of air frost.

Summer: a mean temperature of 0.4°C above the 1981-2010 mean, with 116% of rainfall and +2.4 days of rain.

Autumn: a mean temperature of 1.7°C above the 1981-2010 mean, with 108% of rainfall and +4.7 days of rain and -4.0 days of air frost.

2015	Max T°C		Min T°C		Mean °C		Sunshine Hrs		Rainfall (mm)		Days rain ≥1 mm		Days air frost	
	Act	Anom	Act	Anom	Act	Anom	Act	Anom %	Act	Anom %	Act days	Anom days	Act days	Anom days
January	8.4	0.9	1.4	-0.3	4.9	0.3	70.2	119	99.0	124	15.4	2.8	10.5	0.5
February	7.4	-0.3	0.8	-0.5	4.1	-0.4	80.0	102	60.4	109	9.2	-0.5	10.1	-0.3
March	10.7	0.2	3.1	0.1	6.9	0.2	142.2	124	24.5	43	7.2	-3.4	3.5	-2.7
April	14.9	1.7	4.3	0.0	9.6	0.9	228.5	135	19.4	36	5.8	-3.9	1.6	-1.8
May	16.1	-0.6	7.4	0.1	11.7	-0.2	193.9	97	61.9	113	10.5	1.1	0.1	-0.4
June	20.3	0.7	9.6	-0.4	15.0	0.1	248.0	123	26.7	52	5.3	-3.1	0.0	0.0
July	21.8	-0.2	12.0	-0.2	16.9	-0.2	203.3	95	60.0	116	8.4	0.3	0.0	0.0
August	21.0	-0.9	12.3	0.2	16.6	-0.3	147.9	73	108.6	189	12.6	4.3	0.0	0.0
Sept	17.9	-1.0	8.5	-1.6	13.2	-1.3	184.9	124	67.9	109	8.6	-0.3	0.0	0.0
Oct	15.0	0.2	7.7	0.3	11.3	0.2	96.4	85	58.1	63	8.6	-3.3	0.2	-1.2
Nov	12.9	2.2	7.3	3.1	10.0	2.6	30.2	42	78.0	89	17.3	5.2	2.5	-2.6
Dec	12.9	5.0	8.2	6.2	10.5	5.6	33.9	66	80.4	96	16.0	4.0	0.2	-9.7

Seasonal summary data for Central and South East England 2015 show for **winter** a temperature of 0.2° above the 1981-2010 mean, 96% of mean rainfall with only 1.4 additional days of rain and 1.1 days above the mean number of days with air frost.

Spring: a temperature of 0.3°C above the mean, but only 63% of rainfall with -6.3 days of rain and -4.6 days of air frost.
Summer: a temperature of -0.2°C below the mean, with 122% of rainfall and +1.5 days of rain.
Autumn: a temperature of 0.5°C above the mean, with 84% of rainfall but +1.5 days of rain and -3.8 days of air frost.

2016	Max T°C		Min T°C		Mean °C		Sunshine Hrs		Rainfall (mm)		Days rain ≥1 mm		Days air frost	
	Act	Anom	Act	Anom	Act	Anom	Act	Anom %	Act	Anom %	Act days	Anom days	Act days	Anom days
January	8.9	1.5	2.4	0.7	5.7	1.1	59.2	101	136.4	170	17.9	5.4	6.8	-3.3
February	8.7	1.0	2.1	0.8	5.4	0.9	89.4	113	56.7	103	9.9	0.2	9.2	-1.2
March	10.0	-0.4	2.1	-0.9	6.1	-0.7	137.0	120	86.8	151	10.3	-0.3	7.0	0.8
April	12.6	-0.6	3.7	-0.6	8.1	-0.6	176.1	104	54.2	101	12.7	3.0	4.2	0.8
May	17.9	1.2	8.2	0.9	13.0	1.1	219.7	109	64.8	119	9.2	-0.1	0.7	0.2
June	19.5	-0.2	11.4	1.4	15.4	0.6	127.5	63	95.9	188	14.2	5.8	0.0	0.0
July	22.1	0.1	12.8	0.6	17.5	0.4	213.4	99	21.0	41	4.8	-3.3	0.0	0.0
August	22.9	1.1	12.9	0.8	17.9	0.9	227.3	111	40.3	70	6.4	-2.0	0.0	0.0
Sept	20.9	2.0	12.5	2.4	16.7	2.2	137.5	92	47.6	77	9.0	0.1	0.0	0.0
Oct	15.1	0.3	7.2	-0.2	11.2	0.1	128.2	113	33.3	36	5.8	-6.1	0.2	-1.1
Nov	10.1	-0.6	2.9	-1.3	6.4	-1.0	83.9	117	103.1	118	11.1	-0.9	5.6	0.5
Dec	9.6	1.7	2.6	0.6	6.1	1.1	64.1	125	18.8	22	5.5	-6.5	8.7	-1.2

Seasonal summary data for Central and South East England 2015 show a warm wet **winter** with a mean temperature 2.6°C above 1981-2010 average and rainfall 126% of average, 9.7 additional days of rain and 14.7 days less than average of air frost.
Spring was more normal temperature (-0.1°C of mean) but also wet with 124% of average + 2.6 additional days of rain.
Summer: a temperature of 0.6°C above the mean, with 98% of rainfall and -0.6 days of rain.
Autumn: a temperature of 0.4°C above the mean and dry with 76% of rainfall, -6.9 days of rain and -0.7 days of air frost.