A Study of Hedgehogs in The Regent's Park

Year 3

May and September 2016

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Working in partnership with

Executive Summary

The hedgehogs in The Regent's Park are the only breeding population remaining in Central London. Studies carried out in 2014 and 2015 clearly showed that the population was small, vulnerable and essentially isolated (Gurnell *et al.* 2015, 2016). As in previous years, systematic surveys to ascertain the number and distribution of hedgehogs within the Park (but not on Primrose Hill in 2016) took place in spring, on the nights of 13th-14th and 20th-21st May, and in the autumn, on 2nd-3rd and 10th-11th September. In contrast to 2014/15 when the surveys finished at 00.30 hours, the surveys continued throughout the night. Also, GPS and radio-tracking studies on movement and habitat utilisation were not carried out in 2016.

The surveys were carried out very effectively with the help of over 150 volunteers. ZSL Veterinary Services provided veterinary support and the ZSL Garden Wildlife Health Project carried out post mortem examinations on hedgehog corpses found in the Park during 2016. They also provided hedgehog tissue samples for a small study on rodenticide exposure. These samples were analysed for second generation anticoagulant rodenticides (SGARs) by the Centre for Ecology & Hydrology, Lancaster.

As well as using torches, in 2016 each survey group (except Zone 7, ZSL) was able to use a Thermal Imaging Camera (TIC); these had been trialled in 2015 and found to be effective aids to surveying for hedgehogs in grassland areas of Regent's Park (Gurnell *et al.* 2016). Data collected on TIC detection in September 2016 found a mean detection distance of 23.3 m (stdev = 15.98 m, N = 18, range 3-60 m). Further studies on TIC and torch detection distances will take place in 2017. Individual hedgehogs were marked with six numbered, yellow plastic sleeves attached to the spines on the head. This method of marking was first used in 2015. Although it is not known whether any hedgehogs lost all six markers, the mean number of markers remaining on recaptured animals in both May and September surveys was 3.6 (stdev 1.50, N = 19). This gives encouragement that most if not all recaptured hedgehogs can be identified.

Recruitment of young hedgehogs was poor over the summer of 2015 and numbers in September 2015 were low (Gurnell *et al.* 2016). This situation got worse and only 11 individuals were captured in May 2016 leading to concerns about the future of the population. There were some signs of a recovery to 25 individuals in September 2016, mainly as a result of better recruitment of young over the summer of 2016. For reasons unknown, the number of adult males relative to females captured declined from 48% in May 2015 to 27% in September 2016. As in previous years, adult hedgehogs appeared in good condition. Females were slightly heavier than males at the times of both the spring and autumn surveys across all three years (2014-2016), and both males and females were slightly heavier in autumn than spring. In May 2015, both the average weights of adult males and females were the lightest recorded during the study, and it is speculated that could have been related to a particularly dry spring in that year, which in turn may have influenced the availability of invertebrate prey.

Importantly and for reasons that are not clear, there was a shift in the distribution of hedgehogs within the Park. Looking back, this shift probably began during the summer of 2015. Prior to this time, three hedgehog hotspot areas had been identified. However, by September 2016, hedgehogs had completely disappeared from one and mostly disappeared from another leaving only one hotspot in the northeast of the Park, including the ZSL Car Park. As in 2014 and 2015, the sports pitches and the northern areas of the Park were little used in 2016. Works by Thames Water on a water main in the ZSL Car Park will start in spring 2017. Mitigations for the hedgehogs are planned

and it remains to be seen how the local population of hedgehogs in this area, and the park as a whole, will be impacted. Overall, it is estimated that less than a third of the available space within the Park was being used by hedgehogs in September 2016.

By March 2016, 50 hedgehog nest boxes were in position throughout the Park and they were inspected in March, June, August and December. Few hedgehogs were found in boxes at the times they were inspected, but there was an increase in the number of boxes that appeared to be visited by hedgehogs over the year. These were in areas where hedgehogs were known to be present. The study will continue in 2017.

Five deaths were recorded throughout the year, four (two road casualties, two deaths from unknown causes) occurred between March and May which would have had a significant impact on the already small population. One animal was killed outside the perimeter of the Park on Prince Albert Road near the ZSL Car Park in August. In contrast to previous years, no hedgehogs were found with serious leg injuries in 2016. A small study on tissue samples from 12 dead hedgehogs (collected in 2014-2015) showed that two-thirds of these animals had been exposed to second generation anticoagulant rodenticides. Further studies would be required to know whether such exposure could affect the health of hedgehogs within the Park. As well as deaths, injuries and rodenticide exposure, the report considers other factors that might have affected the numbers and distribution of hedgehogs such as foxes, weather, food and park management. For example, food availability, as well as distance to cover, may be reasons why hedgehogs made little use of the sports pitches. It is likely that different factors affect the population at different times; with such a small population, an illness or death to any one individual could have a significant impact on the population.

We recommend that the six monthly population surveys of hedgehogs should continue in 2017 and through to 2024 to monitor the numbers and distribution of hedgehogs within the Park. Plans and resources should be in place to quickly implement conservation actions should the population show no signs of continued recovery from the low in May 2016. In addition, the hedgehog nest box study should continue in 2017, and further into the future, to get a better understanding of the value of boxes to hedgehogs and as a means to study hedgehogs. Additional research that will help gain a better understanding of the factors affecting the numbers and distribution of hedgehogs should be encouraged. The findings from such studies could feed into conservation management actions if required.

Lastly, we recommend that programme of community engagement, staff training and volunteer recruitment started in May 2014 should continue, in order to raise awareness of the need for hedgehog conservation in Regent's Park and more widely in the country.

Contents

1. Introduction

This study is a continuation of the work begun in 2014 in The Regent's Park to study the last known breeding population of hedgehogs in central London and to provide the data required to develop an evidence-based conservation strategy for this important but vulnerable population.

A full account of the work so far is given in *A Study of Hedgehogs in The Regent's Park, London: May and September 2014* (Gurnell *et al.* 2015) and *A Study of Hedgehogs in The Regent's Park, London: May and September 2015* (Gurnell *et al.* 2016) which both provide a review of the ecological requirements of hedgehogs, the status of hedgehogs in the UK and in The Regent's Park. In summary, there is strong evidence that hedgehogs are in serious decline in Britain (Hof, 2009; Wembridge, 2011; Macdonald & Burnham, 2011; PTES, 2013). New information (PTES, 2015) indicates a continuation of this decline with *Mammals on Roads* and *Breeding Bird Survey* data indicating mean annual losses of respectively 9.1% and 13.7% in rural populations between 2001 and 2014. Less robust data for urban populations are available but the *Garden Birdwatch* (2008-2014) anomalously shows an increase of 3.6% while the *Living with Mammals* survey (reported presence/absence reports mainly from gardens) has shown an overall decline of 30% in the reported presence of hedgehogs between 2003-2014 (Wembridge & Langton 2016) which equates to a mean annual loss of 2.5% that is more consistent with rural trends.

The 2014 study in The Regent's Park (Gurnell *et al.* 2015) established that spotlighting was an effective method for detecting hedgehogs with 27 individuals identified in May and 41 in September. Eleven of the 14 new adults found in September were from the ZSL Car Park; an area not searched in May. The hedgehogs found were generally in good condition with above average body weights. The presence of 5 youngsters in September confirmed that this was a breeding population. The combined use of VHF radio-tracking and GPS tags revealed the ranging behaviour and nest locations of a total of 16 hedgehogs. Ranging behaviour was generally consistent with other studies of European hedgehogs in terms of both nightly distance travelled (mean 798 m) and the area covered each night (mean 1.79 ha: 95% kernel estimation). These figures exclude one unusually wide-ranging male in May. Nest sites were mainly found in informal shrubberies (75% of nests), although some use of hedge bases and formal shrubberies was also recorded. Regarding foraging habitat, it was found that large areas of open grassland are avoided by hedgehogs but grassland within a fine-scale mosaic of formal and informal shrubberies, scrub and hedges is an important resource.

Gurnell *et al.* (2015) emphasised the vulnerability of such a small hedgehog population and advocated that 'risk to hedgehogs' should be an integral factor in evaluating any management procedures or changes of use. Measures to enhance habitat quality and reduce hazards for hedgehogs in the Park were recommended and that three hedgehog 'hotspots' should be particularly safeguarded i.e. Zone 1 the Avenue Gardens and Marylebone Green, Zone 2 the area around the ZSL Car Park, and Zone 5 Queen Mary's Gardens and the area around the Boating Lake.

A major success of the study to date was the Royal Parks Foundation's productive partnership with ZSL, The Royal Parks and other organisations. The project successfully engaged with the community, recruiting and training over 100 volunteer fieldworkers to help reveal a great deal of new information about this previously unstudied hedgehog population.

2. Aims of the 2016 project

The principal aims of the 2016 project build upon the conclusions and recommendations of the 2015 report (Section 8, Gurnell *et al.* 2016):

1. To continue spotlighting surveys to provide systematic counts of hedgehogs in both May and September 2016 (pre- and post-breeding) to determine the distribution and population size of hedgehogs in Regent's Park. Survey areas in 2016 should continue to include The Regent's University, Open Air Theatre and Park Square Gardens. Primrose Hill will not be included.

2. To carry out toxicology testing of c10 Regent's Park hedgehog corpses, held by ZSL and the Garden Wildlife Health Project. Test for the presence of rodenticides which may have accumulated in hedgehog tissue as a result of secondary exposure, possibly from scavenging dead mice or rats poisoned as a result of routine pest control in the park catering outlets.

3. To continue to work with ZSL to establish and record the causes of deaths and injuries of hedgehogs found in the park in order to identify the factors limiting the survival and breeding success of the population. Evaluate and implement viable and sustainable ways of reducing risk to hedgehogs from identified factors.

4. To continue to support ZSL and The Royal Parks with HS2 ZSL Car Park negotiations, petitioning and mitigation.

5. To monitor the effectiveness of hedgehog nest boxes within the Regent's Park hedgehog population (see Appendix 1) for a full report.

6. To study the interrelationship between foxes and hedgehogs in the Regent's Park, investigating how many foxes are in Regent's Park.

7. To continue our successful work with our partners to engage volunteers, the local community and other stakeholders in the project in positive action to benefit the conservation of hedgehogs and other wildlife in the parks and urban environment.

3. A partnership project

The Regent's Park Hedgehog Research Project has again been made possible thanks to a generous gift from The Meyer Family. This project has been a very successful partnership between the following organisations and individuals.

Royal Parks Foundation is the charity that helps to support London's eight Royal Parks. The charity reaches out to make the Parks part of more people's lives and raises funds for a wide variety of heritage, education, wellbeing and nature conservation programmes (registered charity 1097545). The charity delivers a wide ranging and accessible outdoor education programme at the Royal Parks Foundation Education Centre in Hyde Park. The schools programme for primary and secondary schools is linked to the National Curriculum, and there is a year-round programme of informal activities for individuals and groups to join, from guided walks to hands-on sessions. Clare Bowen, Head of Programmes, was the Hedgehog Research Project lead, she was supported by Project Managers Sara Harrison and Tess Pettinger and Project Officer Marion Buggins. The charity provided the management and resources required to drive, coordinate and deliver the fieldwork and recruit, train and manage the volunteers.

The Royal Parks welcome almost 78 million Londoners and tourists each year. The more than 2000 hectares of historic parkland provide opportunities for enjoyment, exploration and healthy living in the heart of London. London's eight Royal Parks are: Bushy Park, The Green Park, Greenwich Park, Hyde Park, Kensington Gardens, The Regent's Park and Primrose Hill, Richmond Park and St James's Park. The Regent's Park and Royal Parks Ecology Unit worked particularly closely on this project providing planning guidance and logistical support for the fieldwork periods.

The Zoological Society of London (ZSL), founded in 1826, is an international scientific, conservation and educational charity whose mission is to promote and achieve the worldwide conservation of animals and their habitats. Their mission is realised through their ground-breaking science, active conservation projects in more than 50 countries and two Zoos, ZSL London Zoo and ZSL Whipsnade Zoo. ZSL provided vital veterinary support during the two weeks of fieldwork in May and September. The Horticulture Manager, Sven Seiffert, also kindly provided guidance, volunteer support and access to the zoo grounds which enabled this 15 ha of Regent's Park to be included in the survey. We worked in partnership with Dr Chris Carbone and Dr Marcus Rawthorne, Senior Research Fellows at ZSL to carry out a camera trapping project to provide detail on fox and hedgehog population numbers and distribution. See appendix 2 for more detail.

The Garden Wildlife Health (GWH) project (www.gardenwildlifehealth.org) is co-ordinated by ZSL's Institute of Zoology in partnership with the British Trust for Ornithology, Froglife and the Royal Society for the Protection of Birds. GWH conducts disease surveillance on free-living populations of garden bird, hedgehog, amphibian and reptile across Great Britain.

Dr Nigel Reeve, BSc, PhD, PGCE, MCIEEM. Dr Nigel Reeve studied zoology for his BSc and obtained his PhD by researching hedgehog ecology; both at Royal Holloway College, University of London. Having completed a PGCE at Garnett College (London), from 1982 to 2002 he taught and researched at Roehampton University and in 1994 published a monograph Hedgehogs in the Poyser Natural History series. From 2002 to 2013 he worked as Head of Ecology for The Royal Parks. Nigel Reeve has provided invaluable expert guidance in the planning, delivery, training, fieldwork and interpretation of the results of this hedgehog research project. He is a co-author of this report.

Professor John Gurnell, BSc, PhD. Emeritus Professor of Ecology, Queen Mary University of London. John Gurnell has carried out research on the ecology, behaviour, genetics, management and conservation of mammals, including methods of study, data analyses and modelling. He is especially interested in forest management, reintroductions and translocations as conservation tactics, modelling mammals in relation to management and disease, and the health and welfare of wild and captive animals. John Gurnell has provided invaluable expert guidance in the planning, delivery, training, fieldwork and data analysis of this hedgehog research project. He is a co-author of this report.

The People's Trust for Endangered Species (PTES) is a UK conservation charity created in 1977 to ensure a future for endangered species throughout the world. Working to protect some of the most threatened wildlife species and habitats; it provides practical conservation support through research, grant-aid and educational programmes, including wildlife surveys, publications and public events. PTES coordinates an annual National Hedgehog Survey and an awareness campaign called Hedgehog Street aimed at ensuring the hedgehog remains a common and familiar part of British life.

The Central Royal Parks Wildlife Group brings together amateur and professional naturalists and ecologists who share an interest in the range of wildlife which survives within the Central Royal Parks, and promotes wildlife-friendly management alongside other priorities for the parks. The Group originally identified the need for a hedgehog survey in The Regent's Park and subsequently provided guidance and volunteer support in the field.

Untyped. All data for this project were collected and hosted on Cartographer (http://cartographer.io), a cloud-hosted service for crowd-sourcing environmental data. Cartographer allows environmental groups to collect data from volunteers and display it using custom maps and charts. The software has been developed by Untyped (http://untyped.com), who kindly provided the project with custom set up and support.

The volunteers. Each period of fieldwork was supported by a team of more than 100 fantastic volunteers, many of them were repeat volunteers, consisting of individuals with a wide range of backgrounds but sharing a keen interest in wildlife and conservation. A number of experienced volunteers again acted as Volunteer Supervisors, leading small teams in the field during the fieldwork.

4. Survey design

4.1 A science-led, community-based research project

This project was carried out under licence from Natural England; licence nº 2016-19710-SCI-SCI. The survey methods changed from 2015 to include two nights of intensive spotlighting in May and two nights in September. No GPS tracking or radiotagging was carried out in 2016.

This approach involved a very resource-intensive period of fieldwork which relied on the recruitment of dedicated volunteer teams and supervisors. The spotlighting survey method tasked surveyors to systematically search for hedgehogs throughout the park and hand capture, mark and release individuals found. Surveys took place on two all-night sessions in May and two in September. Each all-night session was split into two shifts of between 3-4 hours each and each group was able to use a thermal imaging camera to improve search efficiency. After trialling the equipment in 2015, no thermal imaging camera was used in zone 7 (ZSL) due the absence of open spaces.

Recording forms for the spotlighting survey method can be found in Appendix 3. Further details of the methods are presented below and an equipment list included in Appendix 4.

4.2 Division of The Regent's Park into survey zones

Regent's Park covers over 160ha. In order to conduct a systematic search of the entire park, the project management team divided the park into seven zones based zones used during the 2014 and 2015 surveys.

Although included in 2015, Primrose Hill (Zone 8) wasn't included in the 2016 survey due to the lack of recent hedgehog sightings there.

Because Zone 2 is identified as a hedgehog hotspot, it was decided to split it into two sections, 2a and 2b (Figure 4.1), to help ensure the whole area was surveyed in the time available. Zone 2a was surveyed by itself, Zone 2b was joined with Zone 3 to be surveyed by one group.

Areas of the park not managed by the Regent's Park team include Winfield House, The Regent's University, Open Air Theatre, The Holme, Capel Manor College, Park Square Gardens and St John's Lodge. Access to the Regent's University was granted during 2016 and it was included within Zone 1a. Access to Park Square Gardens (Crown Estates Paving Commission) was also granted for spotlighting and included in Zone 1b. The Open Air Theatre (OAT) was also spotlighted and included within Zone 5.

The Project Team was based at the Old Ironworks buildings, just on the Inner Circle, for both survey periods. This acted as 'Hedgehog Headquarters' and provided a safe place to meet, greet and train volunteers and for equipment to be stored.

Figure 4.1 Aerial view of Regent's Park showing boundaries of the 9 survey zones and walk routes (dashed lines). Areas shaded yellow had limited access or no access (The Holme, St John's Lodge). OAT=Open Air Theatre.

4.3 Survey timings

Two nights of intensive fieldwork took place, in May and September:

- 13 May and 20 May 2016 - after the hedgehogs had woken up from hibernation and become sexually active.
- 2 Sep and 9 Sep 2016 - after breeding and prior to hibernation when both sexes were still active. Any young would be from this year and litters would not be disturbed in their nests.

4.4 Volunteer involvement

A team of volunteers were recruited to carry out the spotlighting surveys. These volunteers worked alongside the project team supervisors and trained volunteer supervisors to complete all required activities on each shift and record the date captured. For each shift, 26 volunteers and 10 supervisors were needed, totalling 36 people. Eight shifts were held during 2016 (four in May and four in September), meaning there were 288 slots to fill.

The volunteers were key to the fieldwork's success and together with the project supervisors worked a total of 1,586 hours (199 8-hour days) over the May and September survey periods (Table 4.1).

Table 4.1 Volunteer and supervisor hours worked on the hedgehog survey in May and September 2016. *NB: Some volunteers and supervisors worked across multiple activities and survey periods.*

Month	Activity	Number of volunteers per activity	Volunteer hours in the field	Number of supervisors per activity	Supervisor hours in the field
May	Spotlighting	80	390	22	300
September	Spotlighting	73	576	18	320
	2016 TOTAL	**153**	**966**	**40**	**620**

Figure 4.2 Half of the May Hedgehog Heroes

4.5 Volunteer recruitment, management and retention

In order to foster team spirit and a sense of purpose, the volunteers were referred to as 'Hedgehog Heroes'. A volunteer recruitment pack was produced and shared by email to previous volunteers, groups known to the Foundation and other recommended contacts. Interested volunteers then submitted application forms by email to the Royal Parks Foundation Volunteer Manager who liaised with them closely throughout the project and managed the scheduling timetable.

Volunteers and supervisors were recruited from a number of sources – 102 in May and 91 in September (Table 4.2).

Table 4.2 Recruitment sources of the individual 2015 and 2016 volunteers

Recruitment Source	May-15	Jul-15 (Questionnaire distribution)	Sep-15	May-16	Sep-16
Repeat volunteers	41	17	52	54	62
ZSL	23	0	15	27	20
PTES / Hedgehog Street	15	0	3	0	0
Friends or family	14	3	2	13	5
RPF	7	0	0	4	2
The Royal Parks	2	0	0	1	1
Springwatch	0	6	6	0	0
Land Manager training	0	0	3	0	0
CRPWG	0	0	1	0	0
CIEEM Social	0	0	0	3	1
TOTAL	**102**	**26**	**82**	**102**	**91**

The Royal Parks Foundation Volunteer Manager kept in close contact with the volunteers throughout the project. Volunteers

- received regular email updates
- had the opportunity to attend a training workshop
- were involved in a real life scientific research project
- had the opportunity to handle a hedgehog
- were provided with refreshments during the survey nights
- were invited to thank you drinks in May and October
- received Time Credits as a thank you after each shift (two Time Credits per volunteer shift)
- were supplied with reference letters where requested
- were given the opportunity to buy a specially-designed range of 'Hedgehog Hero' clothing

The feedback from the volunteers was excellent and the project fostered a real sense of community and willingness to stay involved with the hedgehog research and other wildlife research projects in the Parks.

"Thanks again for asking me to join the team of Hedgehog Heroes in Regent's Park. I thoroughly enjoyed the experience and meeting so many wonderful people .Thank you again for your wonderful organisation on the night and the prep beforehand. Tea and biscuits kept us going - great stuff.

Looking forward to the results so do keep in touch and let me know if I can help in any other way." – Alison, Hedgehog Hero 2016

"Although I didn't see any Hogs this time round it was still an amazing experience, I hope to be back in September!" – Clare, Hedgehog Hero 2016

"Just wanted to say that I really enjoyed the opportunity to be involved with the hedgehog surveys over the last couple of weeks, everything was really well organised and communicated throughout. I'm sure everybody has said similar but if there are any other volunteering opportunities that pop up I would be happy to lend a hand if you are in need of people." – Rachel, Hedgehog Hero 2016

4.6 Volunteer training

In order to promote best practice in the field, share basic hedgehog ecology information as well as findings from the previous survey period, to ensure that the hedgehogs' welfare was a priority at all times and build a sense of community, two volunteer training sessions were held in Regent's Park led by the project team and our scientific advisors.

The aims of these sessions were to:

- brief the volunteers on the research programme as a whole
- update on 2015 survey results
- introduce the core project team, partners and location of Hedgehog Headquarters
- demonstrate the techniques and field equipment available and allow time for practice – one volunteer recorded footage of a hedgehog being unrolled in the field to show new volunteers at the start of their shift
- outline the welfare facilities available and run through the risk assessment
- say thank you to all the volunteers
- build a sense of common purpose and team spirit

Two training session options were offered to the volunteers ahead of the May survey. As there were so many repeat volunteers in September, only one session needed to be held. All training sessions were at the Old Ironworks on the Inner Circle in Regent's Park on the following dates:

Saturday 7 May: 09:30 – 12:00
Wednesday 11 May: 18:00 – 20:30
Tuesday 30 August: 18:00 – 20:30

A comprehensive volunteer survey guide was produced for each survey period (Appendix 5).
The main contents of this pack were:

1. Project summary
2. About hedgehogs
3. Survey activities overview
4. Key dates
5. Survey zone maps
6. How to handle a hedgehog
7. Hedgehog marking system
8. Hedgehog first aid
9. Data management
10. Volunteer kit list
11. Risk assessment
12. Hedgehog HQ
13. Emergency procedure
14. Travel
15. Key contact details
16. Project partners
17. How-to-guides

These survey guides were distributed to the volunteers at the training sessions as part of their volunteer 'pack' along with a lanyard with key contact information, Regent's Park out of hours access map, risk assessment and how-to-guides. When volunteers arrived at the training session they were also asked to sign a medical release form and a photograph and film footage release form. Any volunteers who were unable to attend the training were emailed the pack, offered a phone call to run through any questions and asked to sign the waiver forms at the start of their first shift.

Feedback from the volunteers about the training days was excellent:

"Seeing how passionate people are about the wellbeing of hedgehogs and being given the information to support them."

"Everybody is very passionate about the subject!!"

"It was really well organised and informative; I'm really looking forward to volunteering on this project again"

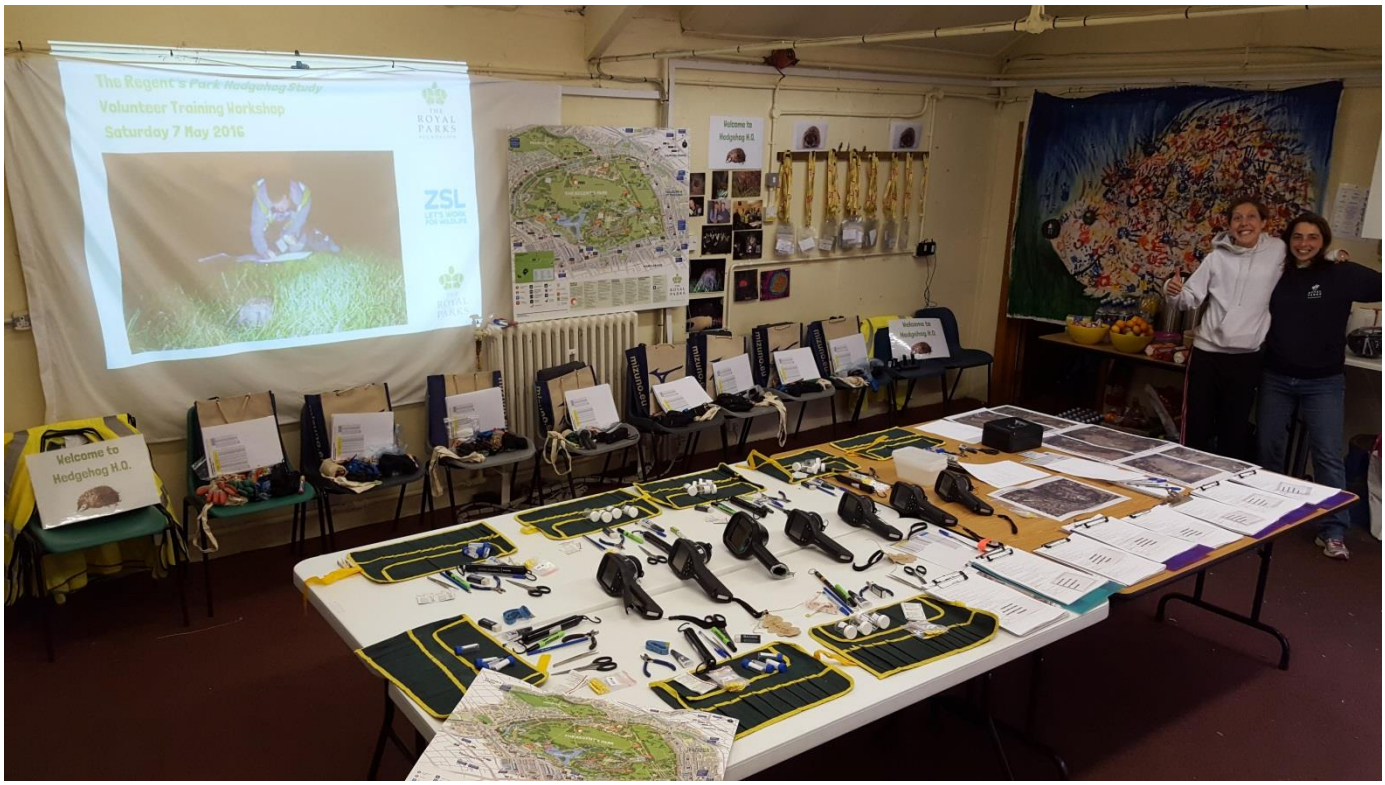


Figure 4.3 Hedgehog HQ set up with all the required equipment and ready for the volunteers to arrive

Figure 4.4 The May Hedgehog Heroes in training

Figure 4.5 Two of our regular volunteers, Wendy and Jim, helping set up for the September training with John and Nigel

4.7 Supervisor training

Given the 2016 plan to carry out all night field work sessions and the drop out of some of our previous supervisors the number of trained supervisors needed to cover the shifts and lead groups of volunteers had to be increased. To do this, a number of 2015 volunteers who had shown good field work skills were invited to receive additional supervisor training for the 2016 sessions.

Supervisors were invited to the volunteer training sessions to hear the introduction and overview with the rest of the group, and then taken aside to receive a separate supervisor briefing, the aim of this briefing was to:

- update the supervisors on the research programme as a whole
- run through the 2015 results
- introduce the core project team and partners
- demonstrate the techniques and field equipment available in detail
- carry out practical field work practice, e.g. use of thermal imaging camera, sexing and weighing a hedgehog etc.
- run through the proformas to be completed for each activity
- outline the welfare facilities and the supervisors role to ensure volunteer safety and management
- build a sense of common purpose and team spirit

4.8 Personnel health and safety

Volunteers' and supervisors' health and safety was of paramount importance to the programme and a risk assessment was produced by the Royal Parks Foundation, signed off by the Park Manager and distributed to everyone involved within their volunteer pack (Appendix 6) at the training sessions. A number of measures were put in place to reduce the main risks involved:

1. Volunteers would always work in a minimum group size of two so they were never alone in the Park.
2. A project supervisor from the core team was always on site in Regent's Park when volunteers were there.
3. Hi-vis jackets were provided to volunteers so they could be easily seen in the Park at night time
4. At night time, individual LED torches were provided to each volunteer for use when walking around the Park.
5. Personal lanyards, which had a card with the projects key contact information including the Regent's Park on call number and the emergency procedure, were given to each volunteer.
6. Gloves and goggles were provided for handling hedgehogs.
7. Hand sanitiser was provided for after handling hedgehogs.
8. All equipment was checked regularly, well maintained & any broken equipment disposed of.
9. When night time and morning shifts started or ended after the last tube, volunteers who didn't have access to their own transport were provided with a taxi ride home.
10. Spare warm clothing was kept at Hedgehog HQ.
11. A separate risk assessment and FAQs were produced for delivery of the local residents questionnaires.
12. A medical waiver form was signed by each volunteer and volunteers were asked to provide emergency contact details.
13. Light refreshments were available at Hedgehog HQ for each survey session to keep volunteers fuelled up and warm with hot drinks

14. The Parks police were informed of the survey dates so they knew volunteers would be on site after the Park had closed.
15. An emergency procedure was also put in place and outlined in the volunteer briefing pack.

4.9 Veterinary support

The Veterinary Services team at ZSL, as key partners to the project, were again on standby during both periods of fieldwork in May and September 2016. It was agreed that any animal deemed visibly unwell or seriously injured would be boxed and delivered to the vet team on site at ZSL where all necessary care would be provided. A set of broad principles about how to handle the injured hedgehogs were agreed between the partners.

1. The welfare of the animals was paramount at all times.
2. The preferred option was always to treat an animal's injuries where possible and release it back into the Park.
3. If an animal could be treated but not released back into the Park due to the nature of its injuries, and it was felt that if it could have some quality of life in a captive setting, then intervention was the agreed option. E.g. operating on or amputating a hind leg. Contingency funds for treating these animals were set aside.
4. If an animal's injuries were so bad that it could not be treated, then it would be euthanased.

A very experienced hedgehog carer, Sue Kidger, kindly agreed to care for and rehabilitate any hedgehogs that would need long term or specialist care at a dedicated hedgehog unit in her own home.

Any hedgehogs found dead or euthanased from The Regent's Park were submitted to the Garden Wildlife Health (GWH) project based at ZSL's Institute of Zoology. GWH vets conducted a detailed post-mortem examination on the animal, where possible, established a cause of death and also recorded significant underlying conditions. A full tissue archive was retained from each case for further studies as required (Appendix 7).

4.10 Exposure of hedgehogs to rodenticides

Second generation anticoagulant rodenticides (SGARs) are used to control rats and mice in various locations throughout TRP such as at food outlets and around the Zoo. Rodenticides are persistent and can be toxic to any mammal or bird that ingests them. Thus they represent a primary or a secondary poisoning risk to non-target species in the Park. A preliminary study on the exposure of hedgehogs to SGARs was carried out in 2016. Liver samples from 12 dead hedgehogs from over the three years of study were provided by the ZSL vets and the Garden Wildlife Health Project team and sent to the Centre for Ecology and Hydrology, Lancaster for analysis of SGARs. A full report on this study is presented in Appendix 8.

5. Survey Methods

5.1 Spotlighting

Spotlighting consisted of systematic nocturnal searches (using designated routes) within nine selected zones of the park and ZSL (Figure 4.1) to locate hedgehogs with the aid of bright torches (LED Lenser P7.2, brightness up to 320 Lumens). Searching also involved listening for the rustles in undergrowth, or the noises made during courtship or fighting. As hedgehogs 'freeze' when they hear the sounds of a potential predator approaching, fieldworkers were instructed to minimise conversation, walk quietly on grass or bound surfaces where possible and wear rustle-free clothing. All spotlighting groups had the use of a thermal imaging camera (see below).

On the two survey nights in May and September. Teams of 4-5 volunteers plus one supervisor were sent to each zone and given a set route to walk around. The volunteer tasks involved:

- searching for the hedgehogs
- recording the data captured for any hedgehog found on a proforma
- assisting the supervisor with sexing, weighing, checking and marking the hedgehog
- taking photographs of the group or hedgehogs found
- recording any fox sightings

The protocol was for groups to spread out but to follow the route at a steady slow rate, pausing briefly every 20 metres or so to listen for sounds. Walking closely to the edges of hedges or borders allowed the searchers to listen for sounds in the undergrowth whilst also scanning the torch across open grassland where hedgehogs were easy to spot. Location records from spotlight searches will inevitably be biased towards open habitats. Experienced searchers will also find hedgehogs in undergrowth but searching by sound will be less effective where there is background noise such as that from wind or traffic or when walking on noisy surfaces.

Spotlighting is a simple, effective and low disturbance way to locate hedgehogs for identification marking, gathering biometric data and attaching VHF or GPS tags. Data were recorded on the Spotlighting Proforma (Appendix 3).

Once found, hedgehogs were marked in the same way as 2015, using six 10mm lengths of yellow plastic sleeves (1.6mm internal diameter polyolefin sleeving) bearing pre-printed numbers (Figure 5.1). This is an adaptation of a method (using hand-drawn numbers) first used by Wroot (1984). To ensure durability to the printed number, prior to field use, we sprayed the sleeving with a fixative (Perfix Colourless Fixative; Daler-Rowney Ltd). Six duplicate sleeves, each bearing the animal's identification number, were glued to spines on the crown of the head using tweezers and superglue. This system made individual identification simpler. Using this system, an animal would remain identifiable even if only one marked spine remained in the pelage.

Using individual identification marks allowed population size to be estimated as well as persistence in the population between the first and second survey periods.

Figure 5.1 Hedgehog 152 Marked in 2015 with five yellow numbered plastic markers glued only to spines on the crown of the head. Markers supplied by Printasleeve Ltd Higher Street, West Chinnock, Crewkerne, Somerset, TA18 7QA. 1.6mm internal diameter Polyolefin sleeving.

5.2 Thermal imaging

Thermal imaging cameras were used by volunteers to detect hedgehogs during spotlighting. Each one of the survey groups had the use of one thermal imaging camera, except for Zone 7 (ZSL).

The model primarily used was a FLIR E60 which had a 4 hour battery life; the battery was easily replaced with a spare in the field to give 8 hours of continuous use. The set-up configuration of the E60 that was used is detailed in Appendix 9.

The 'Above Alarm' mode allowed precise (±0.1^{o} C) adjustment of the temperature threshold above which an object would be displayed in red against a grey background. This allowed the user to compensate for changes in ambient temperature, ensuring good discrimination between a hedgehog and the background. The E60 allowed video (MPEG4) or still (JPEG) images (resolution 320 x 240 pixels) to be recorded to a standard SD card as required. The 'Above Alarm' mode was the best mode for detection at a distance. Under field conditions in amenity grass (up to about 10cm tall) hedgehogs could reliably be detected at distances up to 60m, further in very short grass or less far when the hedgehog was partially obscured by vegetation.

Figure 5.2 The FLIR E60 in field use with display set in 'Alarm mode' for behavioural observations during 30minute sampling periods. .

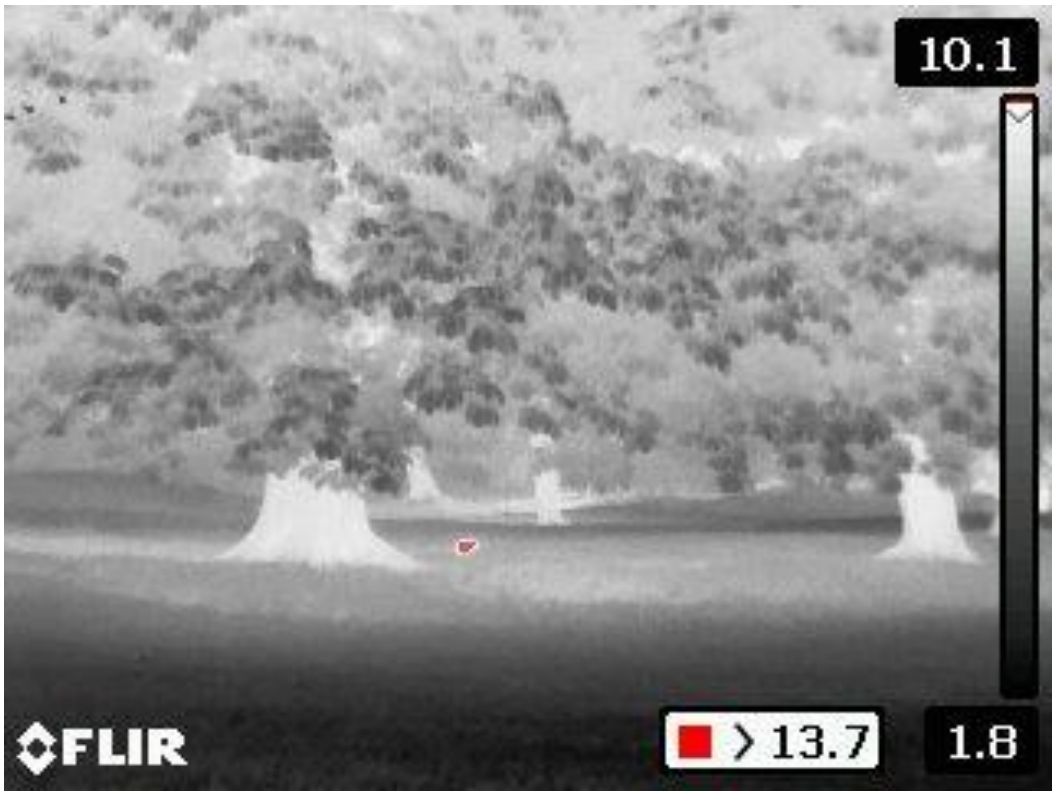


Figure 5.3 Image captured from the FLIR E60 in May 2015 with display in 'Alarm Mode' and the detection temperature threshold set at 13.7°C (a few degrees above the ambient at the time) so that warmer objects show red against a grey background. This hedgehog is clearly visible at an estimated 40 metres.

5.3 Foxes - Camera trapping survey with ZSL

We worked in partnership with Dr Chris Carbone and Dr Marcus Rawthorne, Senior Research Fellows at ZSL to carry out a camera trapping project to provide detail on fox and hedgehog population numbers and distribution. This involved the placement of 60 camera traps (Reconyx and Bushnell models) throughout The Regent's Park and the analysis of recorded detections (particularly hedgehogs and foxes) using a Randomised Encounter Model (REM) to estimate the relative numbers of these species. See Appendix 2 for more detail.

5.4 Rodenticide analysis

See Appendix 8.

5.5 Data management

Survey data were collected by hand in the field using template recording forms as in previous years (Gurnell *et al.* 2015, 2016). The data were then entered into the online data management system, Cartographer by our expert scientists.

Volunteers were asked to take photographs of the hedgehogs to aid identification and to note any distinctive features. The volunteers then uploaded all the photographs onto Dropbox – an online service that allows the sharing of files, photos and videos. Details of how to use Dropbox were sent to all volunteers before they started along with a naming convention so each photo could be identified.

A template form was also used to record data when the nest boxes were inspected.

5.6 Data analysis

Position data on hedgehogs, foxes and nest boxes have been presented on Google Earth maps. Survey data recorded on Cartographer and nest box data have been analysed using Excel, Xlstat and Minitab software.

6. Results

6.1 Population dynamics

6.1.1 Numbers of individuals

From their peak in September 2014, numbers of hedgehogs captured declined through May and September 2015 to a low of just 11 individuals in May 2016. Thereafter they partially recovered to 25 individuals in September 2016 (Figure 6.1). The relative number of adult males to females captured was lower in the second half of the survey period (September 2015 to September 2016) than the first (May 2014 to May 2015), with only one adult male captured in May 2016 (Figure 6.1)[1].

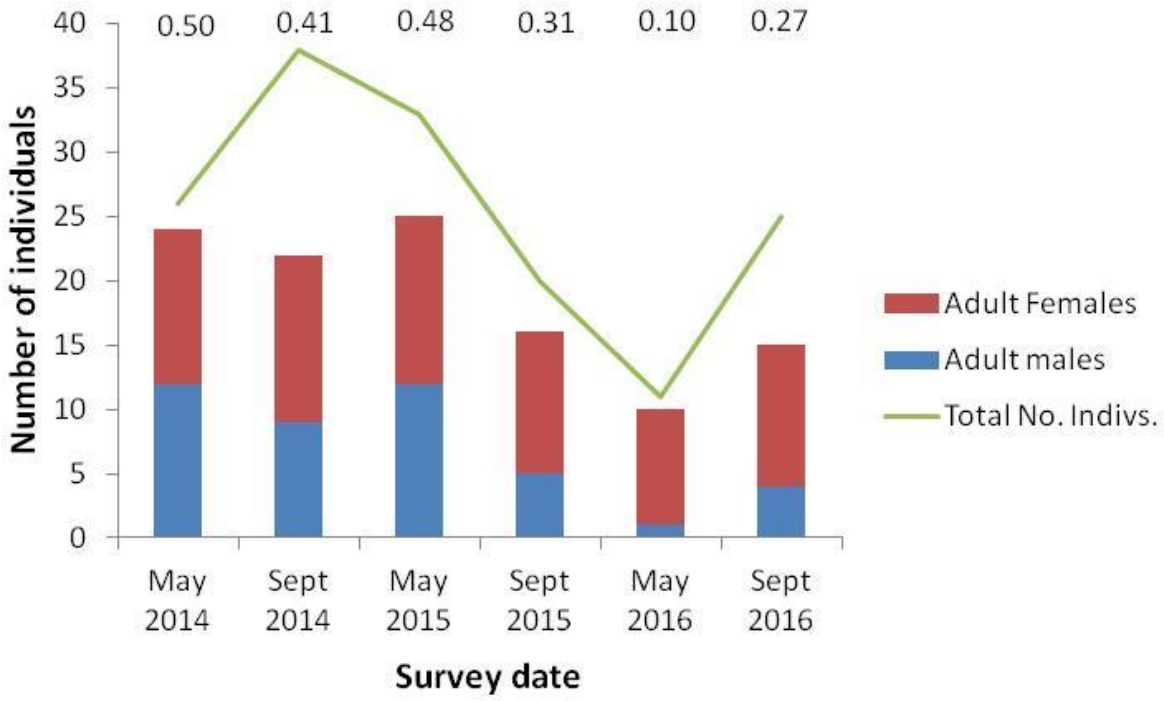


Figure 6.1 Numbers of individual hedgehogs captured during each survey period. Adult animals taken as >=700 g, Total individuals include juveniles and subadults, animals <700 g. The numbers above each survey date show the proportion of adults captured that were males. Note: the ZSL Car Park was not surveyed in May 2014 and it was estimated that, if the ZSL Car Park had been surveyed, then total numbers would have been in the order of 34 individuals (Gurnell *et al.* 2016).

6.1.2 Persistence and recruitment

Male persistence from one survey period to the next declined from May 2014 (33%) to September 2015 (25%) and tended to be lower than female persistence across all survey periods, with the exception of May 2016 (mean female persistence = 56%, stdev = 6.2%, N=5, mean male persistence, excluding May 2016, = 31%, stdev 5.9%, N=4) (Figure 6.2). In May 2016, one adult male was captured and persisted to September 2016[2]. There was no particular pattern in persistence over winter, from autumn to spring, and persistence over summer, from spring to autumn.

[1] Note that the sex of one adult and one juvenile were not determined in September 2014.
[2] In addition. one subadult male captured in May 2016 persisted to September 2016.

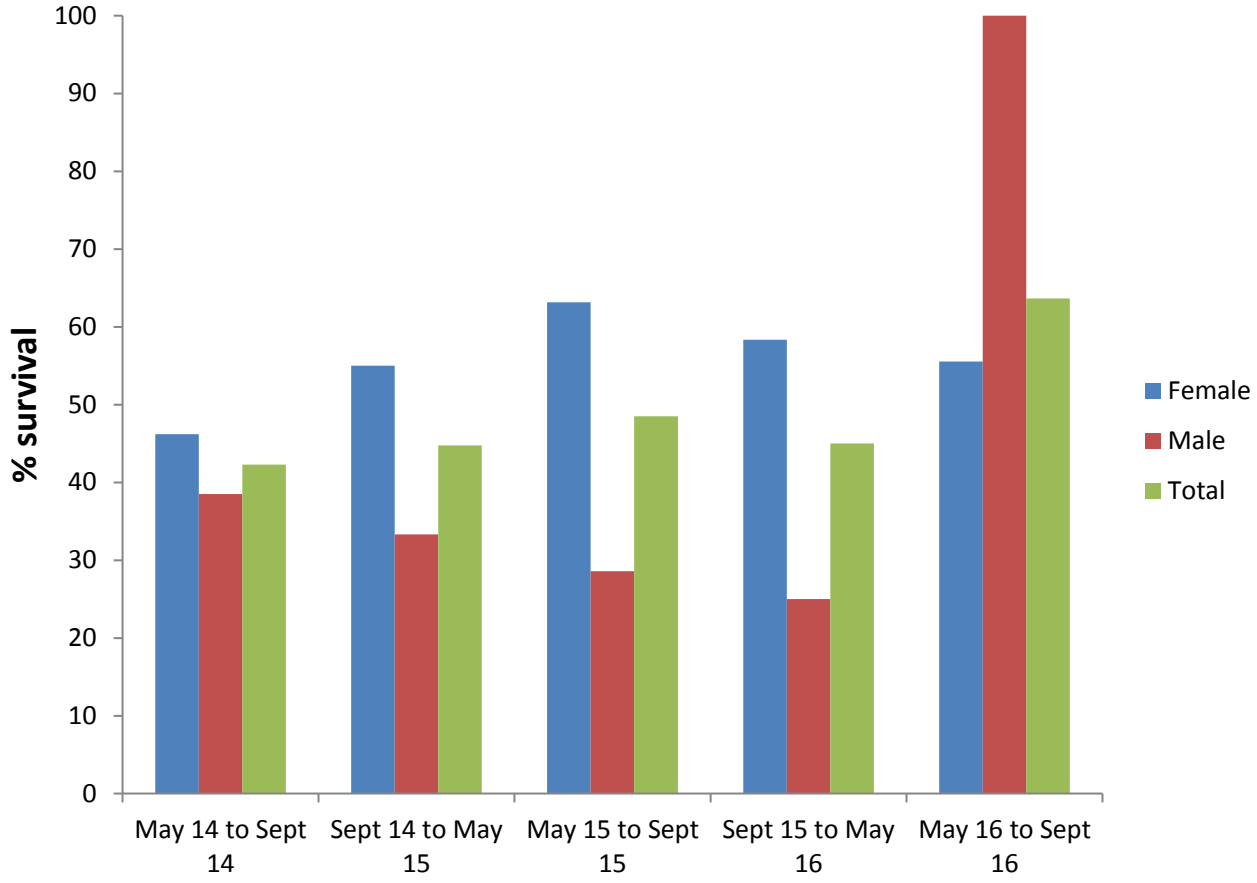


Figure 6.2 Per cent of male and female hedgehogs persisting from one survey period to the next.

Numbers of juvenile/subadult hedgehogs captured in each survey ranged from one individual in May 2016 to 15 in September 2014 (Figure 6.3). Although there is evidence of breeding in the summer of each of the three years of the study, only four young animals were found in September 2015 indicating poor recruitment over the summer. However, this does not include three young in a nest that were found in the eastern part of the Zoo grounds (inside the anteater enclosure) at the time of this survey. The recovery in September 2016 can be attributed to increased recruitment with 44% of the animals captured being juveniles/subadults; this is a higher percentage than the 40% captured at the time of the population peak in September 2014.

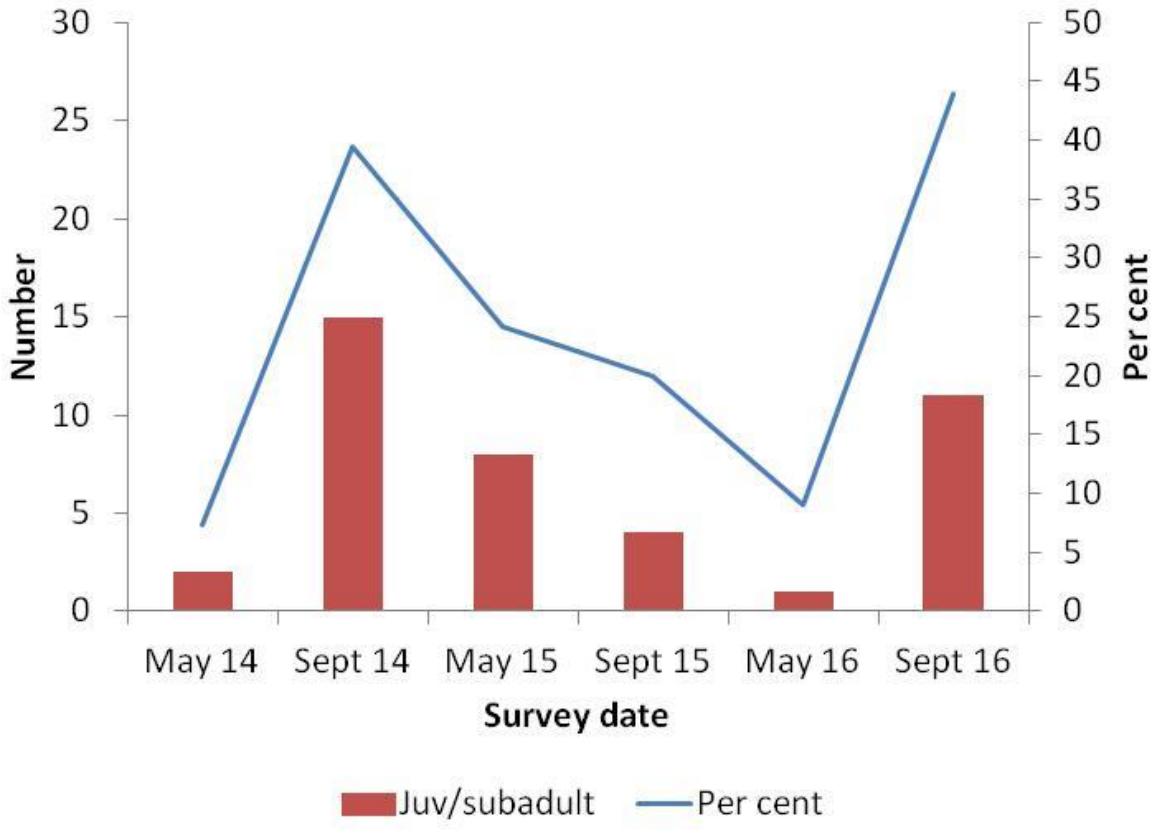


Figure 6.3 Number and per cent of total of juvenile/subadult hedgehogs (<700 g) captured in each survey.

6.1.3 Body weight

Over the survey period, adult body weights ranged from 700 g to 1220 g in males and 700 g to 1450 g in females (Figure 6.4). Pooling years, the mean weight of adult females captured in May was 927 g (stdev = 166.6 g, N = 34) and males was 840 g (stdev = 121.9 g, N = 26). Equivalent figures for September surveys were: females 1019 g (stdev = 162.1 g, N = 34) and males 959 g (stdev - 144.4 g, N = 18). The difference in weights between May and September was significant for females (t_{65}=-2.29, P=0.025) and for males (t_{32}=-2.86, P=0.007). Carrying out a two-way analysis of variance showed there was no statistical interaction in body weight between sex and survey period ($F_{5,111}$=0.43, P=0.827), but there were significant main effects of survey date ($F_{5,111}$=3.85, P=0.003) and sex ($F_{1,111}$=5.91, P=0.017) (Figure 6.5).

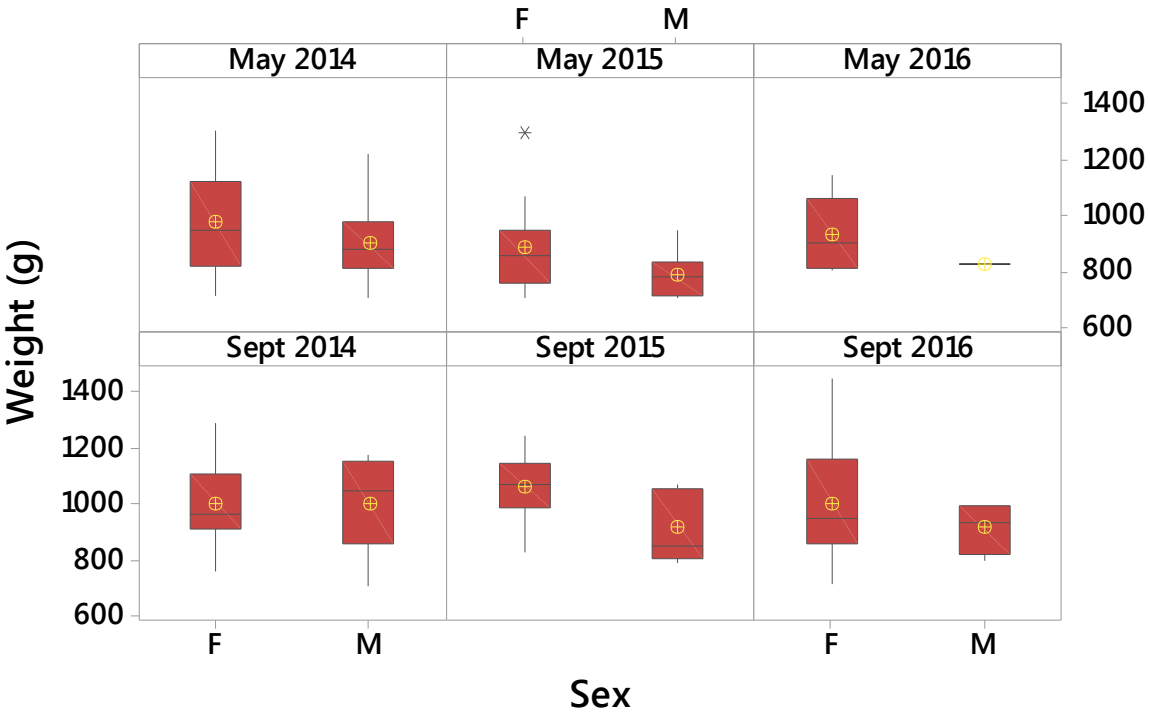


Figure 6.4 Box plots of adult hedgehog body weights (animals >=700 g). Red box represents the inter-quartile range, whiskers = highest and lowest values, * = outlier, yellow cross circles = mean values, F = female, M = male.

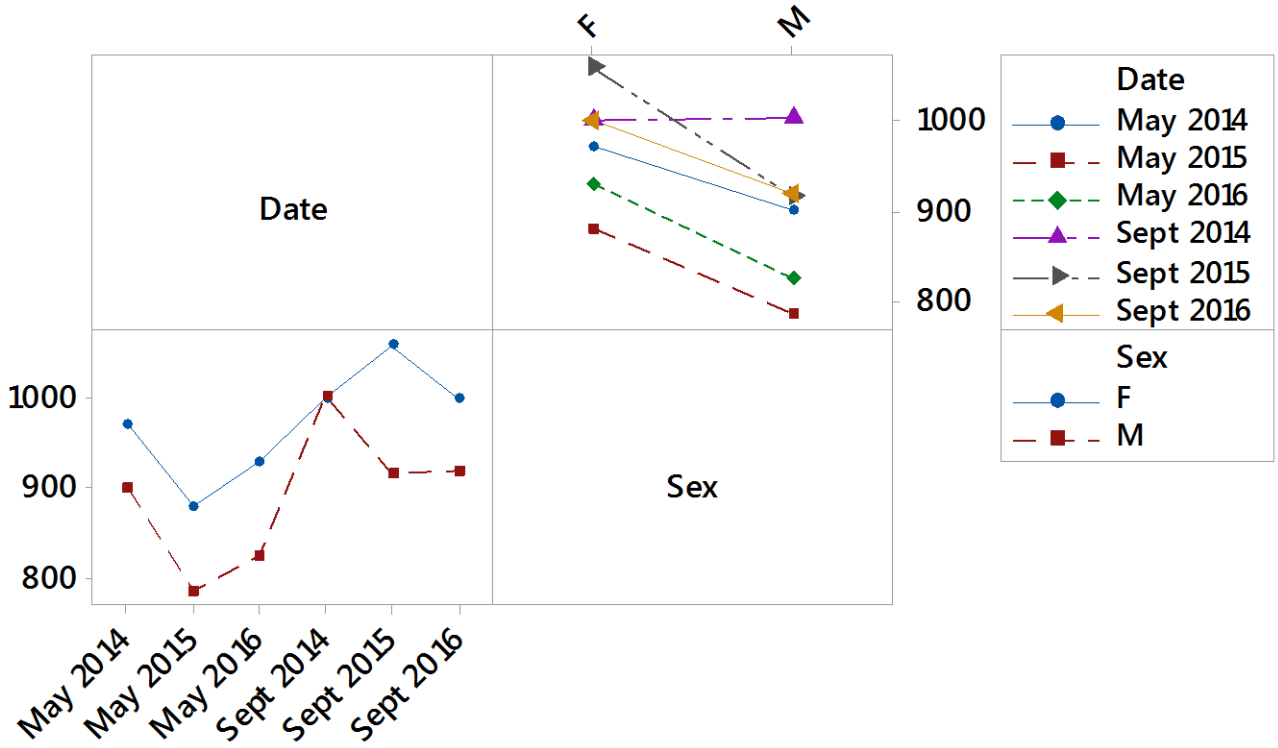


Figure 6.5 Full interaction matrix plot of mean adult body weight (g, y axis) according to survey date and sex. F = female, M = male.

6.2 Distribution of captures

6.2.1 Captures in 2016

In 2015 and May 2016, Primrose Hill was added to the areas surveyed (Zone 8), but no hedgehogs were captured here, and this Zone was not searched in September 2016. In 2016, most captures were in the centre (Zone 4) and north east (Zone 2) areas of the Park with only one or two captures in the far west and south (Figures 6.6 and 6.7).

Figure 6.6 Locations of hedgehog captures within Regent's Park in May 2016. Red = females, Orange = males. Numbers refer to individual animals.

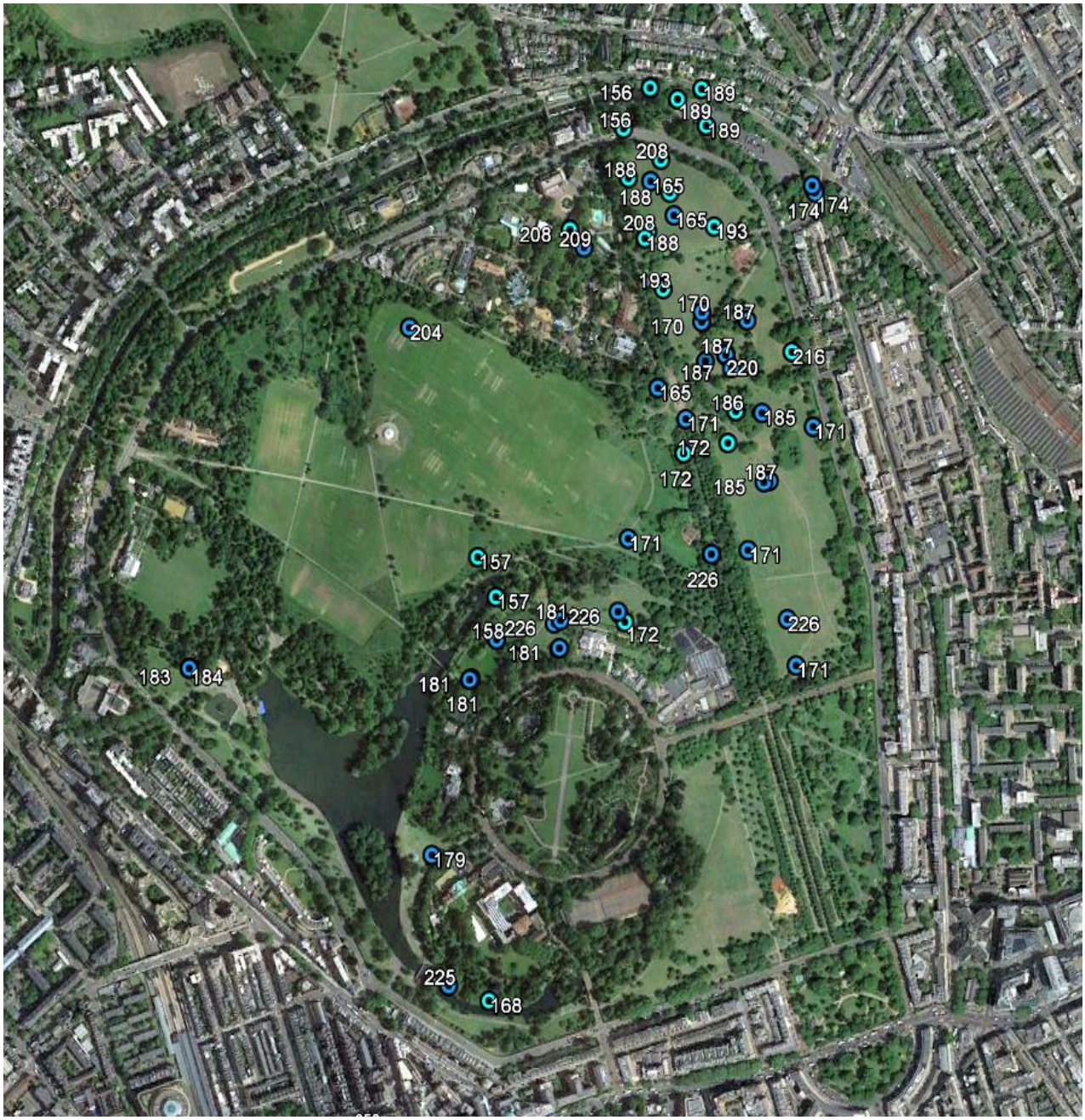
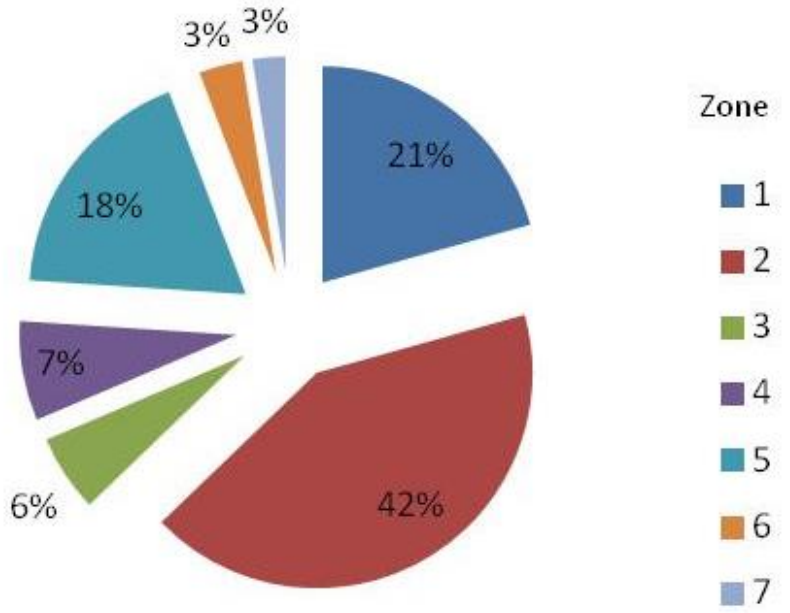


Figure 6.7 Locations of hedgehog captures within Regent's Park in September 2016. Blue = females, Cyan = males. Numbers refer to individual animals.

6.2.2 Shift in hedgehog distribution within the Park, 2014 to 2016

Numbers captured in the park, survey Zones 1-6, and the zoo grounds, Zone 7, over the three years of the study are shown in Figure 6.8a. Overall, Zones 1 (Avenue Gardens/ Marylebone Green), 2 (including the ZSL Car Park) and 5 (around the Boating Lake) were the most frequented and were considered as hotspots in previous reports (Gurnell *et al.* 2015, 2016). In contrast, Zones 3 (mainly the sports pitches), 4 (Wetland areas), 6 (east of Winter Gardens) and 7 (Zoo) appeared to have been little used.

(a)



(b)

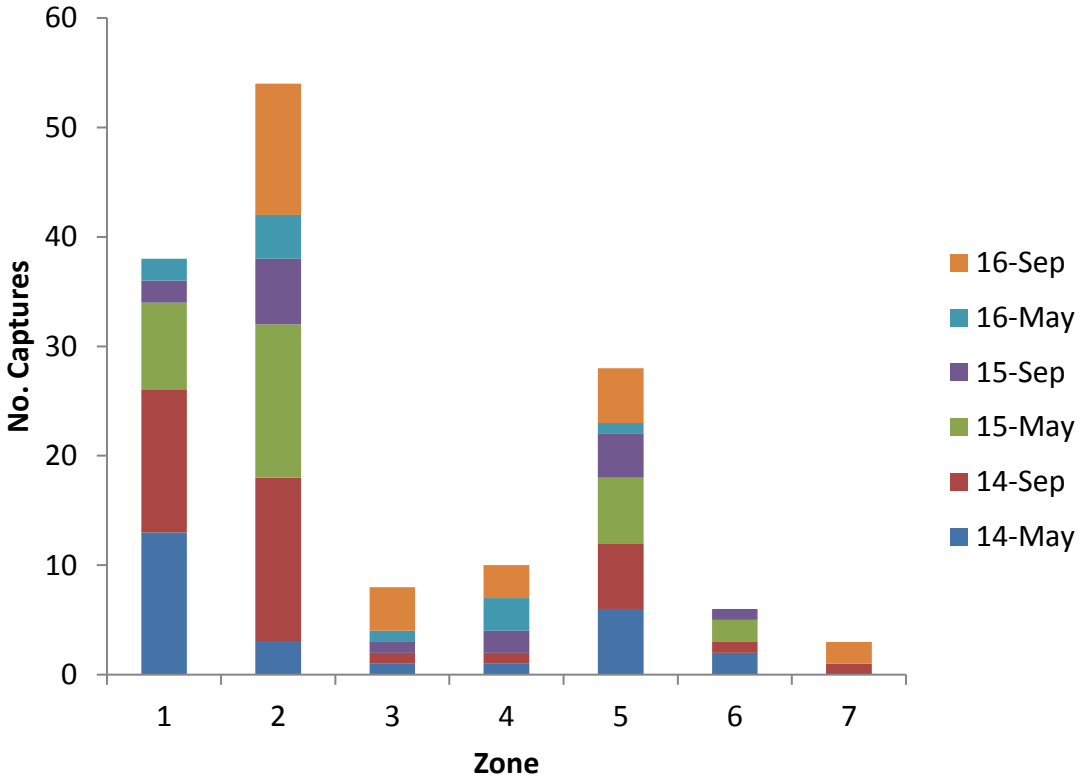


Figure 6.8 (a) Per cent individuals captured in each survey zone, pooled across all surveys (b) Numbers of individuals captured according to zone for each survey (if an animal was captured in more than one zone in a survey, only the first capture zone is counted here.)

However, this broad description masks some marked changes in the distribution of hedgehogs within the Park that have occurred over the three years of the study (Figure 6.8b). To help illustrate these changes, Figures 6.9, 6.10 and 6.11 show the distribution of captures in 2014, 2015 and 2016 respectively, overlain on the 50%, 75% and 95% kernel isopleths[3] estimated using the capture locations from all three years. By scanning through these images, it can be seen that, between 2015 and 2016, there has been a shift in numbers captured from the south (Zone 1) and east (Zone 5), two of the three hotspots identified in 2014 and 2015, to Zone 2, Gloucester Green and Cumberland Green (Zone 2). The ZSL Car Park, a local hot spot within Zone 2, is considered in section 6.2.3. Notably, no hedgehogs were captured in Zone 1 in September 2016 compared with 50% of all individuals captured in May 2014.

[3] The 50% isopleth corresponds to the area in which the probability to capturing an animal is equal to 0.50, and similarly 0.75 and 0.95 for the 75% and 95% isopleths respectively.

Figure 6.9 Overlay of 2014 captures on 2014-2016 all-capture isopleths. Symbols = captures: Red open circles – May 2014 (ZSL Car Park not surveyed), Pink solid circles – September 2014. Lines = Kernel isopleths: Blue – 95% isopleth, Green – 75% isopleth, Yellow – 50% isopleth.

Figure 6.10 Overlay of 2015 captures on 2014-2016 all-capture isopleths. Symbols = captures: Lime open circles – May 2015, spring green solid circles – September 2015. Lines = Kernel isopleths: Blue – 95% isopleth, Green – 75% isopleth, Yellow – 50% isopleth.

Figure 6.11 Overlay of 2016 captures on 2014-2016 all-capture isopleths. Symbols = captures: Cyan open circles – May 2016, Blue solid circles – September 2016. Lines = Kernel isopleths: Blue – 95% isopleth, Green – 75% isopleth, Yellow – 50% isopleth.

6.2.3 ZSL Car Park

The ZSL Car Park was not surveyed in May 2014, but in September 2014 and May and September 2015, 26% of all the individuals captured throughout The Regent's Park and 22% of all captures occurred in the ZSL Car Park (Figure 6.12) and was considered an important local hotspot area (see Gurnell *et al.* 2016). One individual was captured in the ZSL Car Park during the time of the population low in May 2016, and four individuals (16% of the number of individuals captured in the Park as a whole) were captured in September 2016. It is noteworthy that hedgehogs were captured in the grass/scrub areas surrounding all of the central tarmac car park showing they made full use of this habitat.

Figure 6.12 Location of all captures of hedgehogs in the ZSL Car Park during the study period. Pink solid circles – September 2014; Lime open circles – May 2015; Spring green solid circles – September 2015; Cyan open circles – May 2016; Blue solid circles – September 2016. The Car Park was not surveyed in May 2014.

6.3 Habitat utilisation

Over the study period, 75% of all captures took place on short or long cut grass (Figure 6.13). Four to five per cent of captures occurred in woodland, scrub and tussock grassland and the remainder in a variety of different habitats.

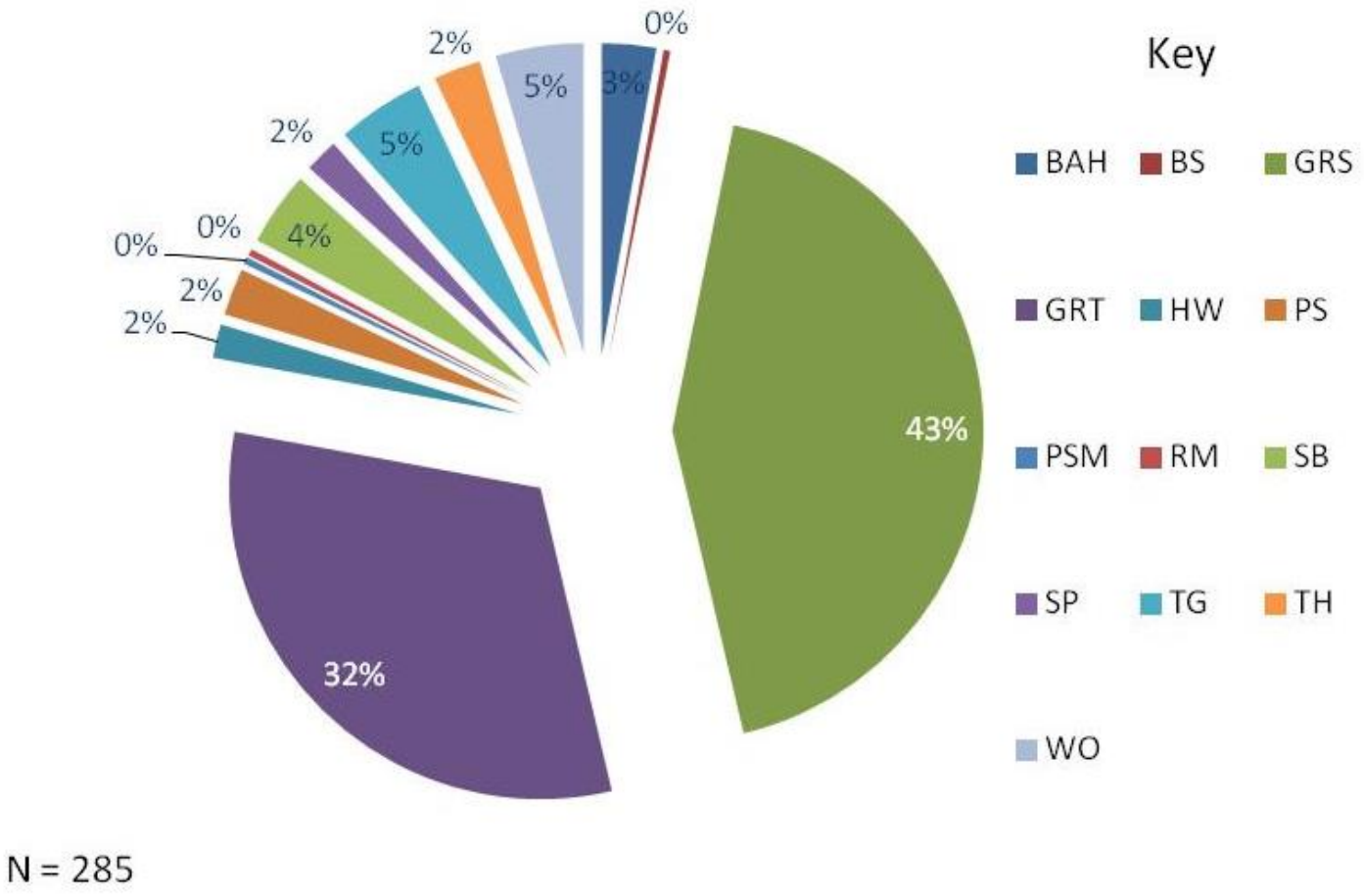


Figure 6.13 Habitats in which hedgehogs were captured - all surveys combined. Key: BAH=Bare artificial habitat, BS=Bare soil, GRS=Grass < 10cm tall (excluding sports pitches), GRT=Grass - cut but > 10 cm tall, HW=Hedgerow, PS=Planted shrubberies and flower beds, PSM=Planted shrubberies and flower beds with mulch, RM=Reedbeds and marginals, SB=Scrub (bramble/bracken, neglected overgrown shrubbery), SP=Sports pitches, TG=Tussock rough grassland > 10cm tall, TH=Tall herbs but not scrub, WO=Woodland floor

6.4 Injuries and deaths

A number of illnesses and injuries were recorded during the study period with particular concerns about injuries to limbs, especially hind limbs, and road casualties (Gurnell *et al.* 2016 and Table 6.1). No deaths or injuries occurred during the time of the May and September surveys in 2016. There were three known road casualties in 2016, in March April and August, one decomposing body found being carried by a fox in May, and one sick animal found in April, which was euthanased by the vets.

Table 6.1 Hedgehog deaths known to have occurred during the period of the study, 2014-2016.

Year	Period	Leg injuries	Road-kill	Other causes	Total deaths
2014	May survey	3	0	2	5
	Sept survey	0	0	0	0
2015	May survey	2	0	2	4
	Summer	3	3	2	8
	Sept survey	0	0	0	0
	Autumn	0	1	1	2
2016	Spring	0	2	2	4
	May survey	0	0	0	0
	Sept survey	0	0	0	0
	Autumn	0	1	0	1
	Total	**8**	**7**	**9**	**24**

Post-mortem examinations supported by microbiology, parasitology and histopathology were conducted by the Garden Wildlife Health Project team and for 2016 casualties; these can be seen in Appendix 7.

6.5 Nest boxes

See appendix 1.

6.6 Foxes

Foxes were regularly seen across the Park during the surveys in 2016, especially in the north-west and centre-southeast (Figure 6.14).

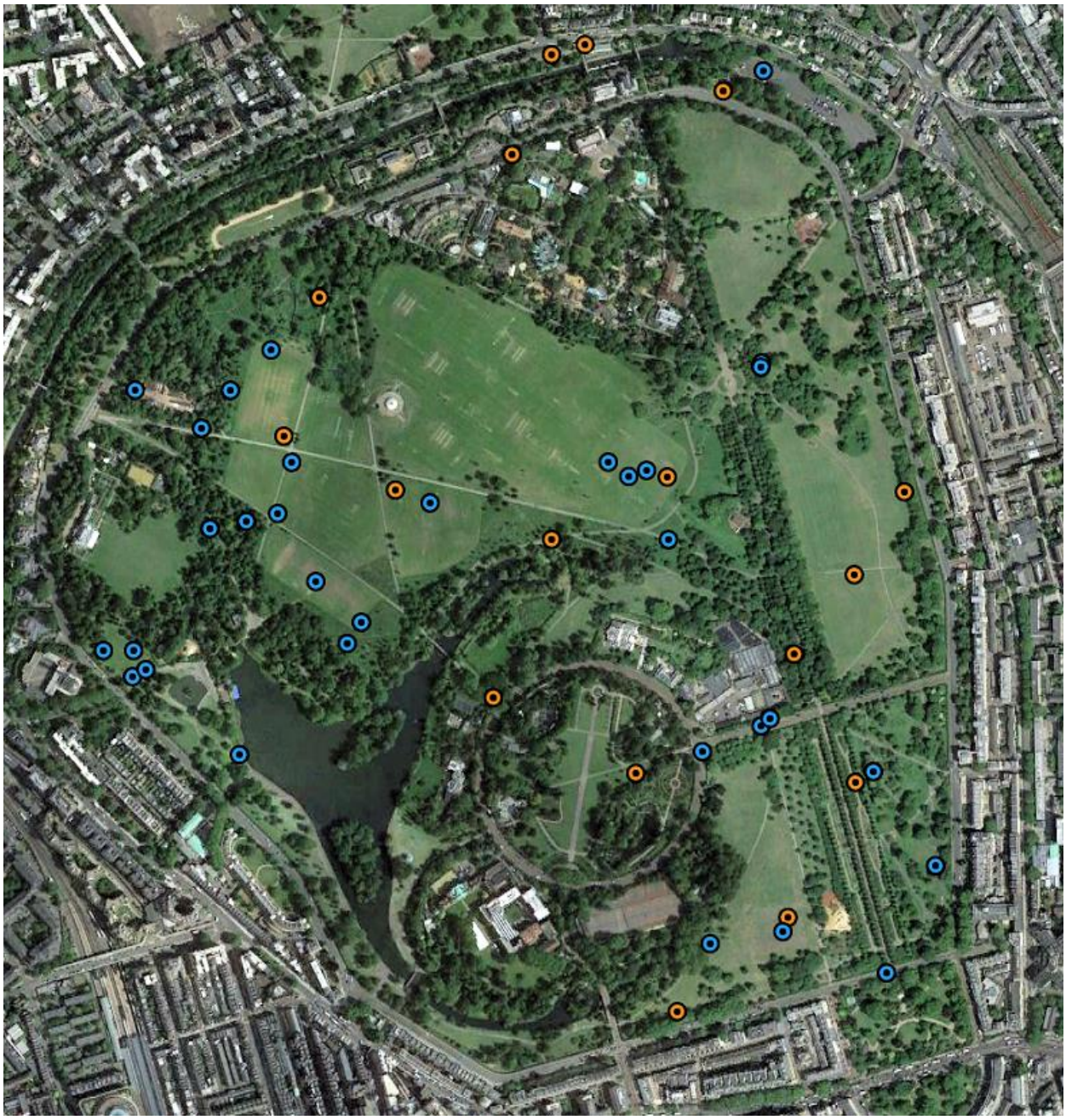


Figure 6.14 Locations fox sightings in 2016. Orange - May, Blue – September

6.7 Exposure of hedgehogs to anticoagulant rodenticides

A full report on the post-mortem analysis of Regent's Park hedgehog liver tissue samples for second-generation anticoagulant rodenticides (SGARs) can be found in Appendix 8. Of the samples taken from 12 dead hedgehogs, SGARs were detected in 67%. Five samples contained residues from two and one three, different SGARs. The SGAR difenacoum was found in seven samples, bromadiolone in six, brodifacoum in one and difethialone in one; concentrations of these SGARs in the liver samples can be found in Appendix 8. Capture locations prior to death of nine of the twelve animals are shown in Figure 6.17. Three other casualties were not identified. Six were captured in the south-east of the Park, one in the Wetlands area, one in the ZSL Car Park and one to the west of the Boating Lake.

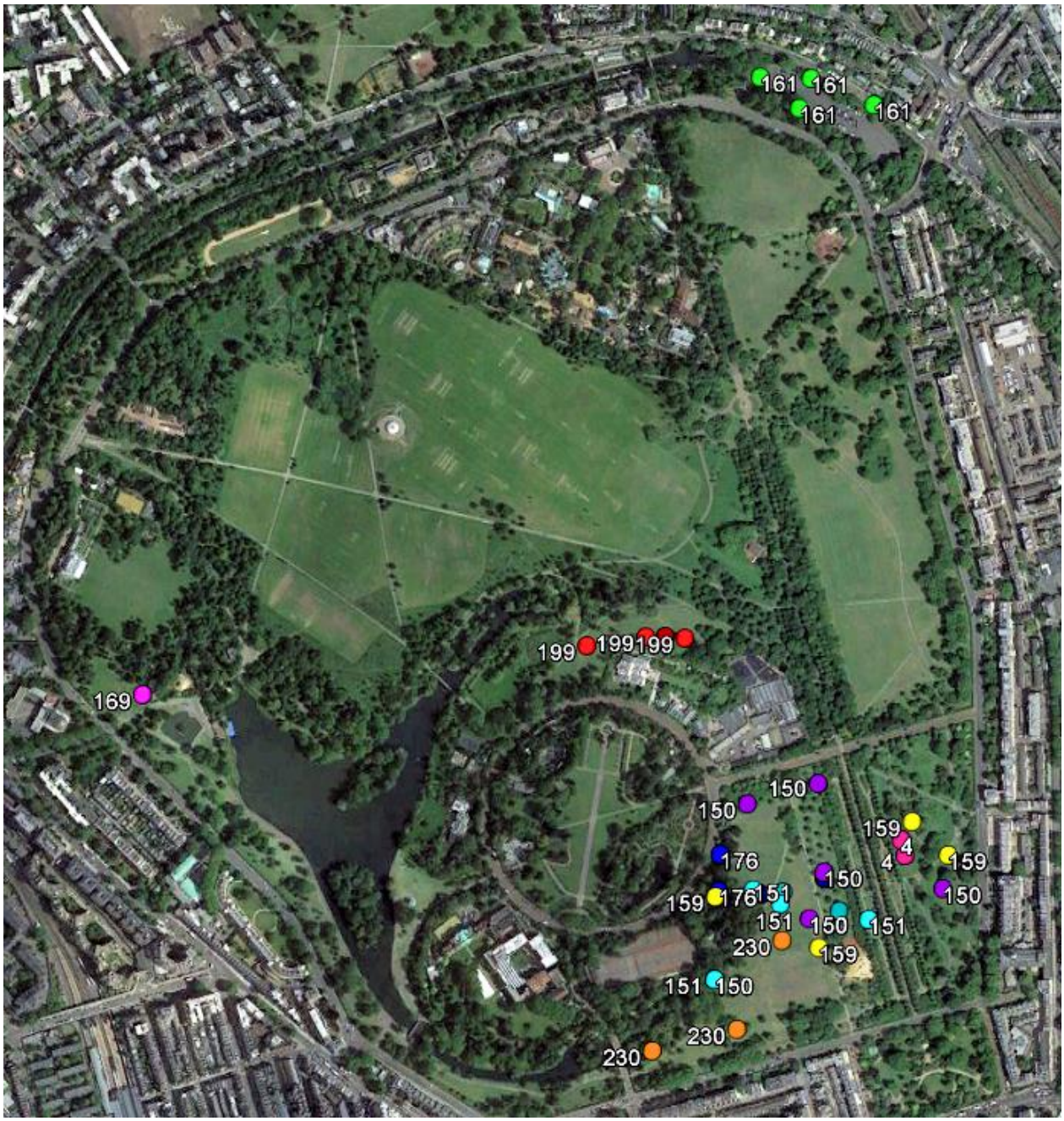


Figure 6.17 Capture locations of nine hedgehogs which subsequently died and were examined for rodenticide residues. Numbers refer to individuals (see Appendix 8).

7 Discussion

7.1 Volunteers

The Regent's Park hedgehog survey continues to attract enthusiastic 'Hedgehog Heroes' who provide the people-power needed to make this survey continue. Working with over 90 volunteers in each survey period requires significant management time before the survey dates - to recruit, carry out training and pull together rotas – during the survey to manage volunteer welfare at night time in the Park – and after to say thank you and keep the volunteers updated for future surveys.

To help keep repeat volunteers engaged it's important to keep a record of which zones they have surveyed in the past so they are scheduled on different zones each time, giving them a better chance of seeing hedgehogs. For each survey group, it's also important to mix new volunteers with repeat volunteers so they can learn from each other.

Additional volunteer supervisors were needed to help cover the two survey shifts on each night. So we continued to train up some repeat volunteers who showed confidence and a good level of skill in the survey techniques to become volunteer supervisors and lead survey groups.

7.2 Study methods

In 2016, in addition to torches, each survey group was able to use a FLIR E60 thermal imaging camera (TIC). These cameras were first tested in 2015 and were considered to be effective for detecting hedgehogs at distances of up to 60 m in TRP, although measurements to support this were not collected (Gurnell *et al.* 2016). Therefore, in both survey periods in 2016, the method by which each hedgehog was first detected was recorded, and in the September survey period, the detection distances using the TIC were also estimated and recorded. In May, when numbers were particularly low, two-thirds of the hedgehogs were detected by torch and the remaining hedgehogs by TIC and sound (Appendix 10 Figure A.10.1a). In September when there were considerably more captures, 52% were detected by torch and, with 46% by TIC with just 2% by sound (Appendix 10 A.10.1b). All methods of detection, therefore, contributed to the effectiveness of the surveys, but a question remained as to whether those hedgehogs detected by TIC would have been detected by torch. The mean detection distance using the TIC was 23 m, with distances ranging from 3 m to 60 m (Appendix 10 Figure A.10.2). It is possible that torches would not have picked out hedgehogs 30 m away or further. Other factors would come into play and affect hedgehog detection, such as how fresh the batteries were in the torches and how much ambient light was present. This was affected by cloud cover and position in the park in relation to street lighting. Further studies will take place on the methods of hedgehog detection during the surveys planned for 2017.

As in 2015, the use of six identically numbered plastic sleeves glued to the spines on the crown of the head of a hedgehog for individual identification proved effective (Gurnell *et al.* 2015). They were notably superior to the use of one or two groups of simple coloured sleeves in different locations on the body to mark individuals as used in 2014 (Gurnell *et al.* 2015). Although it was possible to work out the identify of many hedgehogs using the coloured sleeve system, the loss of all sleeves of either or both colours from different parts of the body, particularly the flanks, caused problems. On average, 3.6 out of the original six numbered sleeves were found on recaptured hedgehogs across both surveys (Appendix 11 Figure A.11.1). This provides encouragement that most recaptured hedgehogs will be identified as such. Even so, and as might be expected, it is not possible to know whether some marked animals had lost all six markers and thus were classified as 'new'. Partly for this reason, and because some individuals may not be captured in a survey period, estimates of persistence (Sections 6.1.2 and 7.3) must be considered minimum estimates.

7.3 The hedgehog population

Numbers reached a worrying low in May 2016 with just 11 individuals captured, but that there was some signs of a population recovery with numbers reaching 25 in September 2016. This was higher than those captured in September 2015, but still lower than those captured during each survey in the first half of the study, from May 2014 to May 2015. The decline in the population during 2015 was mainly attributed to poor breeding recruitment (Gurnell *et al.* 2016); adult survival over this period was similar to previous levels. Recruitment appeared better in 2016 which is largely responsible for the increase in numbers in September. Early in the season and during the breeding season, males are typically more active than females and therefore more likely to be caught, whereas the situation is reversed later in the year (Reeve 1994). However, it was noticeable that the number of adult males captured declined from May 2015 to May 2016, when only one was captured, and numbers were still relatively low compared with females in September 2016. Although this may, at least in part, reflect a lower probability of capture of males than females rather than a real effect, there is no reason why catchability should have declined from the first half of the study (May 2014 to May 2015) when numbers of adult males and females were similar. Although generally the hedgehogs captured in TRP appeared in good condition, males tender to be lighter than females in both the spring and the autumn, except for September 2014. Both males and females were lighter at the time of the spring surveys in 2015 and 2016 than in 2014, which may reflect differences in weather or food conditions during hibernation. Factors that may have affected the changes in population size during the study are discussed in more detail in Section 7.5.

7.4 Distribution and habitat

One of the most striking findings during the 2016 surveys was the shift in the distribution of hedgehogs within the Park. This seems to have started during the summer of 2015 and continued through to September 2016. At the beginning of the study in May 2014, 50 % of all individuals in TRP were captured in the south east of the Park (Zone 1, Avenue Gardens and Marylebone Green) and this area was considered one of three important hotspots. In May 2016, only one individual was captured in this zone, and no individuals were captured in September. Numbers also fell away markedly to the south and west of the Boating Lake (Zone 5), another previously identified hotspot, although they had not completely disappeared from these areas by September 2016. In September 2016 there appeared to be two centres of distribution: a small centre in and around the Wetlands in the centre of the Park (Zone 4), and to the north west (Zone 2, i.e. the northern half of Cumberland Green, Gloucester Green and the ZSL Car Park). This was the third hotspot area identified previously, The ZSL Car Park had also been previously been identified as an important local breeding population (Gurnell *et al.* 2016) but more hedgehogs than previously were found in Cumberland Green and Gloucester Green, especially outside the eastern boundary of the Zoo and to the south west of the Zoo near The Fountain. In 2014 and 2015 holes for hedgehogs had been cut at intervals along the boundary fences to the Zoo (Sven Seiffert pers. comm .), and from September 2015 there has been increasing evidence that some hedgehogs were using these holes and moving in and out of the Zoo grounds. However, the shift of animals away from Zones 5 and 1 cannot be explained. Moreover, the large areas comprising the sports field (Zone 3) and around the Winter Gardens to the north of the Park (Zone 6) were still largely unfrequented (see Section 7.5). A rough estimate suggests that the population of hedgehogs in September 2016 was living in less than a third of the available space within the Park.

7.5 Factors affecting the hedgehog population

7.5.1 Deaths and injuries

There were five known casualties in 2016, four of them in spring before the May survey. This number of casualties was significant since the known population size was only 11 individuals in May. Two were road casualties and two died from unknown causes. One of these was found in Zone 1 during the May

survey. It had maggots and appeared to have been dead for some time. Both its hind legs were missing and there was fresh saliva on the body and it is believed to have been dropped by a fox which was seen nearby. Also in May, one hedgehog was found with twine around its front feet. The twine was successfully removed and the animal released. A further hedgehog was found dead on Prince Albert Road adjacent to the ZSL Car Park in August. In September, a hedgehog was found in Zone 2 with a cut on the top of one of its hind feet. It was removed and examined by a vet and later released back into the Park.

7.5.2 Weather

Most animals were in good body condition although both male and female mean weights were respectively 17% and 15% less in May 2015 than in May 2014 (see Section 7.2). This suggests a lean period over winter or spring. Meteorological Office data (Appendix 12) 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 south east of the country at 34°C in some places. 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 large 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.

7.5.3 Park management

7.5.3.1 General management

A number of measures have been introduced over 2016 to improve the Regent's Park habitat and management techniques for hedgehogs. These include:

- Planting over 3,000 wild flower plugs to improve the species diversity in long grassy area within some of the formal gardens.
- Installing several dead wood stands around the Park with three being surrounded by planting to increase value for nesting hedgehogs and invertebrates when the planting matures.
- Installing 300 metres of barrier along the fence line between the Zoo Car Park and Prince Albert Road to prevent hedgehogs from getting on to the busy main road.
- Installing three sand bag ramps in the children's boating pond near Hanover Gate to provide an escape route for hedgehogs.
- Modifying 200 metres of fence along Longbridge meadow to allow hedgehogs access by creating hedgehog holes.
- Cutting down 50% of twelve bramble stands across the Park to encourage denser growth, creating more suitable hedgehog cover and nesting opportunities.

Figure 7.1 Wild flower grass verges in Queen Mary's Gardens

Figure 7.2 New dead wood stands with surrounding planting to provide more nesting opportunities

Figure 7.3 Fence line barrier along Prince Albert Road

Figure 7.4 Sand bag ramps in the Children's boating pond

Figure 7.5 Hedgehog holes in the fence line along Longbridge Meadow

Regent's Park was approached by Husqvarna to test out a robotic mower in a public park to see how the public interacted with it and whether or not there was a possible commercial application for such machines that have previously only had a domestic market. The park is one of a dozen sites across the UK and Europe where trials are being carried out. Dr Nigel Reeve and Assistant Park Manager, Mark Rowe, raised the issue about injuring hedgehogs and amphibians. Husqvarna took these concerns on-board and modified the robot with a stiff brush attachment to reduce the possibility of injury. Having had this concern raised if the trial is successful they will look at permanent modifications for all their machines.

Figure 7.6 Robotic lawn mower trials in Regent's Park

7.5.3.2 Sports pitches

As in 2014 and 2015, hedgehogs were again rarely encountered during spotlighting on the sports pitches during 2016. The hedgehogs may be avoiding the pitches because of a lack of suitable prey, and/or because of a real or perceived risk of predation in open spaces, or for reasons as yet unknown.

The management of the sport's turf includes fertiliser and herbicide treatments plus occasional use of soil conditioners (e.g. Integrate Plus Granular Soil Aeration, Rigby Taylor) and wetting agents (e.g. Breaker Dynamic Granular Wetting Agent, Rigby Taylor). There also is an irrigation system using borehole water. Unusually however, in The Regent's Park, there is no use at all of the pesticides commonly applied to control leatherjackets (crane fly larvae) or chafer larvae, nor have nematode treatments (e.g. Nemasys, BASF) been used to control these invertebrates. There is also no use of substances such as Carbendazim to reduce earthworm activity and worm cast density. Current practice is to brush worm casts from areas such as cricket wickets and to use netting to protect newly turfed areas from birds.

The low species diversity of plants, frequent mowing and trampling means that, in sports turf, available niches for invertebrates are inevitably reduced. However, in The Regent's Park, the absence of pesticide treatments suggests that earthworms, leatherjackets and chafer larvae could be present in numbers not normally found on more aggressively managed sports turf. Furthermore the irrigation of the pitches might benefit earthworms and other soil invertebrates during drought periods. Information from current and former members of the management team indicates that pesticide treatments for invertebrates have not been used on the pitches since at least 1997; possibly longer. This provides a very positive example of how sports pitches can be managed effectively in a major facility in central London without resorting to such pest control methods.

There is a clear need to understand why hedgehogs have been found to be largely absent from the sports pitches and other significant areas of the park with apparently suitable nesting and foraging habitat. This patchy distribution of hedgehogs is currently unexplained but, as well as unknown possibilities there are many potential explanatory factors including (by day or night) the risk of disturbance or attack from predators such as foxes and domestic dogs, disturbance from human activity and the availability of invertebrate prey during nocturnal foraging.

We recommend that a comparative study is carried out to quantify the availability of a range of invertebrate prey in parkland habitats with different management regimes, including the sports pitches. Ideally a study that extends throughout the active season (March-October inclusive) would provide relevant to the seasonally changing needs of hedgehogs. Currently, in the absence of such invertebrate survey data, we can only speculate about whether or not these various habitats provide suitable prey for hedgehogs and the possible benefits of different management methods.

7.5.4 Use of rodenticides

A full report on the study on the exposure of hedgehogs within TRP to SGARs is presented in Appendix 8. Although a small sample, two thirds of the hedgehogs examined had tested positive to between one and three different SGARs. However, the report concludes that the significance of exposure to SGARs to the health of individual hedgehogs and the hedgehog population in the Park cannot currently be known. In the future, it would be interesting to consider an exposure map for hedgehogs, foxes and rodents across the Park and any future post-mortem studies could look for signs of haemorrhaging if appropriate. In practical terms, the report recommends that all rodent control methods and rodenticide use within the Park are audited and regularly appraised with the aim of minimising the use of poison bait.

7.5.5 Foxes

Foxes were regularly seen throughout the park during the 2016 surveys. No serious hind leg injuries were observed on hedgehogs that had been attributed to foxes and were a concern in previous years. It is not known how many individual foxes live in the Park and their impact on the hedgehog population by predation or causing serious injuries to individuals; this warrants further study. A randomised camera trapping study of foxes and hedgehogs was carried out by the Institute of Zoology in October 2016 to estimate population numbers. Rodents, cats, dogs and birds were also recorded (Marcus Rowcliffe, unpubl.). A report is included in Appendix 2.

We considered a number of other ways in which to learn more about the possible inclusion of hedgehogs in the diet of foxes within the park. These included the possible use of the detection of hedgehog remains or DNA in fox scats (droppings). One of us (JG) trialled the use of a UV fluorescent marker substance added to bait to facilitate the detection of fox scats in the field with some success, However, we decided not to pursue this at this time because:

- Even if hedgehog remains and/or DNA were detected in fox scats, we would not be able to distinguish scavenged corpses from actively predated animals and therefore would be unable to answer the key question about whether or not foxes were a significant source of mortality,
- There is a strong likelihood that hedgehogs are only occasional prey items and that the vast majority of scats would be hedgehog-free. Hence a very large sample of scats would be required.
- The cost of analysis of such a large number of scats would exceed our budget and the human resource required to collect fox scats throughout the park would be considerable, even with the use of a fluorescent marker substance.

7.6 HS2 High Speed Rail (London - West Midlands) Bill

The plan to use a significant proportion of the ZSL car park as a Lorry Holding Area (LHA) during construction phase of the HS2 project (from 2017 until 2033) continues to be promoted by HS2. Nigel Reeve (NR), John Gurnell (JG) and Clare Bowen (CB) continued to support ZSL in their objection to the use of the ZSL car park in this way because of the likelihood of a significant impact on the hedgehogs which depend on this site, and hence a negative impact on the hedgehog population of The Regent's Park as a whole.

The team (JG and CB) were called as expert witnesses to report to a House of Commons Select Committee on 16 December 2015. NR was unavailable. Following this hearing, the Select Committee decided that this matter should be debated by an HS2 Select Committee from the House of Lords. The team (JG, CB and NR) were then called as expert witnesses to report to a House of Lords Select Committee on 14 September 2016.

ZSL's request to consider an alternative site for the LHA was turned down. See extract of the House of Lords report below.

Extract of the House of Lords Special Report – Paper 83

"Urban environments: hedgehogs in Regent's Park

328. We heard a petition from the Zoological Society of London, presented by Professor Field, who called three expert witnesses. The Society's concern was not for the animals in its own care, but for the native hedgehogs that are at large in Regent's Park. There are about a hundred of these and they are the only breeding population in any of London's Royal Parks. In Regent's Park they live in four main

areas, one of which is in the vicinity of the Society's parking area for visitors' cars and coaches in the north-east corner of Regent's Park. This area is surrounded by fairly dense vegetation, whose growth is encouraged in order to provide a sheltered habitat. It is estimated that about one-quarter of the park's population of hedgehogs live in this vicinity. They are nocturnal animals and the car park is empty and quiet at night.

329. About one-third of the car park is to be taken for use as a lorry holding area in connection with the redevelopment of Euston station and the area to the north of the station. This use will be temporary, but will continue until 2033. There is a further complication, which has only recently emerged, in that the same area is to be used in the very near future by Thames Water, which has to divert a 42 inch water main to prepare for the Euston redevelopment.

330. The Society is concerned that the hedgehogs' habitat will be adversely affected by the secure compound that will be constructed for the lorry holding area. They do not nest in the car park itself, but they use it for access to their sheltered habitat. The experts' evidence was that it has not been demonstrated that hedgehogs can learn to use a small tunnel (which the promoter will construct under the access way), although other small mammals and reptiles do make use of such facilities.

331. We understand the Society's concern but we are not convinced that it justifies what would be a major disruption to the promoter's plans. Seven other sites have been assessed as possible locations for the lorry holding park, and none is as satisfactory. The Society and the Royal Parks authorities will continue to monitor the hedgehog population in all four areas where they are concentrated. If the hedgehogs near the car park do not learn to use the tunnel, and seem to be in distress, thought can be given to other measures to assist them. We were told that the lorry holding area will continue to be largely empty and quiet at night, and although it must be secure, that requirement need not preclude other means of allowing these small animals to traverse it."

This report contains some inaccuracies:

1. the estimated total number of hedgehogs in The Regent's Park at the time was no more than 50, not 100 as stated;
2. there are only 3 main areas for hedgehogs in The Regent's Park, not 4 as stated;
3. they are the only breeding population in central London but not, as a stated, the only population in The Royal Parks because there is also a population in Bushy Park;
4. it is also misleadingly stated that 'they do not nest in the car park itself' – possibly referring to the paved area of tarmac - but in fact they do nest in the vegetation immediately surrounding the paved area.

Furthermore Para 331 contains several assumptions:

1. that monitoring by ZSL and TRP will continue throughout the HS2 project;
2. that use of the proposed tunnel will be effectively monitored;
3. that if monitoring reveals that hedgehogs do not use the tunnel, that there is an alternative solution that may be thought of and implemented that will still permit the HS2 project to continue;
4. that there is a practical measure of distress in hedgehogs.

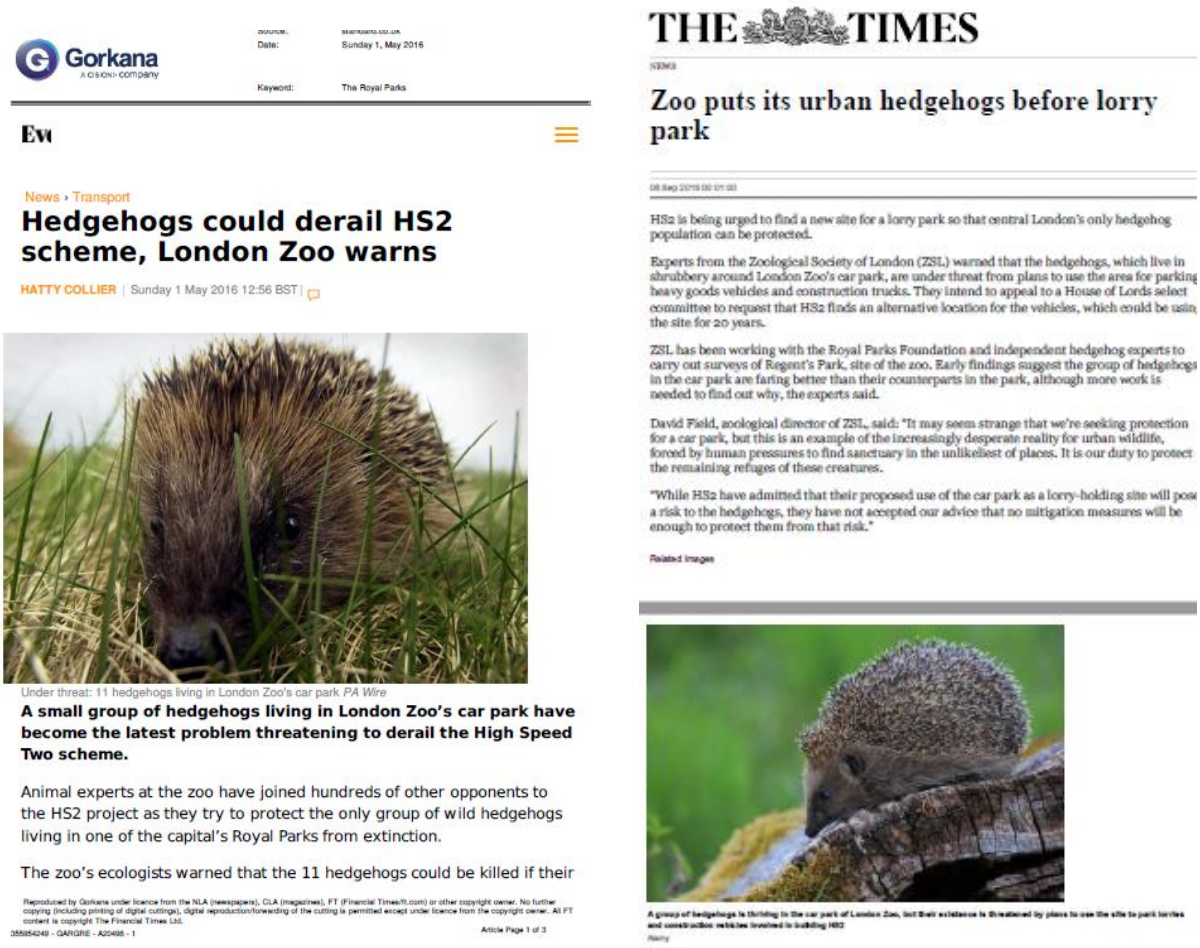
The project team is disappointed that the use of the car park by HS2 has been given the go-ahead and fear that there will be a significant negative impact on this small and vulnerable hedgehog population. In the meantime, as required by the HS2 project Thames Water are working to divert a 42" water main through the ZSL car park and require the construction of a works compound, the digging of a trench and vehicular access (2016-2018). The project team (JG, CB and NR), ZSL and TRP staff are working closely with them to advise on mitigation measures.

8. Public awareness

In June 2016, the Royal Parks Foundation Education Centre ran two hedgehog themed family Discovery Days, each day had over 100 attendees. Children were able to learn about the secret life of hedgehogs and how they hibernate, take part in craft activities, and listen to a story-teller reading 'Herbie's Big Adventure', a children's book based on Herbie the Hedgehog.

Figure 8.1 Our June 2016 Hedgehog themed family discovery days

The study and petitioning of HS2's use of the ZSL Car Park continued to attract media and press attention. Features were written in May, June, September and December 2016 with publications including the Evening Standard, The Times, PA News wire, Huffington Post, Express online and Horticulture Week.



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News › Transport

Hedgehogs could derail HS2 scheme, London Zoo warns

HATTY COLLIER | Sunday 1 May 2016 12:56 BST |

Under threat: 11 hedgehogs living in London Zoo's car park *PA Wire*

A small group of hedgehogs living in London Zoo's car park have become the latest problem threatening to derail the High Speed Two scheme.

Animal experts at the zoo have joined hundreds of other opponents to the HS2 project as they try to protect the only group of wild hedgehogs living in one of the capital's Royal Parks from extinction.

The zoo's ecologists warned that the 11 hedgehogs could be killed if their

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THE TIMES

NEWS

Zoo puts its urban hedgehogs before lorry park

HS2 is being urged to find a new site for a lorry park so that central London's only hedgehog population can be protected.

Experts from the Zoological Society of London (ZSL) warned that the hedgehogs, which live in shrubbery around London Zoo's car park, are under threat from plans to use the area for parking heavy goods vehicles and construction trucks. They intend to appeal to a House of Lords select committee to request that HS2 finds an alternative location for the vehicles, which could be using the site for 20 years.

ZSL has been working with the Royal Parks Foundation and independent hedgehog experts to carry out surveys of Regent's Park, site of the zoo. Early findings suggest the group of hedgehogs in the car park are faring better than their counterparts in the park, although more work is needed to find out why, the experts said.

David Field, zoological director of ZSL, said: "It may seem strange that we're seeking protection for a car park, but this is an example of the increasingly desperate reality for urban wildlife, forced by human pressures to find sanctuary in the unlikeliest of places. It is our duty to protect the remaining refuges of these creatures.

"While HS2 have admitted that their proposed use of the car park as a lorry-holding site will pose a risk to the hedgehogs, they have not accepted our advice that no mitigation measures will be enough to protect them from that risk."

Related Images

A group of hedgehogs is thriving in the car park of London Zoo, but their existence is threatened by plans to use the site to park lorries and construction vehicles involved in building HS2

Getty

Figure 8.2 Examples of press coverage from 2016

Nigel Reeve, John Gurnell and Clare Bowen presented the results of the study at a number of conferences throughout 2016 including:

- European Hedgehog Expert Meeting, Berlin 3-4/11/2016 (NR+CB)
- Public talks for:
  - Holland Park Ecology Centre 15/9/2016 (NR)
  - 'Operation Hedgehog' project Cornwall, 29/11/2016 (NR)
  - Devon Mammal Group, Exeter, 29/11/2016 (NR)
  - London Natural History Society, 14/12/2016 (NR)
  - Wimbledon & Putney Commons Conservators 8/2/2017 (NR)

The project team also shared learnings on running this survey with other hedgehog surveys including Hampstead Heath, Beddington Park and Prickled Hedgehog Rescue.

9. Future work

In 2017 the aim is to continue to survey the hedgehog population in The Regent's Park in May and September using the standard methods developed in these studies. The data collected will help us understand whether the population continues to recover from the low in May 2016 and whether the hedgehogs start to move back into some of the areas they have recently abandoned. We recommend that these twice-annual surveys should continue for a further five years to 2021. The nest box study will also continue throughout the year and provide information on how much the hedgehogs use the boxes, whether females raise litters in the boxes and whether boxes can be used as a monitoring tool. More in-depth studies on factors affecting the numbers and distribution of hedgehops within TRP would be illuminating (e.g. population dynamics and habitat utilisation in different parts of the Park in relation to food resources, nest sites, predator pressure and management) if funding became available. Any significant changes in land management/use of an area should include plans for some monitoring of potential effects. Plans for conservation management interventions are also needed that could be implemented if the population appears in danger of dying out.

10. Conclusions and recommendations

10.1 As in 2014 and 2015, the organisation and running of the surveys went smoothly with the invaluable help of the large numbers of volunteers, many of whom were returnees from previous years and had become very experienced. The work of the volunteers was even more commendable because of the lack of hedgehogs in many areas of the Park meant that many volunteers did not get the reward of seeing or handling a hedgehog.

10.2 As in previous years, surveys in 2016 were carried out on two consecutive Friday nights in May and September. Following the success of the preliminary studies on the benefits of using Thermal Imaging Cameras during the surveys in 2015, each of the six groups was able to use one of these cameras in 2016, except Zone 7 where it wasn't required. The identification of individuals using numbered, yellow plastic sleeves attached to the spines on the head of hedgehogs adopted in 2015 proved effective.

10.3 The key finding from the studies carried out in 2014 and 2015 was that the population of hedgehogs within TRP was declining, and was small and vulnerable (Gurnell *et al.* 2016). Concerns were heightened, therefore, when known numbers of hedgehogs' dropped to just 11 individuals by May 2016 making this, the last breeding population of hedgehogs in Central London, critically endangered.

10.4 There were some signs of a recovery by September 2016, mainly down to recruitment of young animals over the preceding summer. Further surveys in 2017 will ascertain whether this recovery has been maintained over the winter period and whether the 2017 breeding season is successful.

10.5 2016 also saw a shift in the distribution of hedgehogs within the Park with animals disappearing completely from one of the three previously described hotspots in the southeast of the Park, and only very small numbers remaining in another, to the west of the Boating Lake. Most hedgehogs were found in third hotspot area, in the northeast of the Park, an area which includes the ZSL Car Park. It is estimated that less than a third of the available space within the Park was being used by hedgehogs' in September 2016.

10.6 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.

10.7 Although only five deaths were recorded throughout the year, four of these (two road casualties, two deaths from unknown causes) were between March and May before the May survey when few animals were captured. Thus, this number of deaths can be considered significant. One animal was killed on Prince Albert Road near the ZSL Car Park in August. In previous years, there were concerns of injuries to the hind legs of hedgehogs, probably caused by foxes. However, no hedgehogs were found with these injuries in 2016.

10.8 Various factors including deaths and injuries, foxes, weather, park and grassland management and rodenticide exposure have all been discussed in relation to the numbers and distribution of hedgehogs in TRP. Further research on the possible influence of all these and other potential impact factors is needed. It is possible that foxes have had an negative impact, particularly in 2015, and a dry spring in 2015 may have affected invertebrate prey availability which in turn may have affected hedgehog breeding success in that year which in turn lead to a downturn in the population. Food availability, as well as distance to cover, may also be reasons why the hedgehogs were seldom found on the sports pitches.

Recommendation 1. Spotlighting **s**urveys 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.

Recommendation 2. The Royal Parks should have a conservation action plan in place, which can be implemented if the population continues to remain very small and in danger of dying out. Such a plan should consider funding, volunteer and staff resources, and partnerships with academics and other conservation organisations in relation to different management scenarios.

Recommendation 3. Details of hedgehog mitigation for the impending Water Mains work in the ZSL Car Park, and the intended future use of this area as a HS2 Lorry Holding Area, should be negotiated with the contractors and remain under close review for the duration of the time that the Car Park is so affected.

Recommendation 4. Where possible, additional studies that can be integrated with the survey and monitoring work should be encouraged. These might include: hedgehog survival and breeding (e.g. juvenile mortality, overwinter survival, food availability, predation, disease, rodenticide exposure and park management). Such studies would increase our understanding of the factors affecting the population and spatial dynamics of the hedgehog population which in turn would feed into conservation actions.

Recommendation 5. The programme of community engagement, staff training and volunteer recruitment should continue to raise awareness of the need for hedgehog conservation in TRP and more widely in the country.

11. Acknowledgements

The Royal Parks Foundation is hugely grateful to:

The **Meyer Family** for believing in the project team, being adventurous and trialling new survey techniques, for loving hedgehogs and for enabling this project to happen.

John Gurnell and Nigel Reeve for sharing their wealth of wildlife knowledge with the team for a second year and for their incredible patience, leadership, enthusiasm, skill in the field and sheer dedication to the project.

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Sven Seiffert and his team at ZSL for co-ordinating access and leading teams of volunteers in London Zoo on the spotlighting nights and working tirelessly on improving the zoo's habitats for hedgehogs.

The **veterinary team at ZSL** have once again been fantastic at assessing hedgehog casualties and treating them.

We're also hugely grateful to Becki Lawson and her team from the **Garden Wildlife Health Project** team who carried out post-mortem examinations on all the hedgehog carcasses submitted and supplied liver samples for the toxicological analyses.

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Volunteers:

Four all-night shifts of fieldwork would not have been possible without the **150+ Hedgehog Hero volunteers** giving up their evenings to patiently search the park in darkness for hedgehogs.

A special thank you to the **volunteer supervisors** who took on the added responsibility of leading groups in the field with confidence and enthusiasm.

Experts and assistance:

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Centre for Ecology & Hydrology, Lancashire for carrying out the rodenticide work and to Richard Shore for guidance on the results.

Penny Dixie for joining us on all survey nights to capture photo and video footage of the hedgehog survey.

The tenacious, inspiring and ever supportive **Marian Kamlish** for rallying the Friends of Regent's Park, working to raise awareness of the potential effects on hedgehogs of HS2's plan to use ZSL's Car Park and selling many hedgehog adoptions on our behalf.

Dr Chris Carbone and **Dr Marcus Rawthorne**, Senior Research Fellows at ZSL for carrying out the camera trapping project to provide detail on fox and hedgehog population numbers and distribution.

ZSL for petitioning against HS2's proposed use of the ZSL Car Park.

Access:

Thank you to the **Open Air Theatre, Regent's University, Crown Estates Pavement Commission and Winfield House** for late night access to these private areas of the Park to survey the hedgehogs.

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This project has been a fantastic group effort… Thank you! We couldn't have done it without you.

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