Surveys of Hedgehogs in The Regent's Park, London 2014-2020

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Working in partnership with

Summary

The hedgehogs living in The Regent's Park comprise the only breeding population remaining in Central London. Several studies and surveys have been carried out on this hedgehog population since 2014. Previous reports have detailed these studies and surveys through to 2017 (see Reports 2015, 2016, 2017). One important conclusion arising from these studies is that the population is effectively isolated. From the outset, night-time surveys have been carried out throughout the Park in the spring and autumn of each year. These surveys, carried out by volunteers, have provided data on the number and distribution of hedgehogs within the Park (note: hedgehogs were absent from Primrose Hill when surveyed in 2015). In this report we add to these data by providing the results of the surveys carried out in 2018, 2019 and 2020. ZSL Veterinary Services provided veterinary support and the Garden Wildlife Health Project carried out post-mortem examinations on dead hedgehogs found within the Park.

In 2018 and 2019, each spring and autumn survey was carried out using approximately 100 volunteers following a standard protocol established in previous years. This involved groups of five volunteers carrying out standard searches for hedgehogs using torches and thermal imaging cameras. Each of six zones demarcated within the Park was searched by a volunteer group in two shifts, 21.00-12.00 and 00.30-04.00, each night. A seventh zone, London Zoo, was surveyed by zoo personnel. It was not possible to carry out the spring survey in 2020 because of Covid-19 lockdown restrictions. In the autumn, the restrictions were relaxed slightly, and six volunteers were allowed in the Park at any one time. In consequence, the six zones were divided into three groups of two, and each of two zones were surveyed by three volunteers over three consecutive nights (Friday, Saturday and Sunday). This procedure was repeated the following weekend.

Each captured hedgehog was uniquely marked with six yellow plastic sleeves (printed with unique animal identification numbers) attached to the spines on the back of the neck, sexed, weighed, and examined for ectoparasites and injuries.

The size of the surveyed population was consistently small, averaging 29 individuals across the 13 surveys carried out between spring 2014 and autumn 2020. Numbers of individuals reached an exceptionally low level in spring 2016 when only 11 individuals were captured, of which only two were males. Generally, the adult sex ratio was biased towards females. The spring 2016 population recovered quickly by the autumn. Numbers then fluctuated around the average value until autumn 2019 and then declined through to 21 individuals captured in autumn 2020. However, the autumn 2020 figure should be treated with caution because the survey was carried out in a slightly different way to normal with a slightly lower overall survey effort.

The hedgehogs captured typically appear to be in good body condition with adult females slightly heavier than males and autumn adult females and males slightly heavier than spring animals. Breeding took place in every year, but recruitment varied between years being particularly low in 2015 leading to the low spring population the following year. In contrast, recruitment in 2017 was higher than normal. Numbers persisting from one survey to the next also varied between seasons and years. On average, persistence of females was similar over-summer and overwinter averaging approximately eight individuals. This was higher than summer persistence in males that averaged 5.2 individuals and winter persistence that averaged 3.6 individuals. Juvenile overwinter persistence also varied considerably between years, averaging 6.8 individuals. These are small numbers and the loss of just a few animals can have a large effect on population size. Critically, on average only 41% or females and 27% of males persist from one autumn to the next. Thereafter 17% of females and 8% of males persisted for two years and 3% and 1% for three years respectively.

Numbers of known deaths from hedgehogs captured with serious injuries and euthanised by the vets or found dead in the Park have provided clues to why hedgehogs do not survive for very long. The highest number of deaths was 15 in 2015 then 11, 12 and 13 in 2017, 2018, and 2019 respectively. For such a small population these numbers are high, added to which many deaths go undetected. Overall, 73% of deaths are believed to have been caused by predators either indirectly by inflicting serious hind leg injuries from which the animals do not recover or are put down by the vets or directly by killing hedgehogs, including young animals. Foxes are believed to be the main cause of these deaths. Twelve per cent of deaths were road traffic accidents, 10% were attributed to a variety of other factors such as illness, and 15% were due to unknown causes.

The population of hedgehogs in The Regent's Park is small and isolated with variable and generally low persistence and recruitment. Known deaths each year are relatively high for such a small population. It is well established that small populations are subject to random demographic fluctuations and environmental variation as well as a loss of genetic variation which could quickly lead to extinction. It is believed that the Park could hold a population three or four times the size that it is, but it is not clear why this is not the case.

The distribution of hedgehogs across the Park has not been uniform and has changed over the course of the study although the reasons for this are unclear. Areas to the west and south (designated Zones 5 and 1) appeared favourable in 2014 and 2015 but thereafter have had low occupancy. Zone 2 to the east and north was also favoured at the start of the study and subsequently became the main centre of distribution until the autumn of 2020 when there appears to have been a shift towards the centre of the Park, Zone 3. The Zoo Car Park within Zone 2 was a local 'hotspot' throughout the first five years, but numbers of captures have declined in the car park since spring 2018. Thames Water took over part of the car park in 2017 to carry out major work on a water main. Although this coincides with the fall in numbers, the reasons for the decline are probably more complicated than this. HS2 are currently taking over the works compound to make it into a lorry holding area during the building of the high-speed rail line out of Euston. The Royal Parks, ZSL and Nigel Reeve have been and still are liaising with the ecologists at Thames Water and HS2 on the impacts of their works and mitigations. Also worthy of note is that the number of captures has slowly increased around and near the boundary to the Zoo (Zone 7) over the course of the study suggesting that the dense vegetation in those areas may be important hedgehog nesting areas. Hedgehog-sized holes created at the base of the perimeter fence since 2015 have increased the opportunities for free movement in and out of Zone 7.

The evidence from the seven years of study so far shows that the population of hedgehogs in The Regent's Park is in a precarious state being small, isolated, and highly vulnerable to extinction. The present plan is to continue with the six-monthly population surveys until 2024, which will represent the 10-year anniversary of the project. At the same time, and subject to available resources, additional studies building on past work are envisaged to try and untangle the most important factors limiting population size and distribution. At the end of the project the objective is to produce an evidence-based conservation strategy for this important but fragile population.

Contents

1. Background

The research described in this report is a continuation of some of the work begun in 2014 in The Regent's Park on the last known breeding population of hedgehogs in central London. The objective is to obtain the data required to develop an evidence-based conservation strategy for this important but vulnerable population.

Three previous reports provide details of the studies carried out between 2014 and 2017. The first report (Report 2015) describes the rationale behind the project, and together with the subsequent reports (Report 2016, Report 2017) provide a comprehensive account of various studies carried out, the methods used, and the results obtained. These studies include a six-monthly volunteer spotlighting survey of the entire Park carried out every year. This report updates the results from the surveys through to 2020. As a result of national COVID-19 restrictions in 2020, only the autumn survey was carried out and with a slightly modified survey method.

A major achievement of the studies carried out has been The Royal Parks' productive partnership with the Zoological Society of London (ZSL) and close working with other organisations including the Garden Wildlife Health project, People's Trust for Endangered Species Wildlife Trusts, and the Central Royal Parks Wildlife Group. Key to the success of the work is that it has been able to engage with the community, recruiting and training many volunteer fieldworkers who through a great deal of effort and diligence have provided a great deal of valuable information about this previously unstudied hedgehog population.

2. Aims of the surveys

The aims of the surveys and associated work are:

1. to carry out standardised spotlighting surveys of hedgehogs in both May (spring, pre-breeding) and September (autumn, post-breeding) each year to estimate the distribution and population size of hedgehogs in The Regent's Park, not including Primrose Hill which was only surveyed in 2015 and found to have no hedgehogs.

2. to work with ZSL to investigate and record causes of deaths and injuries of hedgehogs found in the Park.

3. to support ZSL and The Royal Parks in negotiating with HS2 and Thames Water with respect to mitigating the impacts of works to the ZSL Car Park area.

4. to monitor the use of hedgehog nest boxes by hedgehogs within The Regent's Park.

5. to engage volunteers, the local community and other stakeholders in the work.

3. Project partners

The Regent's Park Hedgehog Research Project is indebted to a generous gift from The Meyer Family which supported the work during the first years of the project. A dedicated hedgehog fund was established in 2017 that ensures funding for the project through to 2024. This project is a partnership between the following organisations and individuals:

The Royal Parks is the charity that cares for London's eight Royal Parks (registered charity 1172042). Former project leads were Clare Bowen, Sara Harrison and Tess Pettinger whilst the current lead is Bryony Cross.

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. ZSL provide veterinary support during the surveys in May and September each year. The Horticulture Manager, Sven Seiffert, provides guidance, volunteer support and organises the surveys in the Zoo grounds (15 ha). The project team liaises with Dr Chris Carbone and Dr Marcus Rowcliffe , Senior Research Fellows at the Institute of Zoology, concerning camera trapping foxes and hedgehogs within the Park and elsewhere in London.

The Garden Wildlife Health project (GWH), co-ordinated by the Institute of Zoology in partnership with the British Trust for Ornithology, Froglife and the Royal Society for the Protection of Birds, conducts post-mortem examinations and reports on any dead hedgehogs found within the Park.

The Central Royal Parks Wildlife Group of amateur and professional naturalists and ecologists with an interest in the wildlife within the Central Royal Parks originally identified the need for a hedgehog survey in The Regent's Park and have subsequently provided guidance and volunteer support in the field.

The 'Hedgehog Hero' 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 organisation

4.1 Survey dates, 2018-2020

The survey methods used in 2018 and 2019 were the same as in previous years (see 2017 report) This involved two all-night sessions of intensive spotlighting in May (spring), after the hedgehogs had emerged from hibernation and become sexually active, and two in September (autumn), after breeding and prior to hibernation. Hedgehogs were hand captured, marked and released.

As a result of national Covid-19 restrictions, it was not possible to carry out the survey in spring 2020, and the autumn 2020 survey was modified to ensure that no more than six volunteers were in the Park at any one time. In order that the whole Park could be surveyed, the surveys were carried out on three consecutive nights (Friday/Saturday/Sunday) on two consecutive weekends.

The dates were:

2018 - 11th May, 18th May; 31st August, 7th September
2019 - 10th May, 17th May; 6th September, 13th September
2020 – no surveys in May; 4th/5th/6th, 11th/12th/13th September (each survey carried out over three nights)

4.2 Survey zones

To carry out a systematic search of the 160 ha of the Park, it was divided into the seven zones as in previous years. Primrose Hill (Zone 8), surveyed in 2015, was not included. As in 2017 and because of the large number of sightings in this area, Zone 2 (Cumberland Green, Gloucester Green and Zoo Car Park) was searched in two sections, 2a and 2b (Figure 4.1). Zone 1, which had a large number of sightings in 2014 and 2015, was also divided into two sections, 1a and 1b. Areas of the Park not accessed during the surveys include Winfield House, The Holme and St John's Lodge. Access to the Regent's University was granted from 2017 as was access to Park Square Gardens (Crown Estates

Paving Commission). Park Square Gardens and the Open Air Theatre (OAT) were surveyed in 2018 and 2019.

Figure 4.1 Aerial view of Regent's Park (160 ha) showing boundaries of the survey zones and walk routes (dashed lines). Areas shaded yellow had limited access or no access. OAT=Open Air Theatre.

4.3 Surveyors

The spotlighting surveys were carried out by volunteers; many were regulars whilst others were recruited through connections or by word of mouth before each survey period. Volunteer numbers were: 103 - May 2018, 101 – September 2018, 100 – May 2019, 107 – September 2019 and 39 – September 2020. The volunteers were organised by the Royal Parks team as described in previous reports. In 2018 and 2019, each zone was search by a group of four-five volunteers during an early shift (21.00-24.00) and a late shift (00.30-4.00) on each survey night. Every survey group was led by a Project Team supervisor or a trained volunteer supervisor. No surveys were possible in May 2020, and in September restrictions on the number of people who could be in the Park at any one time, meant that the surveys were slightly modified. Only two zones could each be searched by up to three people per zone (including supervisor) on any one night. Therefore, the surveys took place over three nights to cover all six zones within the Park; the Zoo (Zone 7) was surveyed as in previous years (see 2017 report).

The Royal Parks Volunteer Manager liaised closely with volunteers and managed the scheduling timetable. Volunteer training sessions were held in Regent's Park in the week before each survey period led by the project team. Each volunteer received a comprehensive survey guide. A detailed risk assessment was included in the guide.

4.4 Veterinary support

The Veterinary Services team at ZSL were on standby during all periods of fieldwork. Hedgehogs that appeared unwell or injured were boxed and delivered to the vet team on site at ZSL. If a hedgehog could be treated, it was released back into the Park or placed with an experienced hedgehog carer, Sue Kidger. Dead or euthanised hedgehogs were passed to the Garden Wildlife Health (GWH) project based at ZSL's Institute of Zoology. The GWH vets would carry out a post-mortem to try and ascertain the cause of injury or death.

5. Survey methods

The survey methods followed the protocols that were established in 2016, modified slightly from the methods used at the beginning of the project in 2014 (see 2016 report). No survey took place in spring 2020 and the survey in autumn 2020 was modified as described above.

5.1 Spotlighting, using torches and thermal imaging cameras (TIC)

Survey groups carried out systematic nocturnal searches along established routes within each of the survey zones (Figure 4.1). Hedgehogs were detected by sound (rustles in undergrowth or noises made during courtship or fighting) or with the aid of bright LED Lenser torches. Each group (except Zone 7) also used a high specification thermal imaging camera (TIC). The cameras used were FLIR E60s and their set up and operation are described in Bowen *et al.* (2020). The searching method used by the groups is described in previous reports.

Hedgehogs that were found were individually marked with 10 mm lengths of yellow plastic spine sleeves with pre-printed numbers. Six sleeves, each with the same ID number, were glued to spines at the back of the neck using superglue. To keep track of the longevity of markers, the number of markers remaining on recaptured hedgehogs from previous surveys were recorded and the number of markers topped back up to six (Reeve *et al.* 2019). Each animal's GPS location, sex, weight, circumference, parasitic load, general health, and the habitat in which it was found were recorded on a proforma. The location of the hedgehog was also recorded on a map as were incidental fox sightings.

5.2 Data handling

During the surveys, each capture was reported by mobile phone to the Hedgehog Supervisor at Hedgehog HQ. This provided an ongoing assessment of how the survey was proceeding and enabled recaptured hedgehogs from that night to be released with minimal handling. It also facilitated the collection of injured hedgehogs so they could be taken to the vets for examination.

The data were transferred to Excel spreadsheets. Location records are presented on Google Earth Pro maps and data analysed using Excel, Xlstat, Minitab and Ranges software.

The population data are reported for the whole study period 2014-2020, except for maps of the distribution of captures of hedgehogs and habitat are only presented for 2018-2020. The distribution of fox sightings is also only shown for 2019-2020. In the autumn samples, hedgehogs <=700 g in weight have been termed juveniles, unless marked in a previous survey. The term persistence has been used rather than survival to describe how long hedgehogs remain in the surveyed population because of a lack of information on whether animals that 'disappeared' have died or simply not been captured. Sample sizes are small and life history measures (e.g., productivity, persistence) reported as proportions should be treated with caution. The number of hedgehogs found dead or euthanised each year are reported. Hedgehogs with severe injuries to their hind limbs, or with obvious bite marks elsewhere have been interpreted as predation.

Information collected on methods of detection and detection distances (see Bowen *et al.* 2020), longevity of animal markers (see Reeve *et al*. 2019), time of capture during the survey nights and nest boxes are not reported here.

6. Results

6.1 Population dynamics

6.1.1 Numbers of individuals

The average number of individual hedgehogs captured during each survey between spring 2014 and autumn 2021 was 29 (Figure 6.1, Appendix Table A1). Hedgehog numbers fluctuated considerably around this average value over the survey period (Figure 6.1). Peak numbers were captured in autumn 2014 (39 individuals) and autumn 2017 (36 individuals). Numbers of hedgehogs captured declined through spring and autumn 2015 to a low of just 11 individuals in spring 2016. The population recovered to 25 individuals in autumn 2016 with fluctuations around the average value until autumn 2019 (Figure 6.1). It is difficult to interpret the drop in numbers from autumn 2019 to autumn 2020 as a real decline because of the slightly different survey methodology used in autumn 2020 (see Methods).

Consistently, fewer male than female adults were captured (mean number of males = 38%, Coefficient of Variation = 28%, N = 13) except for autumn 2017. Proportionally few males were captured when the population was small in autumn 2015, spring 2016 and autumn 2019 (Figure 6.2). Relatively few males were also captured in autumn 2016 and autumn 2020. Juvenile numbers contributed markedly to peak numbers in the autumns of 2014, 2016 and 2017 whereas low numbers of juveniles were captured in the autumns of 2015 and 2018.

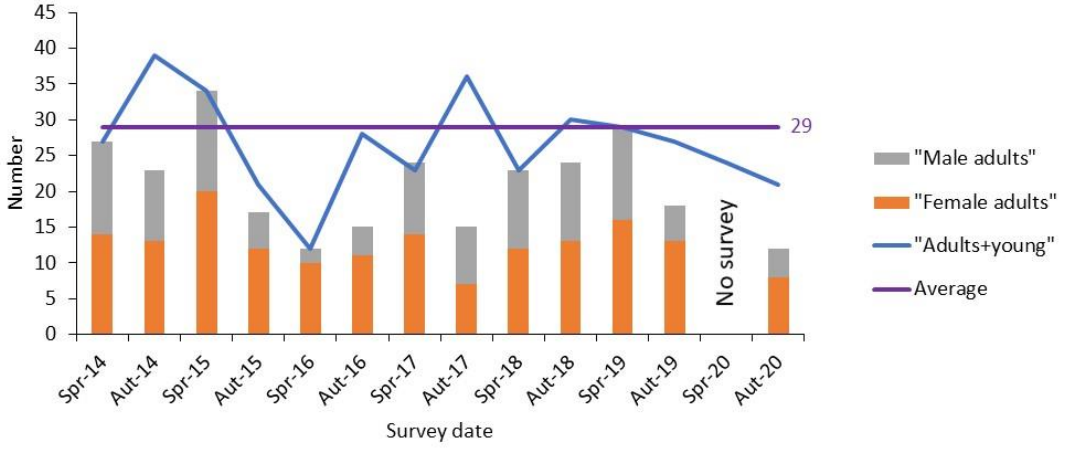


Figure 6.1 Numbers of individual hedgehogs captured during each survey (season-year). The ZSL Car Park was not surveyed in Spring 2014 and it was estimated that, if the Zoo Car Park had been surveyed, then total numbers would have approximated 34 individuals (2016 Report). The average is the long-term average of the number of individuals captured.

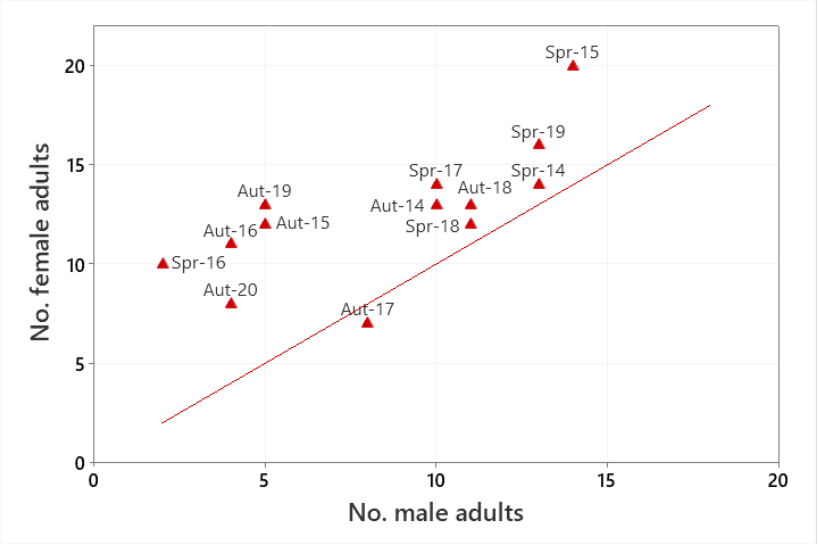


Figure 6.2 The relationship between the number of adult males and adult females captured during each survey. The diagonal line = line of equal numbers

6.1.2 Recruitment and persistence

From the autumn figures on numbers of juveniles captured, there is evidence of breeding in each year of the survey with 2017 appearing to be a good year and 2015 a very poor year (Figure 6.3, Appendix Table A2). Recruitment during 2016 and 2017 enabled the population to quickly rebound from the very low numbers captured during spring 2016.

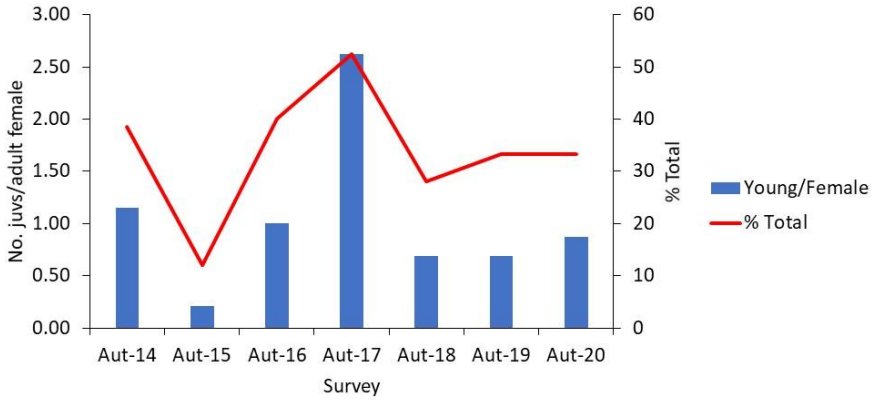


Figure 6.3 Number of juveniles captured per adult female in the autumn surveys and the per cent of juveniles of the total number of hedgehogs captured in each survey.

Because of small numbers, proportions can be misleading and so persistence values are presented both as numbers and percentages (Figure 6.4). Numbers of females (mean = 8.0, Coefficient of variation = 22%, N = 5) that persisted over summer (spring to autumn, average interval 110 days) was higher than males (mean = 5.2, CV = 46%, N = 5) (Figure 6.4a). The two males captured in spring 2016 survived giving 100% persistence (Figure 6.34). In fact, one of these two males survived to spring 2018 and the other to autumn 2018.

The number of females that survived the winter (autumn to spring, average interval = 252 days) was similar to the summer (mean = 7.8, CV = 23%, N = 5), but for males it was lower and again more variable (mean = 3.6, CV = 54%, N = 5). Juvenile (both sexes) overwinter persistence varied

considerably ranging from 1 to 9 individuals (mean = 6.8, CV = 42%, N = 5) (Figure 6.3b). As a proportion of the population, female overwinter persistence varied between 60% and 80% with males 30% to 75% with juveniles again lower and more variable than females (22% to 50%) (Figure 6.3d).

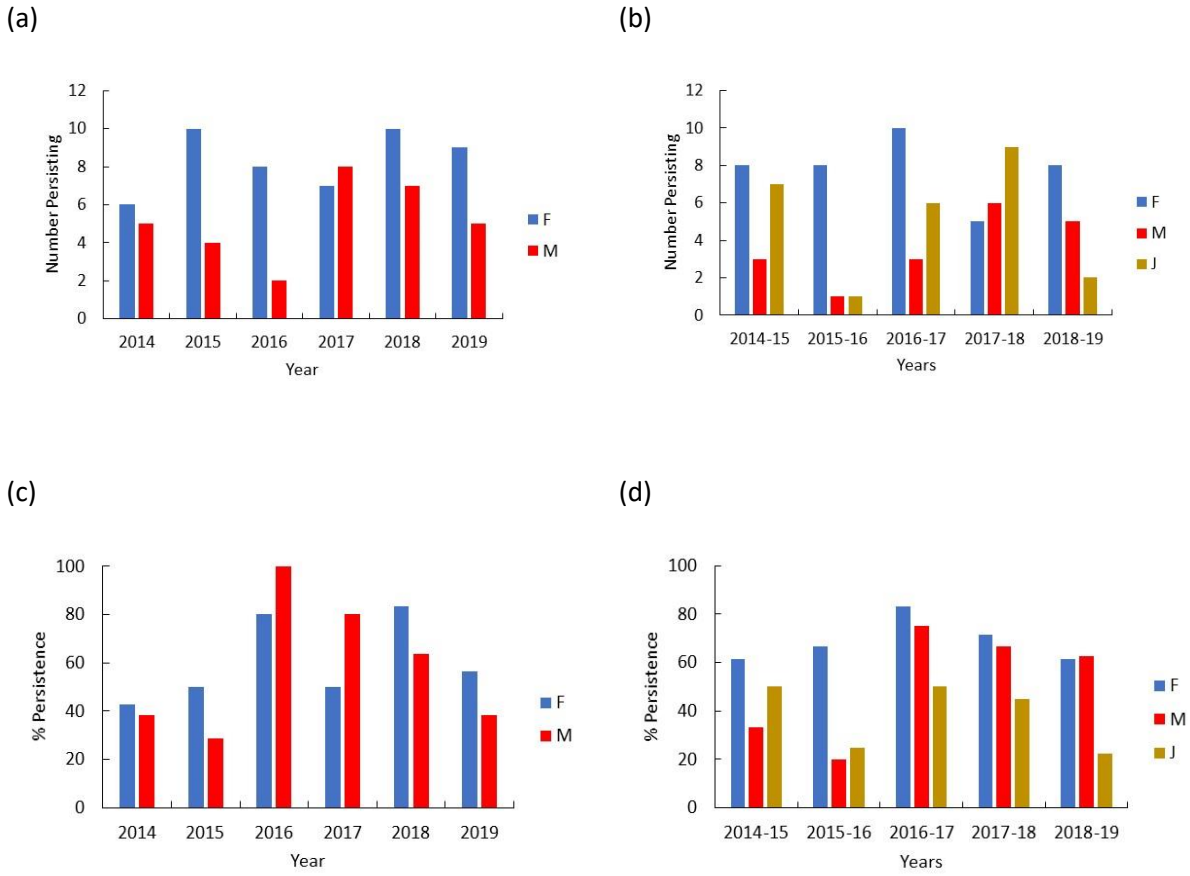
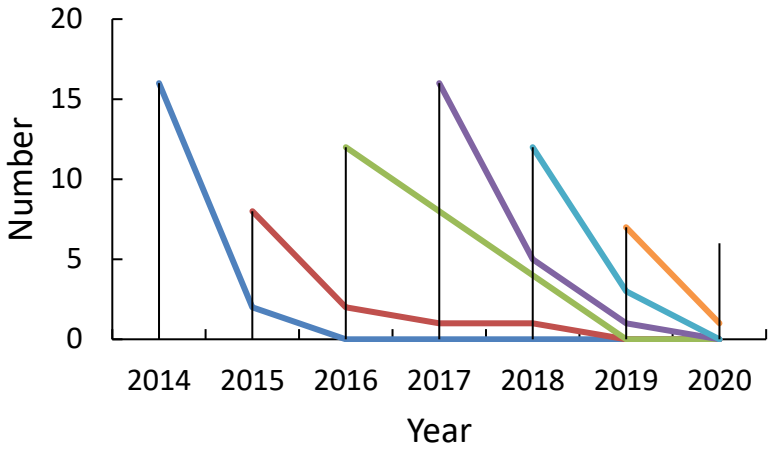


Figure 6.3 Summer and winter persistence (a) Number of individuals persisting over summer, from spring to autumn, (b) Number of individuals persisting over winter, from autumn to spring. (c) Per cent of individuals persisting over summer, (d) Per cent of individuals persisting over winter. F = female, M = male, J = juvenile. No survey was carried out in spring 2020.

The persistence of cohorts of all males and females captured each autumn are plotted through time in Figure 6.4. These clearly show that few animals survive 3 years. The steepest declines occurred over one year with slight variations between cohorts. On average, 27% of males persist for 1 year, 8% for 2 years and 1% for 3 years. Equivalent figures for females are 41%, 17% and 3%.

(a) Males



(b) Females

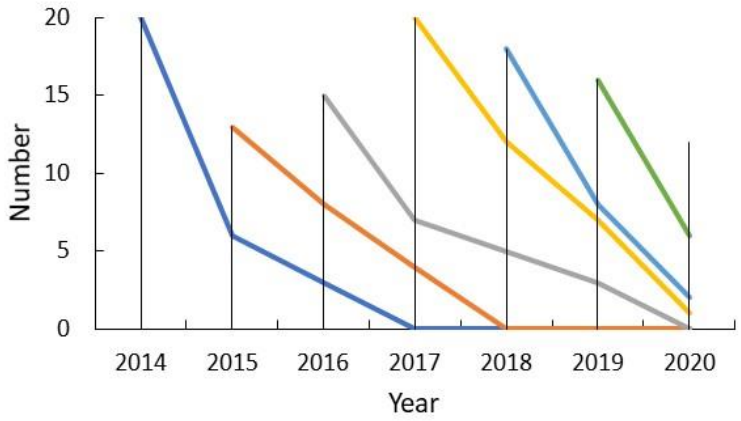


Figure 6.4 The persistence of cohorts of individuals captured each Autumn, irrespective of age. (a) Males, (b) Females.

6.1.3. Deaths

Several hedgehogs were found dead or injured in the Park. Injured animals were examined by the vets and euthanised if the injuries were found to be severe. Some animals were treated and released back into the Park and on two occasions were rehomed with carers but not released back into the wild. The number of hedgehogs found dead, euthanised or rehomed (effectively lost from the population) each year are shown in Figure 6.5 and Appendix Table A3. It is not possible to say why some animals died, but the causes of death in other cases have been attributed to roads, predators or a variety of other factors (e.g., disease, drowning). Considering the small population, the number of known deaths was high in most years, except 2014 and 2016. Predation, probably by foxes (although dogs cannot be ruled out entirely) seems to have been a key factor. One also assumes that many other deaths occur ‘out of sight’.

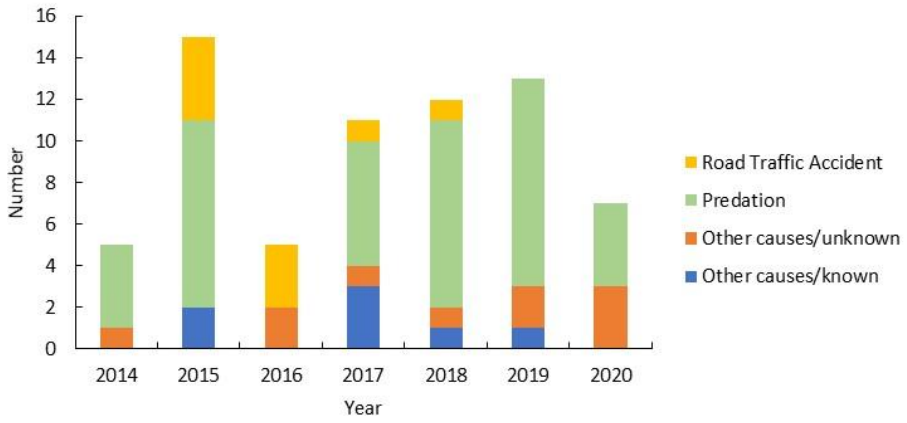


Figure 6.5 Number of known deaths reported in the park each calendar year.

6.1.4 Body weight

Body weights for adult hedgehogs varied from season to season across the years with notably low mean body weights in males in spring 2016 and to a lesser extent in both males and females in spring 2015 and spring 2019 (Figure 6.6).

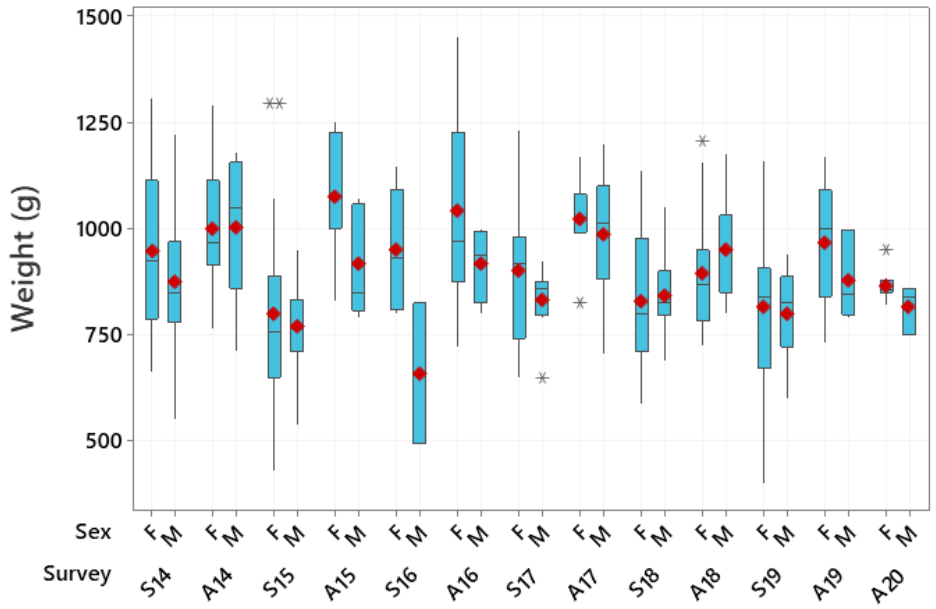


Figure 6.6 Box plots of adult hedgehog body weights. Light blue box represents the inter-quartile range, whiskers = highest and lowest values, * = outlier, red diamonds = mean values, F = female, M = male Survey = season (S = spring, A = autumn) and year.

Across all surveys, there was no interaction between sex and season in adult body weight ($F_{1,264}$ = 0.06, P = 0.808; Appendix Figure A1). Adult females significantly weighed more than adult males within each season ($F_{1, 264}$ = 4.83, P = 0.029), and autumn hedgehogs weighed significantly more ($F_{1, 264}$= 35.98, P <0.001) than spring hedgehogs (mean adult female spring body weight = 865 g, N = 86, SD = 193.5 g, mean adult female autumn body weight = 983 g. N = 75, SD = 163.7 g; mean adult male spring body weight = 816 g, N = 63, SD = 123.0 g, mean adult male autumn body weight = 943 g. N = 44 SD = 134.9 g) (Figure 6.7). The maximum female weight recorded was 1450 g for an individual captured in autumn

2016 and for a male was 1020 g captured in spring 2014. Th mean weight of juveniles captured in the autumn was 480 g (N = 72, SD = 139.8 g, Maximum = 700 g, Minimum = 200 g).

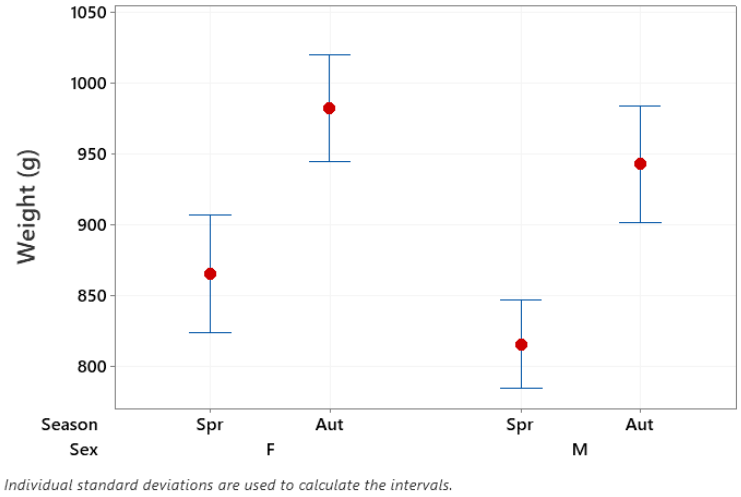


Fig. 6.7 Interval plot for adult body weights showing the means and 95% confidence limits for males and females in spring and autumn. F = female, M = male.

6.2 Distribution of captures

6.2.1 Captures in 2018-2020

In spring 2018, most captures were in Zone 2 (Figure 4.1) to the north and east of the Park with few captures elsewhere (Figures 6.8). This was also the case in the autumn of that year, although noticeably more captures took place in the central and northern sectors, Zones 3 and 4. This pattern of distribution continued throughout 2019, but in the autumn of 2020, there appears to have been a shift away from Zone 2 with most captures in Zones 3 and 6 and a small number in Zone 1 where they had been largely absent since 2016.

Spring 2018

Autumn 2018

Spring 2019

Autumn 2019

Spring 2020

No survey

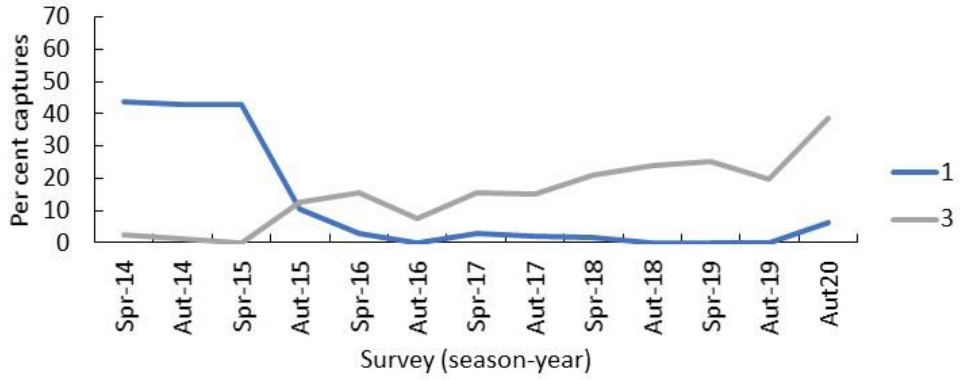
Autumn 2020

Figure 6.8 Distribution of captures during each survey between 2018 and 2020.

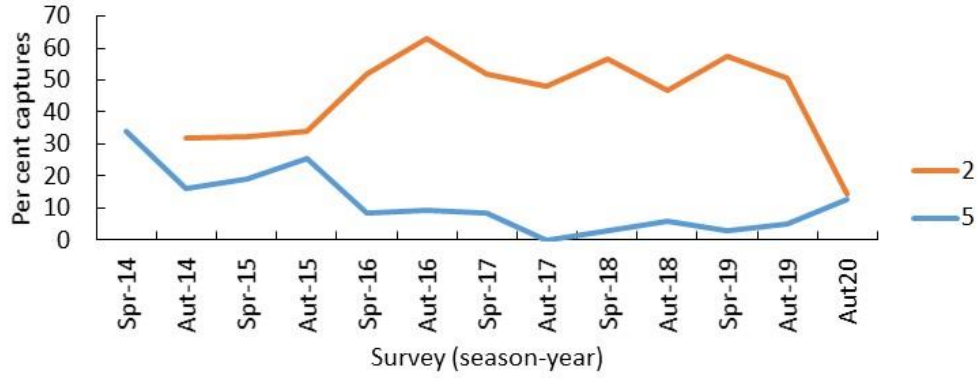
6.2.2 Distribution of hedgehog captures within the Park, 2014-2020

The changing pattern of distribution over the course of the study can be seen in Figure 6.9. At the start of the study, Zones 1, 2 and 5 were described as 'hot spots' where most of the hedgehogs were captured (see earlier reports). By 2016, hedgehogs had virtually disappeared from Zone 1 in the south and declined to low numbers in Zone 5 to the west of the Park. Between 2016 and 2019 most hedgehogs captured took place in Zone 2 and was the principal 'hot spot'. Captures in Zone 3 have increased slowly during this period as have numbers during the autumn surveys in Zone 4. Elsewhere, captures have been low with the south and west not favoured. Zone 2 includes the Zoo Car Park where many hedgehogs were captured at the beginning of the study. The Car Park was not surveyed in spring 2014 but 25% of all captures occurred in the Car Park in autumn 2014 and 20% in spring 2015 (Figure 6.10). Numbers of captures in the Car Park have fluctuated at a lower level through to spring 2018 but have fallen away since then; no hedgehogs were captured in the Car Park in autumn 2020. Considerable disturbance has occurred in the eastern part of the Car Park since 2018 with major water mains being replaced and the start of the construction of a Lorry Holding Park for the HS2 project at nearby Euston Station (see details in 2017 Report*)*.

Zones 1 and 3



Zones 2 and 5



Zones 4, 6 and the Zoo

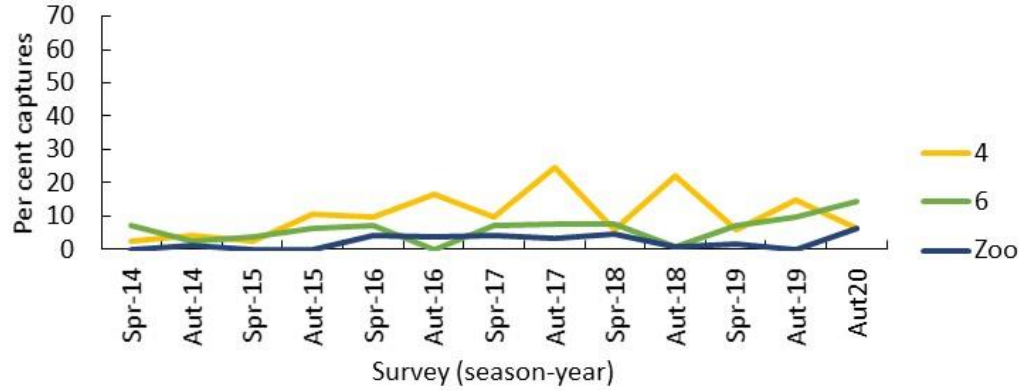


Figure 6.9 Per cent of captures in each zone for spring and autumn surveys, 2014-2020. No survey was carried out in spring 2020. Plotted as lines for illustrative purposes only. The Zoo Car Park in Zone 2 was not surveyed in spring 2014 and this data point is omitted.

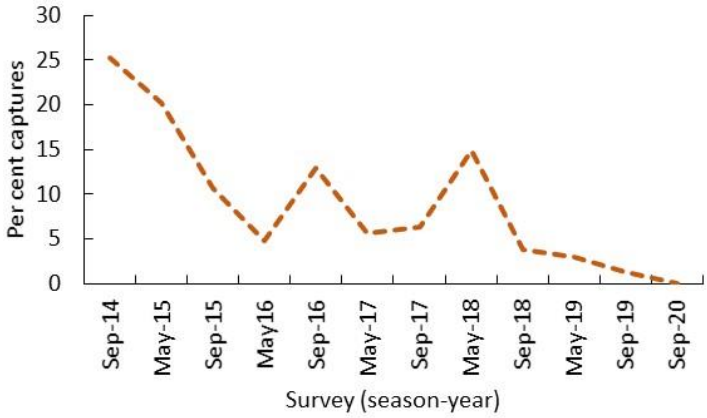


Figure 6.10 Per cent of all captures in the Zoo Car Park

6.3 Habitat

Over the period from 2018 and 2020, 68% of hedgehog captures took place in short grass (<10 cm tall) and this was consistent across all surveys (Figure 6.10). Captures in each of the other nine recorded habitats were relatively few and without any specific pattern, although there were more captures on the sports pitches in Autumn 2020 than any previous survey (going back to 2014).

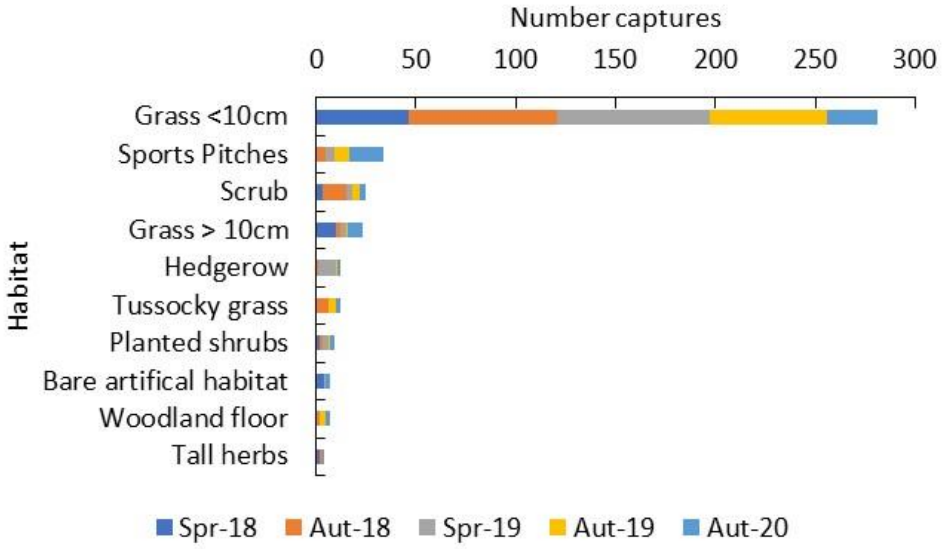


Figure 6.10 Number of captures according to habitat in each survey between 2018 and 2020, Total N = 414.

6.4 Foxes

Foxes continue to be seen across the park during the hedgehog surveys. Results from 2019 and 2020 are shown in Figure 6.11. Of note is the large numbers of foxes seen around the Zoo and in Zone 2 in autumn 2020.

Figure 6.11 Fox sightings during the surveys in 2019-2020. Red -spring 2019. yellow – autumn 2019, blue autumn 2020. Records not available from 2018.

7 Discussion

7.1 Covid restrictions 2020

The inability to carry out surveys in spring 2020 leaves an unfortunate gap in the data. Moreover, the modifications to the standard survey method in autumn 2020 meant that the whole Park was surveyed over three nights in each of two consecutive weekends rather than one night, and the search effort was lower than normal with only three volunteers searching each zone, rather than the minimum of four volunteers used in previous surveys. The number of individuals (21) captured in autumn 2020 was the second lowest across the whole survey period, the lowest being spring 2016 (11). It is not possible to know whether the variation in the survey method resulted in fewer animals being captured than would have been normally. Hopefully, surveys will take place as usual in 2021 whereby a better understanding will be obtained as to whether the low autumn 2020 figures truly reflect the state of the population, or whether the surveying was less efficient than usual. At our present state of knowledge, the population figures for autumn 2020 should be treated with caution and they will not be considered in detail below.

7.2 The hedgehog population

The size of the population of hedgehogs at Regents park was low fluctuating around a mean value of 29 over the survey period from 2014 to 2020. From the area and nature of the habitat available, it is estimated that The Regent's Park could hold three to four times that number but so far, the population has not shown any period of sustained growth. The population is believed to be isolated (see previous reports) and importantly, chance factors leading to a combination of poor breeding and poor survival (persistence) could drive it towards extinction. This situation was approached in spring 2016 when only 11 animals were known to be alive within the Park. The population recovered from that low point but is still highly vulnerable.

Generally, numbers were higher in the autumn than in the spring reflecting the recruitment of offspring into the population from summer breeding, which has taken place every year. However, breeding has been better in some years than others being particularly good in 2017 and particularly bad year in 2015. It is appreciated that some hedgehogs born late in the year may not have been picked up in the autumn surveys. Generally, hedgehogs in Britain are believed on average to have litters of 4 to 5 young (Reeve 1994). If we assume an average litter size of 4.5 and taking the number of adult females captured in the autumn survey, then over the entire study only approximately 20% of potential offspring were captured in the autumn. Although there are many sources of error in carrying out this exercise, it does strongly suggest that large numbers of young have been lost between birth and independence when they could be captured during the autumn surveys.

The numbers of adult females that persisted over summer and over winter were similar, but the number of adult males was lower and more variable over summer and again more variable and considerably lower over winter. The number of juveniles that persisted over winter was about twice that of adult males, but again varied considerably from year to year. Because of the fluctuations in small numbers, it is difficult to discern any real patterns in persistence other than these general observations. The bias towards females in the population is interesting but unexplained. In most field studies (see Reeve 1994) males are easier to find during the breeding season (spring and summer) as their greater activity and larger home ranges increase the likelihood of them being encountered. In the autumn, females tend to dominate the sample. In a 5-year study Jackson (2007) found a spring sex ratio of 1:1 in juveniles (that had overwintered) but a 1.8:1 (M:F) ratio among adults. However, in a seven-year study, Kristiansson (1990) found an overall sex ratio of 1:1.

The autumn survey cohort analysis clearly shows that persistence in the population is short lived with overall only 40% of individuals captured in the autumn persisting for one year, 17% for two years and only 3% for three years.

The body weight data do not provide any clues as to why hedgehogs do not persist in the population for very long. On average, adult females are about 40 g heavier than adult males and autumn adults about 120 g heavier than spring adults. However, and although bodyweight does vary, nearly all animals captured seem to have a good body weight and it is difficult to discern any overall pattern. Further analyses on body condition will be carried out in the future.

One factor of concern is the large number of deaths that have been recorded each year, and of course it can be assumed that many deaths have gone undetected. The largest mortality factor appears to be predation with foxes being the most likely predator, although domestic dogs cannot be ruled out. Foxes are likely to be responsible for the serious injuries to the hind legs of hedgehogs which often lead to their death or, if found alive, will result in them being put to sleep by the vets. In addition, a fox has been observed with a baby hedgehog in its mouth and they are probably responsible for some of the dead young found in the Zoo grounds. Further studies are needed, but it is possible that foxes take and kill young hedgehogs from the nest which would significantly affect recruitment.

7.3 Distribution and habitat

The 2016 and 2017 reports have highlighted the changes in the distribution of hedgehogs within the Park since the beginning of the study, and some further changes have been seen more recently. In 2014, three ‘hotspots’ were identified, Zones 1, 5 and 2. By 2016, there were few to no captures in zones 1 and 5 and most captures occurred in Zone 2. This was the predominant pattern through to 2019, although there was a slowly increasing number of captures in Zone 3, on and around the sports pitches in the middle of the Park. In autumn 2020, the relative number of captures dropped in Zone 2 with Zone 3 continuing the upward trend. It is difficult to understand why these shifts in distribution have taken place, especially the losses of hedgehogs from the south and west of the Park. With small

numbers of individuals generally, if several hedgehogs were to die within a particular zone recolonisation may take place slowly accounting for the losses.

Two things are worth noting with respect to the north and east of the Park. The Zoo Car Park (approximately 2.6 ha in area less 0.8 ha of tarmac) was identified as a local hotspot at the start of the study with many individuals and captures occurring within this small area. Considerable disturbance with some loss and fragmentation of habitat have taken place in the Car Park since 2017 when Thames Water established a compound (~ 0.4 ha) in the Car Park to carry out work on a major water mains diversion (see Figure 7.1, 2017 Report). Thames Water's ecologists have and continue to work with the Royal Parks and Dr. N. Reeve on mitigation measures for the hedgehogs. In 2021, HS2 will be taking over the compound and creating a lorry holding area to support the development of the new rail link out of Euston Station. Since spring 2018, the numbers of captures of hedgehogs within the Car Park have declined (Figure 6.10), although this may only partly be due to the on-site works.

The other interesting observation is the importance of the Zoo (Zone 7). Starting in 2014-15, zoo staff have cut holes have been cut in the boundary fence to allow hedgehogs to move freely in and out of the Zoo (Sven Seiffert pers. comm.). Hedgehogs are frequently reported, and some have been captured within the zoo grounds (Sven Seiffert pers. comm.), but many have been captured around the outer edge of the zoo (Figure 6.8). The most rational explanation is that hedgehogs are nesting in or around the edge of the zoo grounds and move out to feed on the more open grassland area within the Park during the night. During the surveys, hedgehogs were found in a range of habitats, but were detected most frequently in areas of short grass (68% of all captures, Figure 6.10). From GPS and radiotracking studies carried out in the park in earlier years, short grassland is an important hedgehog foraging habitat. Interestingly, few hedgehogs were captured on the sports fields at the beginning of the study in 2014, but captures have increased since autumn 2018.

Figure 7.1 Zoo Car Park and the Thames Water compound outlined in red.
Image taken from Google Earth Pro dated 4th November 2020.

7.4 Foxes

Foxes are of particular interest because of their probable role in causing serious injury to hedgehogs, predating them, or disturbing nests and killing infants. During hedgehog surveys fox sightings were recorded and they were found to be abundant and widespread throughout the Park (Figure 6.11). This is supported by the independent camera trap studies carried out within the Park by by ZSL (Chris

Carbone, pers. Comm.). Further detailed studies on foxes and fox-hedgehog interactions within the Park are warranted.

8. Factors that affect the hedgehog population

Previous reports on The Regent's Park hedgehog population published in 2015, 2016 and 2107 have considered various factors that could be important in limiting the population, including: small population size, genetics, inbreeding and population isolation, habitat, nest site and invertebrate food availability, park management, exposure to anticoagulant rodenticides, deaths, illness and injuries, weather and predation. Although further detailed consideration of these factors will not be included in this report, they are being kept under review and will direct future specific studies to augment the survey monitoring programme, subject to the availability of resources.

9. Future work

The current plan is to continue the surveys in spring and autumn each year through to 2024, which will represent a 10-year period; the studies on nest box utilisation will also continue. To try and understand the factors affecting the population and spatial dynamics of the hedgehogs in the Regent's Park and their long-term future, further work on a number of topics is being considered, including:

- Invertebrate food availability;
- Movement and habitat utilisation of hedgehogs within the Park using GPS and radiotracking;
- Fox-hedgehog interactions;
- The effects of Park management on food resources, nest site availability and predator pressure.

Plans for conservation management interventions will be drawn up so they can be quickly implemented should the population appear to be dying out. At the end of the project recommendations for the management of the Park and the hedgehog population will be made to help secure the long-term future of hedgehogs in The Regent's Park.

10. Conclusion

The 6-monthly hedgehog surveys effectively carried out by volunteers in The Regent's Park between 2014 and 2020 paint a bleak picture. The population is isolated, has remained small over this period and well below the perceived carrying capacity for the Park. The factors limiting the population are not yet fully understood but include predation and disturbance, habitat management, barriers to free movement, food availability and weather. The concern is that the population could go extinct at any time. Continued monitoring of the population is essential and is currently planned through to 2024. Further studies on the above limiting factors would be helpful. By 2024, it will be necessary to have a robust conservation plan in place to assure the long-term future of hedgehogs in The Regent's Park.

11. Acknowledgements

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This project has only been possible because of the support of our brilliant volunteers…thank you to everyone who has helped.

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Appendix

Table A1 Numbers of adult females, adult males and young captured each survey.

	Survey													
Category	Spr-14	Aut-14	Spr-15	Aut-15	Spr-16	Aut-16	Spr-17	Aut-17	Spr-18	Aut-18	Spr-19	Aut-19	Spr-20	Aut-20
Adult females	14	13	20	12	10	11	14	7	12	13	16	13	No	8
Adult males	13	10	14	5	2	4	10	8	11	11	13	5	Survey	4
Young	0	16	0	4	0	13	0	21	0	6	0	9		9
Total	27	39	34	21	12	28	24	36	23	30	29	27		21

Table A2 Number of young per adult female captures and the per cent of young of the total number of individuals captured in each autumn survey.

	Autumn survey						
Category	Aut-14	Aut-15	Aut-16	Aut-17	Aut-18	Aut-19	Aut-20
Young/Adult Female	1.15	0.21	1.00	2.63	0.69	0.69	0.88
% Juveniles of total number captured	38	12	40	53	28	33	33

Table A3 Known hedgehog deaths.

	Year						
Cause of death	2014	2015	2016	2017	2018	2019	2020
Other causes/known		2		3	1	1	
Other causes/unknown	1		2	1	1	2	3
Predation	4	9	0	6	9	10	4
Road Traffic Accident		4	3	1	1		
Total	5	15	5	11	12	13	7

Figure A1 Interaction plot showing means of body weight (g) for sex (F = female, M = male) and season (S = spring, A = autumn). Y-axes are body weight (g).