LONDON HOGWATCH
Hampstead Heath 2021 Survey

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Acknowledgements

Introduction

Hedgehogs have recently been classified as vulnerable to extinction in the UK as their numbers are estimated to have declined by 46% in the last 13 years[1]. The causes of this decline are complex, as there are many interacting factors, but these are likely to include habitat loss, use of pesticides and other agricultural chemicals, road traffic and increasing badger populations[2-4]. A recent study showed that hedgehogs occur in over 70% of urban centres across their geographic range and this highlights the importance of suburban and urban habitats for the species[5].

London HogWatch is aiming to mitigate the effects of hedgehog population decline within Greater London. One main problem with conservation efforts is a lack of knowledge about the distribution and size of current London populations. Having this information would allow for efforts to be targeted and more successful. Currently, data is predominantly gathered from citizen science surveys, such as the PTES Big Hedgehog Map[6]. Whilst this method can provide useful data on hedgehog presence, little can be inferred about their absence and relative abundance. London HogWatch uses systematic camera trapping surveys, to provide a more robust and consistent way of estimating presence and relative abundance. In addition, camera traps collect information on a range of other species that may impact hedgehogs, such as red foxes and badgers.

Located in North-West London in zone two (UK grid reference: TQ 26346 87312), Hampstead Heath is a Site of Metropolitan Importance for Nature Conservation less than four miles from the centre of London[7]. The 320-hectare open space comprises of a mosaic of habitats such as hedgerows, amenity grasslands, woodlands, and meadows. Open 24 hours a day, the Heath is also a recreation site to its nine million yearly visitors, with bathing ponds, sports facilities, and a café[7]. An area of the Heath called Hampstead Heath Woods, was granted a Site of Special Scientific Interest (SSSI) designation in 1975[8]. This SSSI contains native ancient and veteran trees which can support a range of fauna and flora species as well as carbon storage[8,9]. Several UK Biodiversity Action Plan (BAP) species have been recorded here, such as soprano pipistrelle, grass snake, and reed warbler[10,11].

This report describes the results of the camera trap surveys conducted on Hampstead Heath in 2021. It was last surveyed by London HogWatch in the spring of 2018 with a total of 150 sites[12]. In 2021, camera traps were placed across the entirety of the Heath in similar locations to 2018. The aim of these surveys was to assess the frequency of hedgehog sightings, and the extent to which they occur across the survey area, with an added focus on other nocturnal mammals such as foxes, as well as bird diversity.

Methods

Camera Trap Deployment

The camera trap survey took place from the 19th of May 2021 to the 9th of June 2021, for a total of three weeks. A total of 150 Browning Strike Force Pro BTC-5HDP camera traps were deployed across the entirety of Hampstead Heath by Heath Hands, City of London staff, the London HogWatch team, and around 60 volunteers (Figure 1). Once the cameras were collected, the images were examined to determine if the full length of the three-week survey had been captured and if camera placement was satisfactory for hedgehog detection. If not, another camera was placed close by to the original camera placement, but with a better field of view. In total, a further 53 cameras were redeployed between May and August 2021. These cameras were also placed for approximately three weeks, with the last camera trap collection date in September 2021.

Cameras were set to take a photo every second that an animal was in the detection zone. Use of infrared flash allowed the cameras to be active for 24 hours a day. The same location points for the camera traps were used from the 2018 survey[12]. Placement of the cameras followed a predetermined grid pattern, to ensure even coverage of each site and based on Random Encounter Model[13] protocol. Site coordinates generated by computer were uploaded to Google's custom map maker, MyMaps, for volunteers to be able to reach the camera location points using their smartphone. The cameras were set-up pointed to the ground to maximise the detection of hedgehogs and avoid collecting images of humans.

Data Processing and Analysis

All images from the survey were processed using the artificial intelligence software MegaDetector v4.1. This software automatically sorts data into various classifications, which allows large sets of images to be processed with ease and reduces data protection issues. The MegaDetector was used to detect and classify 'blank', 'human', and 'animal' images. For the hedgehog analysis, a dataset containing both the blank and animal images was processed and tagged. Blank images were kept in to avoid the accidental loss of hedgehog detections which may have been inaccurately classified as a blank. For all other species, blanks and humans were removed, so that only the animal images were processed. All mammal and bird species identified over the course of each 24-hour period were tagged to capture the full diversity of species present in Hampstead Heath. This tagged data was then used to calculate trapping rates for each species, which is the total amount of sightings per number of nights the camera was active. Only four sites were completely excluded from the hedgehog analysis. This was due to the cameras overgrown with vegetation or because they had a poor field of vision (poor placement). Unfortunately, due to time constraints which limited the time spent on tagging, sixteen sites were only tagged for hedgehogs. This means that these sites have been excluded from the analysis of the other species.

The 2018 and 2021 results were compared for four key species (hedgehog, fox, rabbit, and muntjac). This was done to assess potential changes in trap rate and distribution between the two surveys. To facilitate this comparison, the same camera sites were excluded from the 2018 as the 2021 data, as this would allow a more accurate comparison to be made between the species values. Nine sites were excluded from the 2018 analysis, and these were combined with the specific sites excluded from the 2021 hedgehog, fox, rabbit, and muntjac analyses.

It is important to note that the ability to compare trap rates was limited due to methodological differences between the two surveys. In 2018 the tagging intervals used were 6pm-8am and in 2021 the tagging intervals were 24h, meaning it is possible more contacts were registered in 2021 than 2018 as a result. Although very unlikely to affect the hedgehog comparison due to their nocturnal activity pattern, it is likely to have a greater impact on more diurnal species. However, differences in the ways the cameras were deployed may also have an effect on the comparison between years.

Maps on 2021 hedgehog distribution, 2021 mammal and bird ratios, and 2018-2021 comparisons between the four main species (hedgehog, fox, rabbit, muntjac) can be found in the Results section below. The maps on 2021 fox, rabbit, and muntjac distribution with all possible sites included are included in the Appendix.
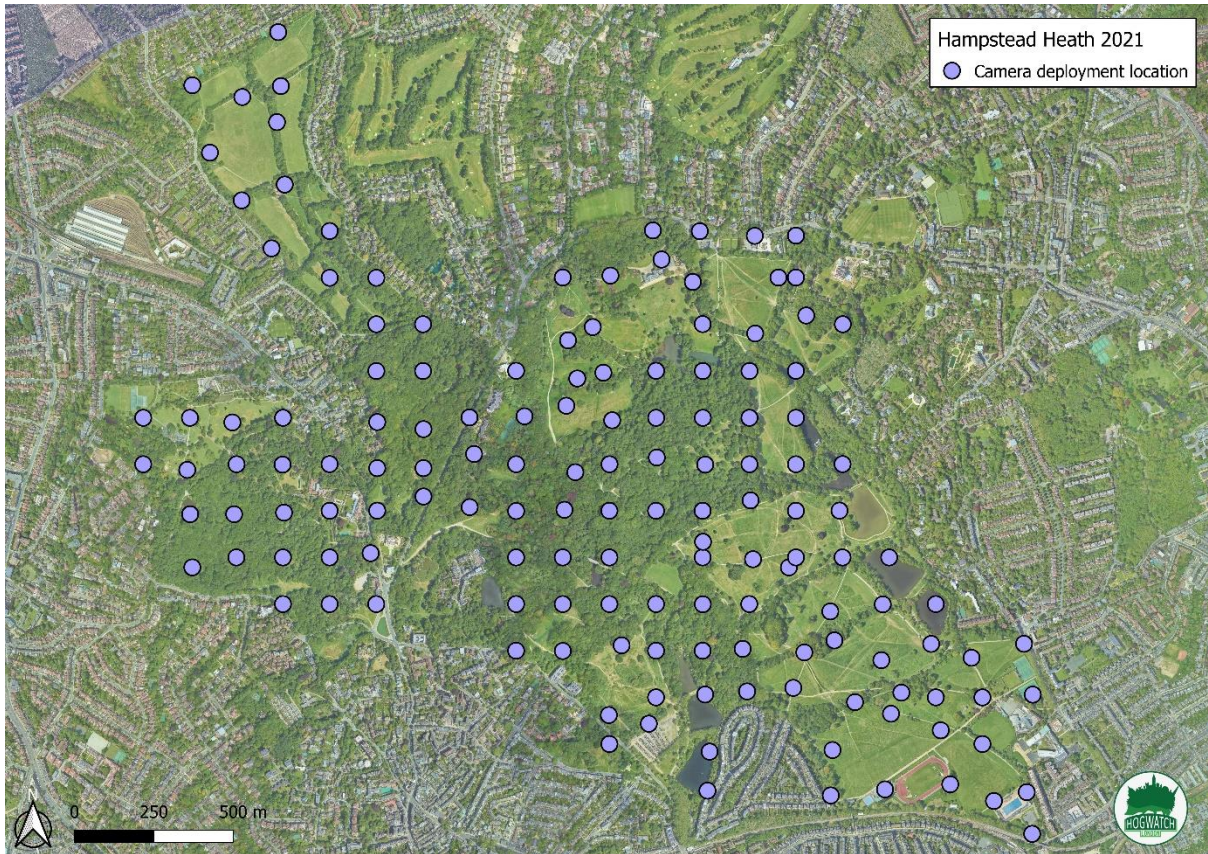
Figure 1. Camera deployment locations for the 2021 Hampstead Heath survey.

Results

In total 321 hedgehog sightings were made across Hampstead Heath with an overall trap rate of 0.11 (Table 1). They were found to have a wide distribution across the Heath, with sightings made on 44% of the camera sites (Table 1, Figure 2).

Overall, a total of 11 mammal species and 38 bird species were identified. Hedgehogs were the only UK red listed mammal species which are classified as 'vulnerable'. Other than hedgehogs, other mammal's species seen included cats, dogs, field vole, foxes, horses, mice, muntjac deer, rabbits, rats, and squirrels. Sixteen bird species detected were of UK conservation concern[14]. This includes four species on the Red List (greenfinch, herring gull, house sparrow, and starling) and eleven on the Amber List (common gull, dunnock, grey wagtail, kestrel, mallard, moorhen, song thrush, stock dove, tawny owl, wood pigeon, and wren).

Table 1. Hedgehog results for the 2021 Hampstead Heath survey.

Hedgehogs Results – 2021 Survey			
Sites: 146 (4 excluded/failed) Effort: 2877			
Species	**Number of Sightings**	**Number of Sites Present (%)**	**Overall Trapping Rate**
Hedgehog	321	64 (44%)	0.11

Table 2. All other species results for the 2021 Hampstead Heath survey. Amber list species are denoted with an asterisk (*), red list species are denoted with two (**).

All Species Results – 2021 Survey			
Sites: 134 (16 excluded/failed) Effort: 2604			
Species	**Number of Sightings**	**Number of Sites Present (%)**	**Overall Trapping Rate**
Blackbird	335	51 (38%)	0.129
Blackcap	1	1 (1%)	0.0004
Blue tit	3	3 (2%)	0.001
Canada goose	19	4 (3%)	0.007
Cat	129	19 (14%)	0.050
Chaffinch	4	1 (1%)	0.002
Chiffchaff	2	2 (1%)	0.001
Common gull*	9	1 (1%)	0.003
Crow	454	49 (37%)	0.174
Dog	12320	118 (88%)	4.731
Dunnock*	89	12 (9%)	0.034
Egyptian goose	81	3 (2%)	0.031
Feral Pigeon	93	13 (10%)	0.036
Field vole	1	1 (1%)	0.0004
Fox	3787	125 (93%)	1.454
Great spotted woodpecker	2	2 (1%)	0.001
Great tit	12	8 (6%)	0.005
Green woodpecker	2	2 (1%)	0.001
Greenfinch**	4	2 (1%)	0.002
Grey wagtail*	1	1 (1%)	0.0004
Heron	17	1 (1%)	0.007
Herring gull**	1	1 (1%)	0.0004
Horse	5	4 (3%)	0.002
House sparrow**	1	1 (1%)	0.0004
Jackdaw	10	1 (1%)	0.004
Jay	65	26 (19%)	0.025
Kestrel*	2	1 (1%)	0.001
Magpie	1141	88 (66%)	0.438
Mallard*	168	13 (10%)	0.065
Mandarin duck	46	1 (1%)	0.018
Moorhen*	55	5 (4%)	0.021
Mouse	1579	50 (37%)	0.606
Muntjac	28	14 (10%)	0.011
Nuthatch	3	2 (1%)	0.001
Pied wagtail	1	1 (1%)	0.0004
Rabbit	237	9 (7%)	0.091
Rat	403	14 (10%)	0.155
Robin	621	48 (36%)	0.238
Siskin	2	1 (1%)	0.001
Song thrush*	187	12 (9%)	0.072
Squirrel	6862	114 (85%)	2.635
Starling**	4	1 (1%)	0.002

Stock dove*	15	6 (4%)	0.006
Tawny owl*	4	4 (3%)	0.002
Treecreeper	1	1 (1%)	0.0004
Unidentified thrush	153	34 (25%)	0.059
Wood pigeon*	818	73 (54%)	0.314
Wren*	37	12 (9%)	0.014

Table 3. Comparison of hedgehog results for the 2021 and 2018 Hampstead Heath surveys.

Species	Number of Sightings	Number of Sites Present (%)	Overall Trapping Rate
2021 Hedgehogs Sites: 137 (13 excluded/failed) Effort: 2692			
Hedgehog	308	59 (43%)	0.11
2018 Hedgehogs Sites: 137 (13 excluded/failed) Effort: 2027			
Hedgehog	376	70 (51%)	0.19

Table 4. Comparison of fox, rabbit, and muntjac results for the 2021 and 2018 Hampstead Heath surveys. The differences in tagging intervals between 2018 and 2021 are not an issue for nocturnal species but may limit the comparison of diurnal species.

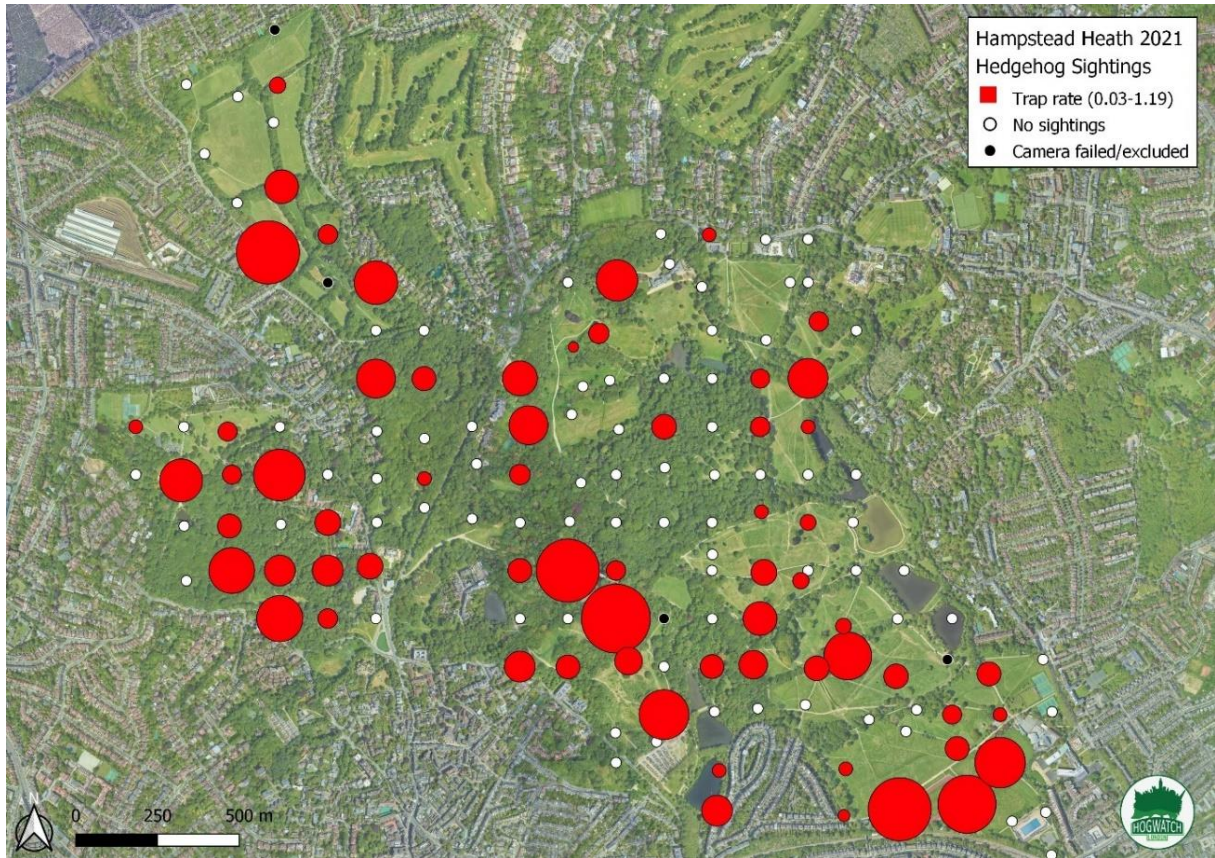| Species	Number of Sightings	Number of Sites Present (%)	Overall Trapping Rate
2021 Main Mammals Sites: 125 (25 excluded/failed) Effort: 2419			
Fox	3677	119 (95%)	1.52
Rabbit	237	9 (7%)	0.10
Muntjac	24	13 (10%)	0.01
2018 Main Mammals Sites: 125 (25 excluded/failed) Effort: 1835			
Fox	1836	113 (90%)	1.00
Rabbit	108	6 (5%)	0.06
Muntjac	12	6 (5%)	0.01

Figure 2. Hedgehog activity based on sightings from the 2021 Hampstead Heath survey. The red circles represent hedgehog sightings and are scaled by trapping rate (larger circles = higher trap rate). White indicates an absence of hedgehogs and black indicates cameras which either failed or were excluded.
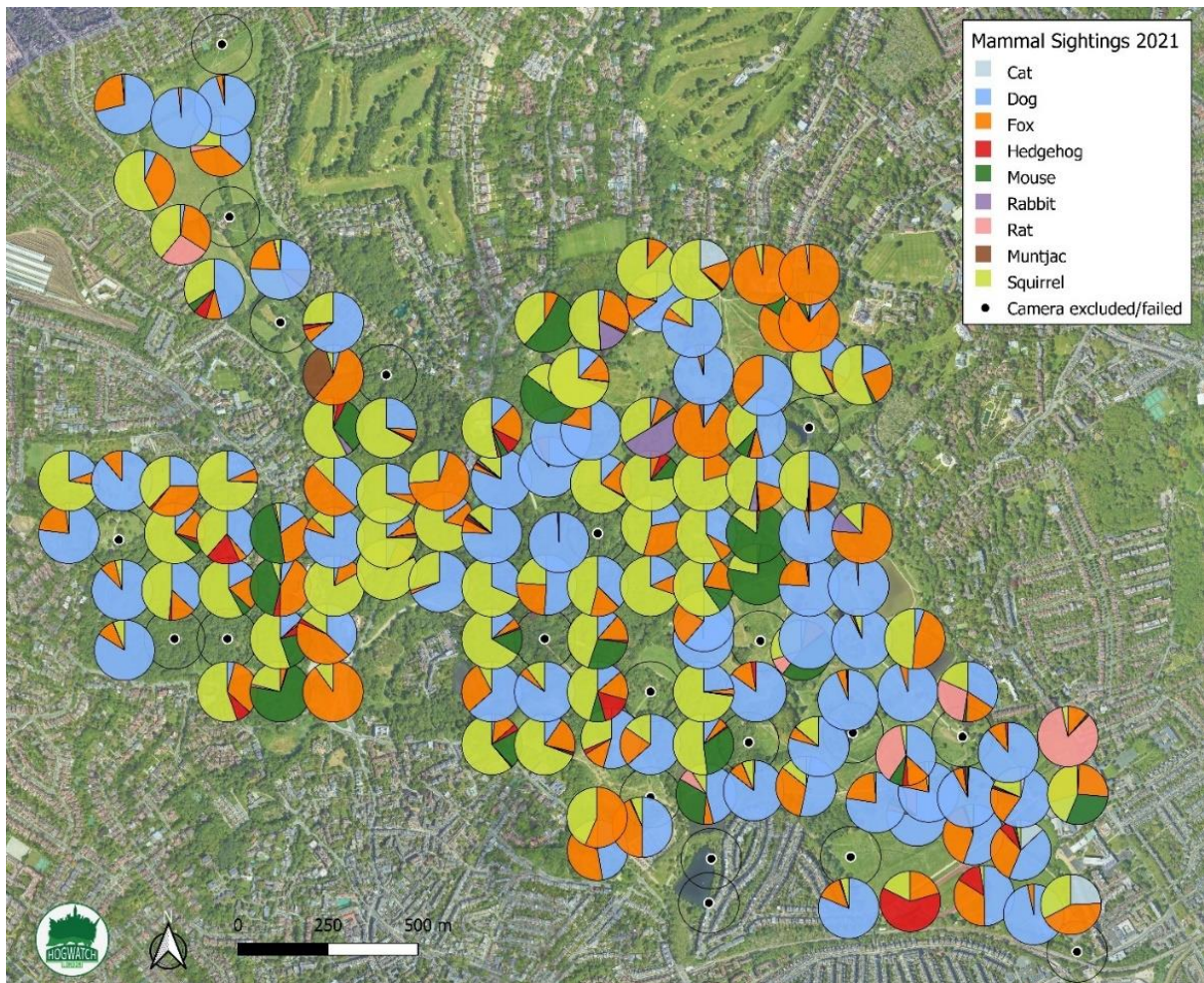
Figure 3. Pie charts indicating the ratio of mammal species recorded in the 2021 Hampstead Heath survey. Black indicates cameras which either failed or were excluded.
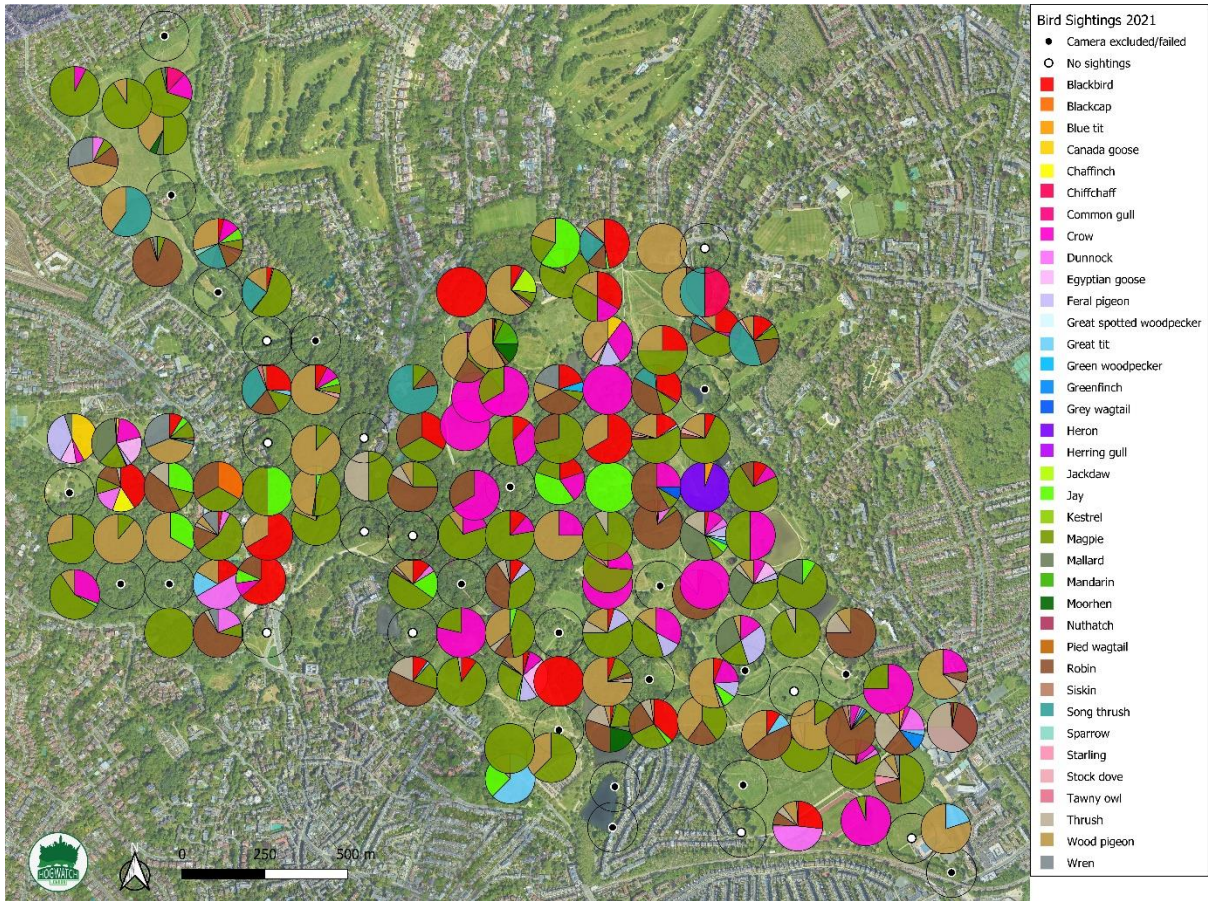
Figure 4. Pie charts indicating the ratio of bird species recorded in the 2021 Hampstead Heath survey. White indicates an absence of species and black indicates cameras which either failed or were excluded.

Figure 5. Comparison of hedgehog activity between the 2018 (dark red) and 2021 (light red) Hampstead Heath surveys, scaled for trap rate. White indicates an absence of hedgehogs and black indicates cameras which either failed or were excluded.
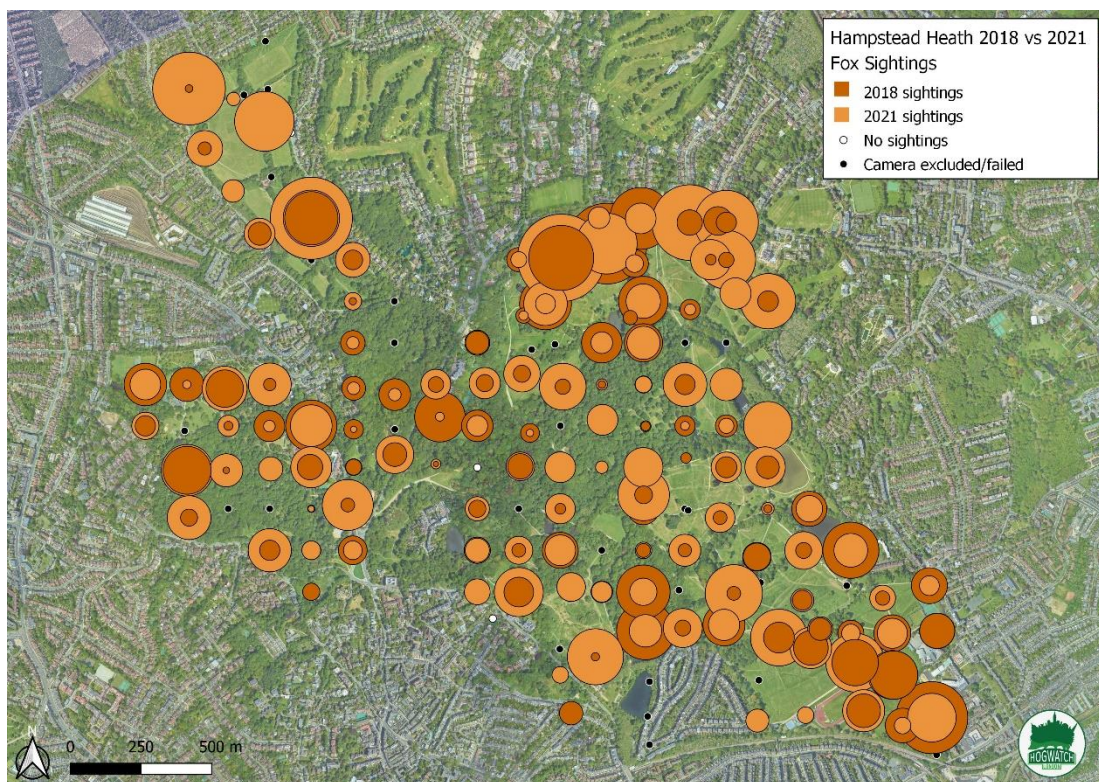

Figure 6. Comparison of fox activity between the 2018 (dark orange) and 2021 (light orange) Hampstead Heath surveys, scaled for trap rate. White indicates an absence of foxes and black indicates cameras which either failed or were excluded.
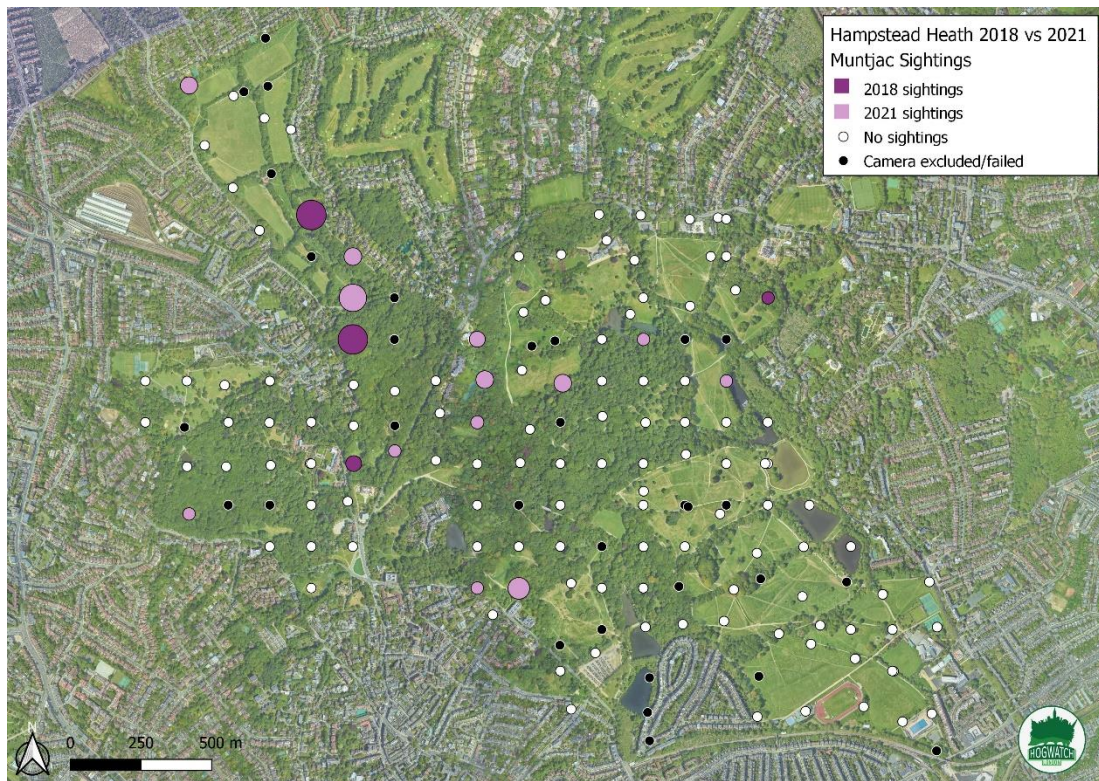
Figure 7. Comparison of muntjac activity between the 2018 (dark purple) and 2021 (light purple) Hampstead Heath surveys, scaled for trap rate. White indicates an absence of muntjac and black indicates cameras which either failed or were excluded.
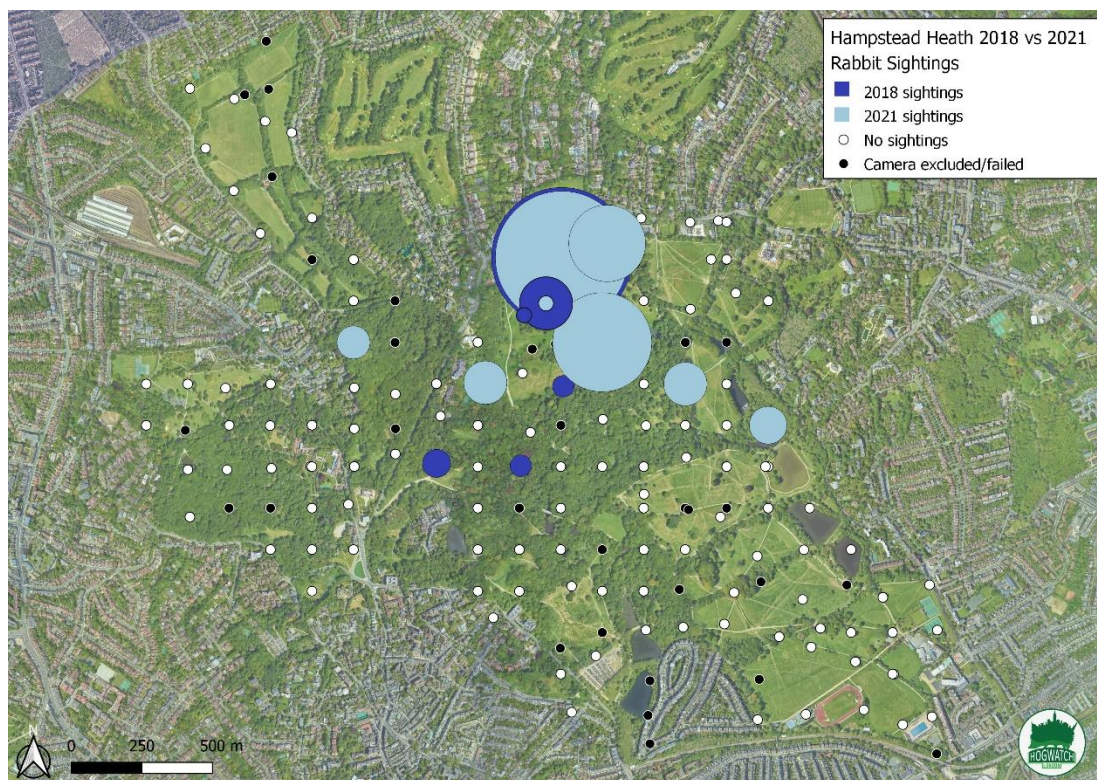

Figure 8. Comparison of rabbit activity between the 2018 (dark blue) and 2021 (light blue) Hampstead Heath surveys, scaled for trap rate. White indicates an absence of rabbits and black indicates cameras which either failed or were excluded.

Discussion

Hedgehogs

The results of the 2021 Hampstead Heath survey are positive, with 321 individual sightings and an overall trap rate of 0.11 (Table 1). The distribution of hedgehogs was also widespread across the Heath, with hedgehog sightings recorded on 44% of the cameras. Although these values are lower than the 2018 survey results, there were several changes in methodology between the surveys, which may have contributed to the levels of detection. However, the 2021 results are still amongst our highest recorded values for hedgehogs within a green space in Greater London. As such, these results show that Hampstead Heath is supporting a robust population of hedgehogs and continues to be a critical site for hedgehog conservation in London.

Our results often show that smaller, well-connected residential green spaces generally provide more suitable habitats for hedgehogs than in the larger public ones. As such, it is exciting to observe such high levels of sighting rates of hedgehogs and to see that they are widely distributed across Hampstead Heath. One reason why the Heath may be capable of supporting a large population of hedgehogs is its size. Many of the parks and green spaces we survey in the Greater London area are significantly smaller than Hampstead Heath. Research suggests that the required habitat size necessary to support a minimum viable population of hedgehogs is around 90ha[15]. The Heath is more than three times this size, which may be allowing it to sustain a robust hedgehog population.

Hampstead Heath also has a wide variety of habitat types which may also be supporting its hedgehog populations. The habitats in the Heath include acid grassland, heathland, woodland, wildflower meadows, streams, and a significant number of lakes and ponds[16]. This level of habitat diversity is likely providing hedgehogs with a wide range of food and water sources as well as safe places to hide and nest. The Heath also has over 4km of hedgerows, which can act as important wildlife corridors and refuges for hedgehogs. The trapping rates for hedgehogs appeared highest in the southern and western sections of the Heath. Specific hotspots include the bottom of Parliament Hill (near the athletics track and cricket ground), around the Viaduct Pond, the West Heath and Golders Hill Park, and the Hampstead Heath extension. The results from 2018 showed a similar trend, as there the highest hedgehog activity was in the south-eastern corner near the lido, although the recorded levels in this area decreased slightly in 2021. The high number of hedgehogs sightings recorded in Hampstead Heath compared to other areas we have surveyed in London emphasises Hampstead Heaths importance as a stronghold for hedgehogs in North London. Findings show there is a greater occurrence and activity of hedgehogs along the Heath boundaries. This information combined with London HogWatch's previous camera trap surveys, in Golders Hill Park and Fitzroy Park Allotments, combined with records from the Big Hedgehog Map[6], suggest there is hedgehog movement from the Heath into nearby residential gardens and other greenspaces. As such, the Heath could be acting as a source of hedgehogs for surrounding areas, aiding hedgehog conservation across the wider region. This highlights the importance of improving habitat corridors around the perimeter of the Heath and across sites surrounding it (e.g., Holly lodge Estate).

Hampstead Heath is surrounded by several SINCs and other urban greenspaces (like the Fitzroy Allotments) which have the potential to support hedgehog populations. Although hedgehogs can migrate on average 3km per night in search of food and a mate, they have relatively poor dispersal abilities in urban areas. The presence of barriers such as roads and walls/fences can often prevent them from accessing areas that would otherwise be suitable[17]. To extend and strengthen the population connectivity between Hampstead Heath and these spaces would need to be improved to facilitate the dispersal of hedgehogs between them. Additionally, future surveys could be targeted to areas not previously surveyed, such as to the south and east of the Heath. This would help identify the dispersal of hedgehogs from the Heath into surrounding areas and monitor the impact of introducing habitat connectivity schemes.

Foxes

Foxes were widely distributed across the survey area and sighted at 93% of the camera sites (125 cameras, Table 2). They also had the second highest trap rate of all species found in the 2021 survey, just after dogs with a trap rate of 1.45 (Table 2). In comparison to 2018 (Table 4), across the same number of sites, fox presence increased from 90% to 95% in 2021, and the overall trap rate was higher. It is important to note that the 2018 tagging interval was from 6pm-8am and in 2021 it was 24 hours a day, which may have influenced the results. However, foxes are a nocturnal species, meaning it is less likely that the differences in methodology have influenced the results as much as for diurnal species.

The distribution of foxes in 2018 and 2021 was very similar. The site trapping rates in 2021 (Figure 6) suggest that foxes may be favouring areas around the edges of the Heath, in the northern and southern edges of the Heath. This is similar to what we found in 2018 that fox activity reduced as distance to edge increased[18]. Specific hotspots were Hampstead Heath extension, lower part of Parliament Hill, Athlone House gardens, Kenwood Nursery, and the northern area of Kenwood House. This preference for the edges of the Heath could be due to the proximity of human housing. Foxes are a highly adaptable species and show little negative effects to anthropogenic activity. For example, residential areas often act as a good source of food and den sites for foxes. Their prevalence across the Heath suggests their presence is not affected by different habitat preferences and show they have strong ecological flexibility. It is unlikely that the fox presence in the Heath has an impact on the hedgehog population. Foxes are found throughout London, even in places with high hedgehog numbers. Although they have overlapping diets, which could suggest the potential for food competition, there is little evidence that fox presence has a significant impact on hedgehog populations.

Muntjac

Muntjac were sighted at 10% of the camera sites (14 cameras, Table 2) and had a comparatively low trap rate of 0.011 to other mammal species found. In comparison to 2018, across the same number of sites, muntjac presence in the heath doubled from 5% to 10%. However, again, it is important to consider this finding in the context of differences in methodology between the two years, particularly as muntjac can be both diurnal and nocturnal (Table 4).

Distribution between the two years differed slightly. In 2018 site trapping rates suggest muntjac had greater presence in the western area of the Heath, however in 2021 they were more widely distributed in northern, southern, and north-eastern sections of the Heath (Figure 7). Specific hotspots in 2021 were in the woodland in Hampstead Heath Extension and North End. Interestingly, findings from both years suggest that muntjac seem to be found in more densely vegetated areas such as woodland, and less in more open landscape which tend to be more human-dominated areas of the heath, such as Parliament Hill Fields.

Rabbits

Rabbits were sighted at 7% of the camera sites (9 cameras) and had a trap rate of 0.091 (Table 2). In comparison to 2018, rabbit presence in the heath was similar at 5% and the overall trap rate increased slightly from 0.06 to 0.10 (Table 4). Again, it is important to consider this finding in the context of differences in methodology in the two years. However, rabbits are known to crepuscular, meaning that they are most active at dusk and dawn meaning changes in methodology may have had less of an effect on differences in findings seen between surveys.

Distribution between the two years differs slightly. In 2018 site trapping rate maps suggest rabbits were found in the central woodland of the Heath leading up to the north near Kenwood House (Figure 8). In 2021, results suggest rabbit distribution seems to have expanded. Although still found predominantly in the north, some rabbits were also seen further east in North End and further west near Highgate Gate. Specific hotspots in 2021 were in the West Meadow, Springetts Wood, and near

Kenwood House. This distribution suggests a preference for woodland and meadows. Additionally, Kenwood Estate is the only part of the Heath where access in early morning and evening, preferred rabbit feeding times, is restricted. It is also one of the few areas where fencing protects rabbit warrens adjacent to feeding meadows.

Conclusion

It is very encouraging that the 2021 Hampstead Heath survey has shown the continued presence of a robust and widespread hedgehog population in the Heath. While the sighting rates were somewhat lower than in 2018, the Heath has some of the highest numbers recorded from across Greater London. Due to the Heath's size and potential connectivity to wider areas, we believe it supports the largest population we have found in London to date and indicates the importance of Hampstead Heath as a stronghold for hedgehogs in north London.

Although methodological differences mean the slight decrease between 2018 and 2021 may not be significant, it would still be beneficial to conduct repeat hedgehog surveys in the Heath. This would facilitate the continued assessment of hedgehog population trends within the Heath. The sharp decline of hedgehog numbers in nearby parts of London, such as the Regents Park population, highlights the importance of continuously monitoring hedgehog populations.

One of the most beneficial hedgehog conservation measures to be implemented from this survey would be improving the connectivity between Hampstead Heath and its surrounding residential areas and green spaces. The Heath has a continued strong population of hedgehogs and has the potential to act as a source of hedgehogs in nearby greenspaces. Schemes such as the creation of hedgehog highways, which is where a 13cm hole is created in a wall or fence to permit hedgehog movement, could be introduced around the Heath and the residential areas bordering it to improve the habitat connectivity. This would allow the resident hedgehog populations increase in size and expand their distribution, promoting hedgehog conservation within the Heath and beyond. Additionally, looking to the future, it would be interesting to continue to conduct surveys in greenspaces surrounding the Heath. This would help increase our understanding of hedgehog dispersal and movement from the Heath into surrounding residential areas and other green spaces. Surveys could be focused in areas to the south and west of the Heath. These are near the main hotspots of hedgehog activity found in this surveyed and have not been surveyed before.

It is also encouraging to see such a range of mammal and bird species within Hampstead Heath. An incredible number of 50 species were detected in the 2021 survey, 17 of which are of UK conservation concern[14]. The presence of indicator species such as field voles and birds of prey, which we rarely find in our London surveys, highlight the importance and wealth of biodiversity found across the Heath and the need for its continued protection. The presence and abundance of urban wildlife here, reflects the ongoing conservation efforts made within Hampstead Heath. We highly encourage these efforts to continue to support the hedgehog population and wider biodiversity.

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Appendix

Appendix A. Fox distribution based on sightings from the 2021 Hampstead Heath survey, scaled by trapping rate (larger orange circles = higher fox trap rate). White indicates an absence of foxes and black indicates cameras which either failed or were excluded.
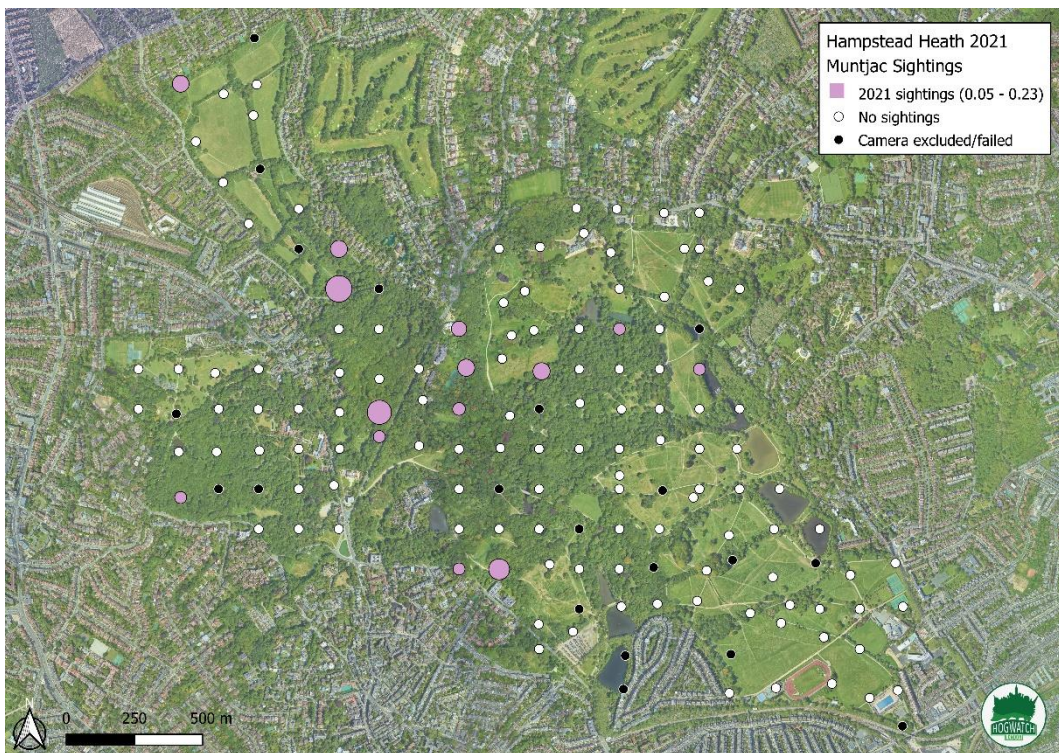
Appendix B. Muntjac distribution based on sightings from the 2021 Hampstead Heath survey, scaled by trapping rate (larger purple circles = higher muntjac trap rate). White indicates an absence of muntjac and black indicates cameras which either failed or were excluded.
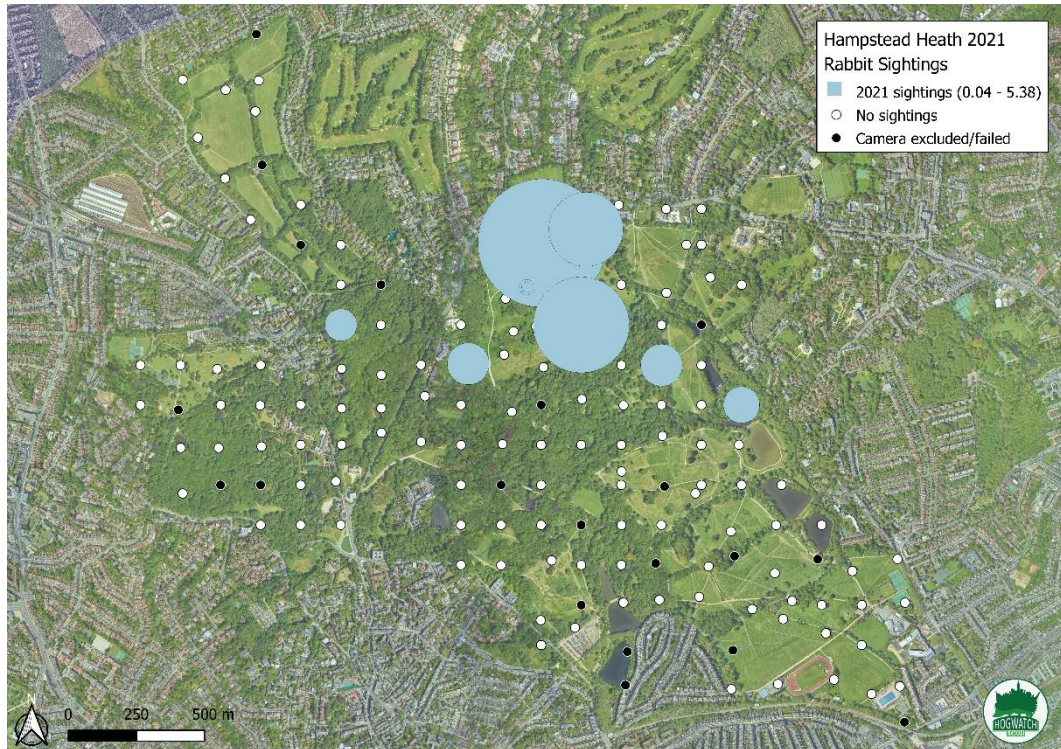
Appendix C. Rabbit distribution based on sightings from the 2021 Hampstead Heath survey, scaled by trapping rate (larger blue circles = higher muntjac trap rate). White indicates an absence of rabbits and black indicates cameras which either failed or were excluded.