FOOTPRINT ECOLOGY

Hart, Rushmoor and Surrey Heath SPA Mitigation Project: Access Management Research Study.

Chris Panter & Durwyn Liley

FOOTPRINT ECOLOGY, FOREST OFFICE, BERE ROAD,
WAREHAM, DORSET BH20 7PA
WWW.FOOTPRINT-ECOLOGY.CO.UK
01929 552444

Footprint Contract Reference: 600
Date: 25th September 2020
Version: Final
Recommended Citation: Liley, D. & Panter, C. (2020). Hart, Rushmoor and Surrey Heath SPA Mitigation Project: Access Management Research Study. Unpublished report by Footprint Ecology.

Cover photo TBHP https://www.instagram.com/tbhpartnership/

Summary

The strategic mitigation scheme for the Thames Basin Heaths SPA is long-running and has been successful in allowing sustainable housing growth while ensuring protection for the European sites. The scheme has successfully delivered greenspace sites (Suitable Alternative Natural Greenspace – SANGs) that are clearly well used. However, SANGs delivery in the long-term is likely to be increasingly challenging given high land prices and a relative lack of potential sites in some areas. Opportunities for SANG delivery are reducing and there is concern that if the current approach of reliance on SANGs for avoidance and mitigation is not revisited, the challenges to SANG delivery in the future could ultimately result in a moratorium on new residential development in parts of the Hart, Rushmoor and Surrey Heath Housing Market Area. The three Councils have therefore been awarded funding from central government to undertake joint work to investigate and seek to implement alternative and complementary avoidance and mitigation measures.

Increasing the role of SAMM – Strategic Access Management and Monitoring – is one of a range of measures the Councils are exploring. SAMM measures funded to date included:

- Promotion of SANGs.
- On-the-ground wardening service to supplement existing wardening efforts.
- An SPA-wide education programme.
- Creation of new volunteering opportunities.
- Demonstration of best practice for strategic access management of visitors and visitor infrastructure where the supply of greenspace is heavily dependent on protected areas.
- Monitoring of visitor usage of SANGs and the SPA.
- Monitoring Annex 1 birds on SPA sites.

In this report we explore the potential for implementing access management measures as additional mitigation, instead of SANG. The report is structured to address the particular questions raised by the client authorities.

How expansion of the existing SAMM project would be effective as a mitigation measure

The Thames Basin Heaths Partnership SAMM team currently deploys over 12 full-time equivalent staff undertaking ranger duties during the spring and summer, and the ranger time averaged across the year is over 9 full-time equivalents. Warden time on-site is spread across the day but our analysis indicates there is scope for additional time to be focussed in the afternoon, or current warden effort shifted to the afternoon, in order to best match when visitors are present.

We estimate that around 5,000 hours warden time over a year (the approximate current level) could result (if deployment were perfectly matched to visitor numbers and distribution) in

around 28.4% of visitor groups coming into contact with a warden once and 19.8% if two encounters were the target. Current levels of wardening are such that a high proportion of very regular visitors are likely to be encountered over the year, but less frequent visitors (e.g. those visiting weekly or less) are likely to be missed. Modelling warden deployment based on current estimates of visitor numbers at different access points (and assuming wardens were deployed at or close to access points) suggests that focussing warden effort at busy access points is likely to result in the greatest number of visitor-warden encounters.

Use of social media indicates steady increase over time. The current maximum reach of social media is over 30,000 people, which is broadly equivalent to the number of individual groups that visit the SPA over a year. Social media clearly has an important role in extending the reach of the wardening team and some avenues have only just been opened. However, there is perhaps limited scope to further expand given the current level and rising trajectory.

Education work is primarily through a dedicated education officer whose work includes work directly with schools (visits to schools and to heaths), wildfire session in schools, promotion of alternative greenspace and engagement with community groups. There are at least 282 primary schools and 90 secondary schools within 5km of the Thames Basin Heaths SPA. Postcode from 2020 data indicates there are also around 333,000 residential properties (potentially with 800,000 residents) living within 5km of the SPA. These figures would suggest there is clearly a large audience for such work and potential for extra staff resources to expand the current reach.

The Thames Basin Heaths Partnership also run various events that culminate in Heath Week, at the end of July. This involves events and activities over a 7 day period and spread across the Thames Basin Heaths area.

Expansion of the SAMM could include:

- More warden focus towards afternoons;
- Extending the bird breeding season focus to include February;
- Greater focus on wildfires;
- Potential for wardens to have powers to enforce (e.g. dogs on leads) if necessary;
- More education provision., reaching more schools.

There is scope for more detailed spatial analysis and modelling to derive the optimal spatial and temporal coverage for the wardening. In order to facilitate this in the future, we suggest that wardens should on occasion keep detailed logs with explicit spatial data recording where they walk and how long they spend talking to different visitor groups in different locations.

Scope for implementation

Mitigation is currently delivered as a package, involving a suite of measures. This provides greater certainty as to effectiveness, as the different parts of the package address different impacts, dovetail and complement each other. Placing greater emphasis on one element (such as SAMM) at the expense of another (SANG) will reduce that level of confidence and risks undermining the approach as a whole.

Some options for dedicated funding, that could be easily costed as separate and additional to the current 'baseline' SAMM, could include:

- Access management infrastructure or other elements on the SPA or supporting areas that require significant one-off investment, for example art installations, cycling infrastructure, dog-related infrastructure;
- Temporary or pop-up, seasonal engagement material, such as mobile art installation or similar;
- Fire-related measures, for example fire management plans, hiring temporary fire wardens during fire risk periods or, as an example, in Dorset mitigation money has been used to fund fire hydrants and similar infrastructure;
- Specific projects relating to particular parts of the SPA and adjacent areas, for example access management plans, that could target local issues and help to ensure effective dove-tailing of SANG, SAMM etc.

We see a role for site-specific access assessments to help identify projects on the ground and particular measures, but only in specific circumstances. A range of access management measures are identified, with context as to where they are likely to be effective and the costs of different elements.

Potential capacity

We very cautiously suggest that there could be scope to increase the warden team by up to twice its current size and that this could provide additional mitigation. The current provision is a single warden for 374 new houses and the additional benefits of further wardening coverage will be ever decreasing, as such an additional 9 wardens could perhaps be sufficient to provide SAMM-type mitigation for 2,700 houses. It is important to recognise that this is estimated simply based on extending the current SAMM – which functions as part of a package of mitigation alongside SANGs. The additional mitigation is estimated in this context. There is no clear way to estimate additional capacity (using a formulaic approach) from increased education work, additional access infrastructure or other approaches that are discussed. The additional mitigation that might be achieved if greater weight were placed on these at the expense of SANG is very hard to calculate.

Contents

Summary ii
Contents v
Acknowledgements vi
1. Introduction 7
Overview 7
The Thames Basin Heaths SPA ('TBH SPA') 7
The need for this work 9
Report structure and approach 9
2. Aim 1 - To demonstrate how expansion of the existing SAMM project would be effective as a mitigation measure 12
Are there opportunities for additional work areas/expansion of existing elements of the SAMM project? 12
Face-to-face engagement: current levels *12*
Face-face engagement, models to test optimum levels *16*
Online engagement *22*
Education work *24*
Heath Week *25*
What locations could benefit from an expansion of the wardening, education or communication service? 26
Wardening *26*
Education work *37*
Whether specific aspects of the wardening, education or communication service could benefit from expansion and does this vary in different parts of the SPA? 39
Whether there is a point at which expanding the wardening, education and communication service no longer increases the degree of mitigation? 40
3. Aim 2 - To explore scope for implementing these measures 45
How the expansion of the project could be funded, and could funds be targeted to specific aspects of the project or particular parts of the SPA? 45
SAMM payments in context with SANG *47*
Could site-specific access assessments be used to target expansion of the project and/or define catchments for funding? 48
Are there particular areas where access management measures would be most effective? 50
What are the potential costs of delivering these potential measures? 54
4. Aim 3 - To consider the potential capacity of these measures 56
What would be the potential scale of mitigation achieved by expanding the SAMM project? 56
5. References 60
Appendix 1: Technical details relating to models and how models constructed 64
Modelling datasets used 64
SPA accessible area, patches and use of a 50m grid *64*

Data on parking locations *67*
SPA bird data *68*
Modelling access within sites *70*
Model predictions 71

Acknowledgements

This report was commissioned by Rushmoor Borough Council on behalf of the Rushmoor, Hart and Surrey Heath Councils. Our thanks to Miranda Petty (Rushmoor Borough Council) for overseeing the work and her help with sourcing data. Our thanks also to Simon Thompson (Natural England) for useful discussion and information. We are grateful to the following for providing us with information and data: John Eyre (2Js Ecology); Sarah Bunce (Thames Basin Heaths Partnership); Katherine Sydney, Dave Green and Matthew Parkhill (all LUC) for information sharing and helpful discussion.

1. Introduction

Overview

1.1 This report explores the potential for implementing greater access management measures in the Thames Basin Heaths Special Protection Area (SPA) as mitigation for new housing growth. The work considers the current levels of engagement, through wardening, education and communication; whether there are any gaps in current engagement and whether there is the possibility for further growth in engagement.

The Thames Basin Heaths SPA ('TBH SPA')

1.2 The TBH SPA (Map 1) is designated for the presence of Nightjar *Caprimulgus europaeus*, Woodlark *Lullula arborea* and Dartford Warbler *Sylvia undulata*. The SPA covers some 8,000 hectares of heathland and forestry, fragmented into separate blocks by roads, urban development and farmland. The SPA comprises 13 component Sites of Special Scientific Interest (SSSIs). The individual heaths are surrounded by an existing high level of housing, and are subject to heavy visitor pressure.

1.3 There is now a considerable body of evidence linking visitor access and urban effects to the abundance, distribution and breeding productivity of Annex 1 heathland birds. Research on the impact of disturbance on Woodlark population size (Mallord, Dolman, Brown, & Sutherland, 2007) shows birds avoid areas of high visitor pressure and they occur at lower densities in areas with higher densities of surrounding housing (Mallord, 2005). For Dartford Warblers, studies in Dorset (Giselle Murison et al., 2007) indicate breeding success is related to disturbance, with birds breeding less successfully in heather dominated territories with high levels of access. For Nightjars, there is a clear relationship between nest density and urban development, with lower nest densities on heaths (in both the Thames Basin Heaths and Dorset Heathlands) surrounded by high levels of housing (Liley & Clarke, 2003; Liley, Clarke, Mallord, & Bullock, 2006). Evidence suggests more people visit heaths surrounded by high levels of housing (see Murison 2002; Liley *et al.* 2006b; Clarke, Liley, & Sharp 2008a). In the absence of development/visitors it has been estimated that the Dorset and Thames Basin Heaths could support around 14% more nightjars (Clarke et al., 2008).

1.4 These studies have implications for additional development in the Thames Basin Heaths area, as the sites are protected by strict legislation. There are a number of ways to mitigate the impacts or avoid the problems associated with urban development and recreation, for example through the careful siting of new housing, through management of access on sites, or through the provision of alternative green space. Such approaches have been established strategically through the Thames Basin Heaths Delivery Framework (Thames Basin Heaths Joint Strategic Partnership Board, 2009) and are documented by relevant local authorities in respective planning documents and mini-plans. Within 400m of the TBH SPA there is a presumption against new development, while within 400m-5km the Delivery Framework recommends the provision of mitigation measures for all new development. Furthermore, large scale development proposals, beyond 5km and out to 7km may also be required to provide appropriate mitigation, considered on a case by case basis. These various buffers are shown in Map 1.

1.5 Pivotal to the measures to mitigate and avoid impacts of new development in the Thames Basin Heaths area is the provision of Suitable Alternative Natural Greenspace (SANGs). SANGs are provided on the basis of at least 8ha per 1,000 population. The creation of such additional greenspace provides opportunities for recreation, such as dog walking, drawing users who might otherwise visit the TBH SPA. SANGs[1] are also included in Map 1.

1.6 In 2018 there were 324,445 residential properties within 5km of the TBH SPA. Reviewing the previous 5 years, the data suggest an increase of around 4% (12,141 additional dwellings) since 2013, when there were 312,304 dwellings within 5km. The data suggest in the year 2017-2018 around 3,000 new dwellings were built within the zone. These data reflect the steady increase in housing around the SPA and the year-on-year growth. SANGs provision has kept pace with this growth and has been at least in line with the level of new housing growth (Liley, Panter, & Rawlings, 2015).

1.7 Alongside SANG provision has been access management measures ('SAMM' Strategic Access Management and Monitoring). SAMM measures funded to date included:

- Promotion of SANGs.
- On-the-ground wardening service to supplement existing wardening efforts.
- An SPA-wide education programme.

[1] SANGs data as provided by the TBH partnership in July 2020

- Creation of new volunteering opportunities.
- Demonstration of best practice for strategic access management of visitors and visitor infrastructure where the supply of greenspace is heavily dependent on protected areas.
- Monitoring of visitor usage of SANGs and the SPA.
- Monitoring Annex 1 birds on SPA sites.

The need for this work

1.8 The strategic mitigation scheme for the TBH SPA is long-running and has been successful in allowing sustainable housing growth while ensuring protection for the European sites. The scheme has successfully delivered greenspace sites that are clearly well used (e.g. Liley, 2015; Liley et al., 2015; Panter, 2017). Delivering SANGs is however proving to be a challenge given high land prices and relative lack of potential sites in some areas. Opportunities for SANG delivery are reducing and the Councils are concerned that if the current approach of reliance on SANGs for avoidance and mitigation is not revisited, the challenges to SANG delivery in the future could ultimately result in a moratorium on new residential development in parts of the Hart, Rushmoor and Surrey Heath Housing Market Area. In recognising this risk and the need to seek solutions that enable continued protection of the TBH SPA whilst delivering the needed housing growth, the three Councils have been awarded funding from central government to undertake joint work to investigate and seek to implement alternative and complementary avoidance and mitigation measures.

Report structure and approach

1.9 This report directly relates to access management measures as a potential approach to achieving additional mitigation. Other reports – produced in parallel to this one – address other potential mitigation measures, with separate reports covering Dog Controls, Access Restrictions and Parking Controls.

1.10 In this report we consider how the implementation of further access management (i.e. a greater focus on SAMM) would be effective as a mitigation measure, exploring the scope for implementing further measures and estimating the capacity of such measures.

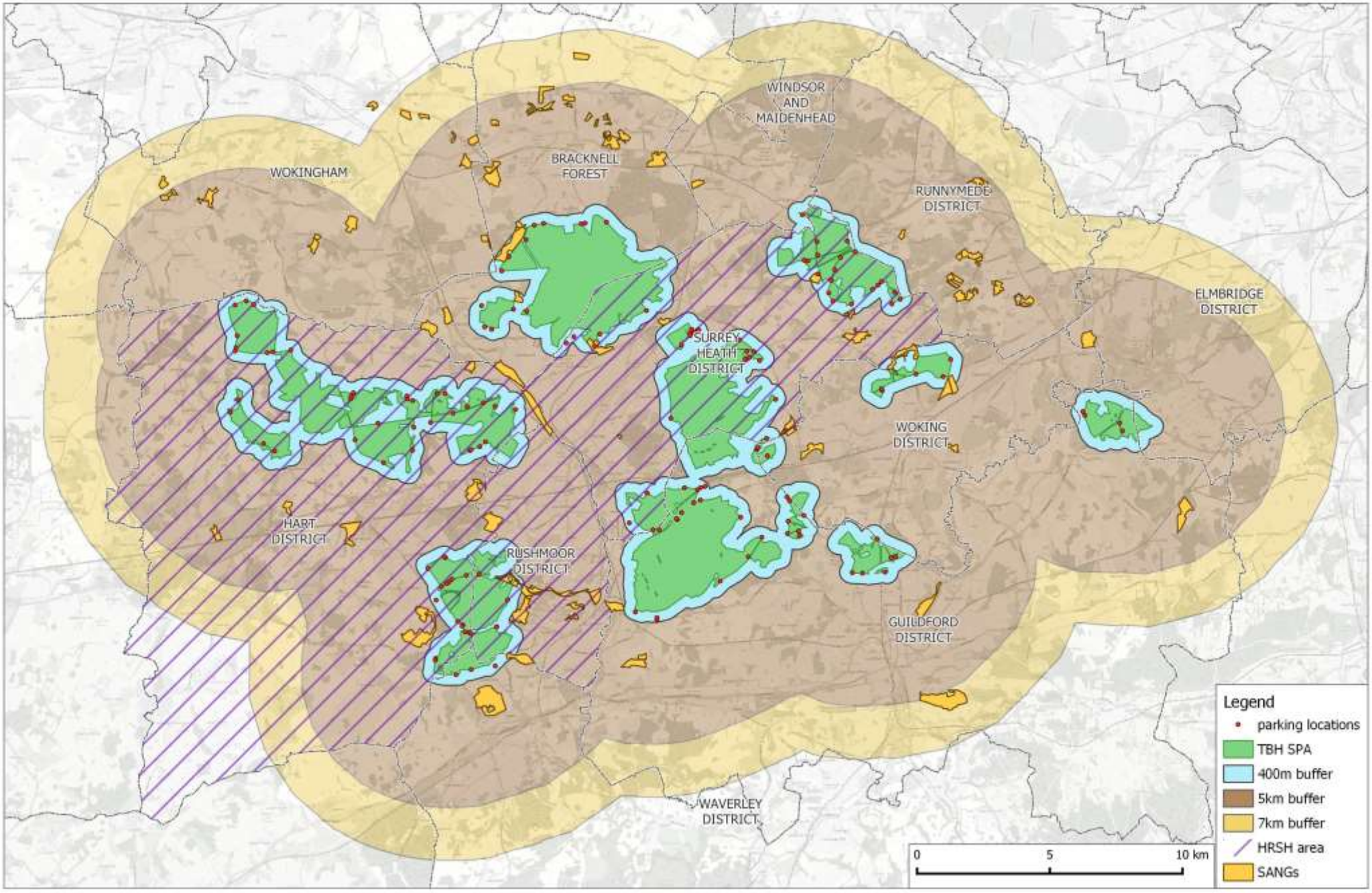
1.11 The report is structured to address particular questions set by the three councils, namely:

- Aim 1 - To demonstrate how expansion of the existing SAMM project would be effective as a mitigation measure

    - Are there opportunities for additional work areas/expansion of existing elements of the SAMM project?
    - What locations could benefit from an expansion of the wardening, education or communication service?
    - Whether specific aspects of the wardening, education or communication service could benefit from expansion and does this vary in different parts of the SPA?
    - Whether there is a point at which expanding the wardening, education and communication service no longer increases the degree of mitigation?
- Aim 2 - To explore scope for implementing these measures
    - How the expansion of the project could be funded, and could funds be targeted to specific aspects of the project or particular parts of the SPA?
    - Could site-specific access assessments be used to target expansion of the project and/or define catchments for funding?
    - Are there particular areas where access management measures would be most effective?
    - What are the potential costs of delivering these potential measures?
- Aim 3 - To consider the potential capacity of these measures
    - What would be the potential scale of mitigation achieved by expanding the SAMM project?

1.12 We address each question in turn and draw on a range of data sources and analysis which are explained in the relevant section.

Map 1: Thames Basin Heaths SPA, buffer zones, the HRSH area and main parking locations.



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

2. Aim 1 - To demonstrate how expansion of the existing SAMM project would be effective as a mitigation measure

Are there opportunities for additional work areas/expansion of existing elements of the SAMM project?

Face-to-face engagement: current levels

2.1 The current SAMM team consists of 6 wardens employed full-time and an additional senior warden/comms lead who is also full-time, but spends less time out on site undertaking ranger duties. In addition, the Thames Basin Heaths Partnership employs 6 seasonal staff each year, during the spring/summer. This means that during the spring/summer there are over 12 full-time equivalent staff undertaking ranger duties and the time averaged across the year is over 9 full-time equivalents. The SAMM team's roles also extend beyond wardening, for example one of the team has an education role and the team has also recently recruited a data analyst.

2.2 Warden time is spread across the SPA and a rota drawn up monthly, with the previous month's rota used to inform the next month, allowing any gaps in coverage from the previous month to be filled. The rotas allocate staff to particular sites on a half-day basis, with each warden usually working on their own and roaming the allocated site (i.e. roaming the paths on the site) and then switching at lunchtime. When wardens are using branded vehicles they try to park these prominently and use main car parks, but otherwise they will park at a range of car parks including quieter ones. Different wardens tend to have preferences as to where they park and focus their time. The only parking locations that are avoided are two locations where there are known anti-social behaviour issues, near the A3.

2.3 There is no set approach to allocate time according to visitor numbers, instead the rotas and planning are based on the teams knowledge and experience. The rota is planned to ensure good geographic coverage with some flexibility to respond to particular circumstances, for example MOD site closures which might deflect visitor use to other locations.

2.4 In addition, pit-stops are held at car parks and mini pit-stops away from car parks. These involve the wardens being static with a small gazebo and greeting all people passing.

2.5 At quiet sites, the wardens aim to speak to everyone, at busy sites some users will be particularly targeted, for example dog walkers with dogs off-lead or (during hot, dry weather) visitors having picnics or barbeques. The expectation is that the wardens will spend as much time as possible talking to visitors and engaging with visitors. Only when it is quiet will other tasks (such as bits of monitoring, taking photographs etc.) be undertaken.

2.6 The wardens carry leaflets to hand-out to visitors, there are 2 core bits of information: a leaflet that explains about sensitive species and general good behaviour, and then a directory of SANGs. Sometimes there is also site-specific information available which the wardens hand out, for example leaflets produced by the landowner/manager.

2.7 The warden logs summarise 131 formal events or pit-stops on the SPA and adjacent sites between 2015 and 2019 (Figure 1). These have been spread over a wide geographic area and, as Figure 1 shows, spread in time too. A total of 56 (43%) of the formal events/pits stops were at weekends. A breakdown of pit stops and formal events at locations are summarised in Table 1. It can be seen that 91 pit stops have been held 2015-2019.

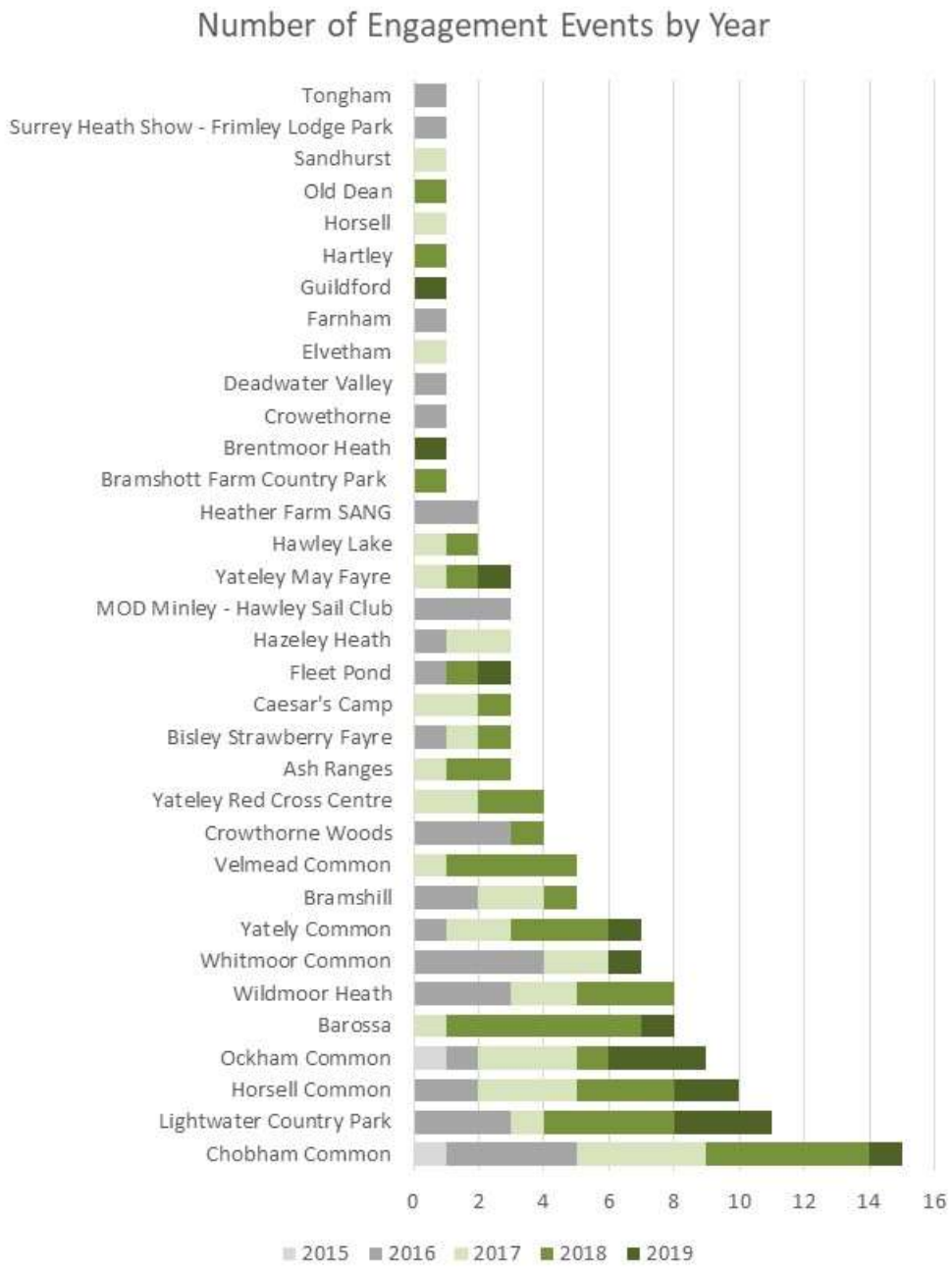


Figure 1: Combined number of 'pitstop' and formal event engagement-days carried out each year by TBHP between 2015 and 2019, by location. Note totals for 2015 and 2019 are incomplete.

Table 1: Number of 'pitstop' and formal event engagement-days carried out by TBHP between 2015 and 2019, split by location. The largest 5 values in each column are shaded grey. Note that partial data were only available for both 2015 and 2019. Locations outside the SPA are italicised.

Location	Event	Pitstop	Total
Ash Ranges	0	3	**3**
Barossa	1	7	**8**
Bisley Strawberry Fayre	3	0	**3**
Bramshill	0	5	**5**
Bramshot Farm Country Park	1	0	**1**
Brentmoor Heath	0	1	**1**
Caesar's Camp	1	2	**3**
Chobham Common	1	14	**15**
Crowthorne	1	0	**1**
Crowthorne Woods	2	2	**4**
Deadwater Valley	1	0	**1**
Elvetham	1	0	**1**
Farnham	1	0	**1**
Fleet Pond	3	0	**3**
Guildford	1	0	**1**
Hartley	1	0	**1**
Hawley Lake	0	2	**2**
Hazeley Heath	0	3	**3**
Heather Farm SANG	2	0	**2**
Horsell	1	0	**1**
Horsell Common	0	10	**10**
Lightwater Country Park	1	10	**11**
MOD Minley - Hawley Sail Club	0	3	**3**
Ockham Common	0	9	**9**
Old Dean	1	0	**1**
Sandhurst	1	0	**1**
Surrey Heath Show - Frimley Lodge Park	1	0	**1**
Tongham	1	0	**1**
Velmead Common	0	5	**5**
Whitmoor Common	0	7	**7**
Wildmoor Heath	0	8	**8**
Yateley May Fayre	3	0	**3**
Yateley Red Cross Centre	0	4	**4**
Yateley Common	3	4	**7**
Total	**32**	**99**	**131**

2.8 Wardening effort is currently spread across the day (green bars on Figure 2). Warden effort does not however appear to match visitor use, with average data across the sensors (orange line on Figure 2) indicating that visitor numbers are high in the afternoon and evening, when wardening effort is low. This would suggest there is potential to adjust warden effort to more closely dovetail with visitor use and that any increased wardening effort would be best focussed towards the afternoon/evening, especially on long summer evenings. The late afternoons and evenings on long summer evenings can be particular times when large groups might gather and potentially have evening camp fires.

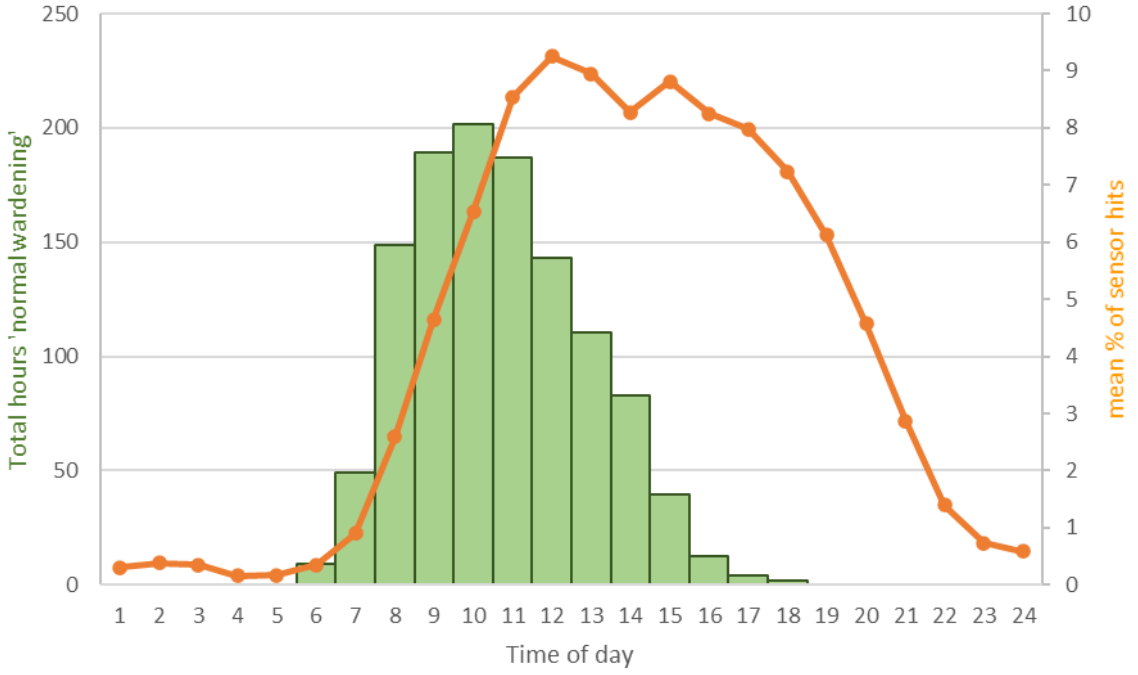


Figure 2: Warden hours (green bars, from normal wardening in warden log, covering January-August 2019) and sensor data (all sensor data 2016-2017, all months).

Face-face engagement, models to test optimum levels

2.9 One way to consider the potential for further face-face engagement from wardens is to estimate the percentage of visitors that can be spoken to with different levels of warden coverage.

2.10 Our first approach was to assume:

- Wardens undertook shifts of 3.5 hours and undertook 2 shifts per day;
- A total of 2,487,110 groups visit the SPA per year, this is from our modelling work (see Appendix 1 for details);
- Visit frequencies matched those in Southgate *et. al.* (2018) with 35.2% visiting daily (i.e. making roughly 300 visits per year), 34.4% visiting 2-3 times per week (roughly 125 visits per year), 12.7% visiting weekly (roughly 50 visits per year) and 6.4% visiting monthly (roughly 10 visits per year);
- The likelihood of a warden encountering an individual was purely based on the individuals frequency of visit and warden coverage was 'perfect' so as to match exactly the level of use and distribution of visitors.

2.11 In Figure 3 we show how the percentage of SPA visit groups spoken to by a warden might change with ranger effort. The different lines reflect different levels of interaction, with the blue line showing the % of visitors that would be spoken to once, the orange line visitors spoken to twice and the grey line visitors spoken to 5 times. The plot is based on the assumption that ranger effort would be spread across the SPA and that they would always achieve speaking to 3.59 groups per hour. This is the based on the maximum rate of warden-visitor interactions from recent wardening logs, at Horsell Common in 2017-2018.

2.12 The relationship between the percentage of visitors engaged and ranger time is not linear, as some visitors are infrequent visitors and as such will be less likely to be encountered than those, for example, that visit daily.

2.13 The current level of warden time during the period March 1st to mid-September could be in the region of 11,000 hours[2], if warden time was almost solely spent out on site. Figures from 2019 from the Thames Basin Heaths Partnership indicate around 3,300 hours of warden time were spent on the SPA January to August. Rounding this to a year would suggest around 5,000 hours of warden time on site at current levels. Based on our plot such an annual level of coverage could achieve around 16.6% of visitor groups being spoken to once, or 10% spoken to twice or 4% spoken to five times.

[2] This is based on 12 full-time equivalent staff over the period 1st March – mid September, during which there are potentially 137 working days. We have allowed 10.8 days for statutory holiday, 2 days for training and 2.4 days sick leave, giving around 913 hours per warden.

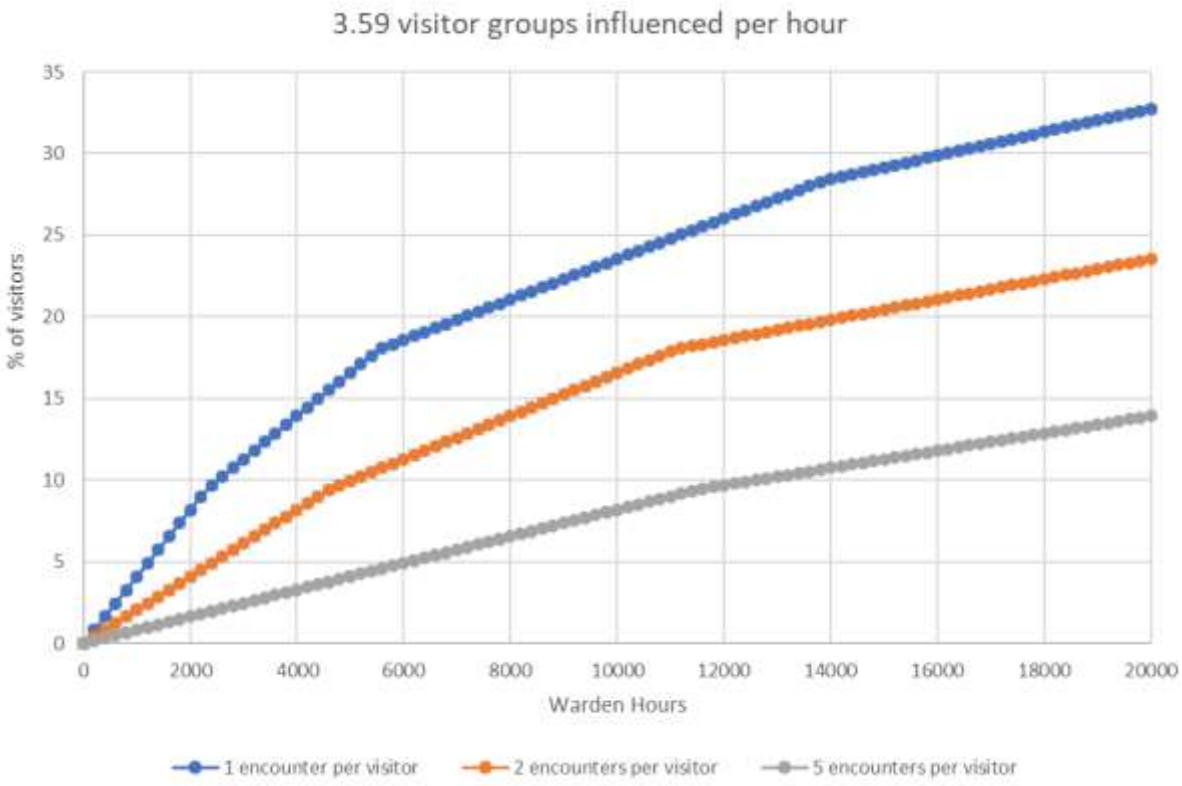


Figure 3: Percentage of visitors engaged with, in relationship to warden time. Plots based on assumption that warden could achieve speaking to 4 different groups per hour. The different lines reflect different degrees of targeting, i.e. how many repeat interactions with a given visitor group.

2.14 A similar plot is shown in Figure 4. Here the plot is derived using the same approach as Figure 3, however here we assume that a warden can influence 10 visitor groups per hour, rather than 3.59 per hour. Each hour the warden is assumed to influence a different 10 people and while this is perhaps an ambitious assumption, it is realistic if the influence of the warden extends to those who might merely see the warden or the warden's vehicle, rather than speak to them directly.

2.15 With this level of reach, it can be seen that around 5,000 hours warden time (the approximate current level) could result in around 28.4% of visitor groups coming into contact with a warden once and 19.8% if two encounters were the target.

Figure 4: Percentage of visitors engaged with, in relationship to warden time. Plots based on assumption that warden could achieve influencing 10 different groups per hour. The different lines reflect different degrees of targeting, i.e. how many repeat interactions with a given visitor group.

2.16 We do not know what proportion of SPA visitor groups need to be influenced to achieve a particular behaviour change. Based on both the two plots above however, it is evident that less additional benefit is achieved above somewhere around 5,000 hours and there is potentially some further flattening around 10,000 hours of annual warden time.

2.17 An alternative way of looking at this is to also consider the spatial warden deployment and therefore the interaction with visitors at individual access points. This allows us to test what the optimum strategy for spatial deployment might be, and allows us to consider the impact of warden time at quiet sites not necessarily achieving a high level of interactions.

2.18 We considered a range of scenarios, detailed in Table 2, which investigate the effect of different staffing levels and deployment options upon the number of visitor groups that can be interacted with across 744 identified access points during the SPA breeding bird season. The scenarios vary in:

- Staffing levels (12 versus 15 wardens deployed over the SPA breeding bird season);
- The number of wardens deployed at individual sites on a given day (1 or 2);
- The allocation of warden hours (either equal distribution of warden hours across all access points/sites, or organisation in fixed 3.5hr half-day shifts), and;
- The distribution of wardens across the 744 access points across the 6.5 month period (equally across all, randomly across a subset, or stratified across busier locations).

2.19 Warden hours/shifts were calculated assuming 137 work-days in the period 1st March to 15th September, with subtractions made for minimum statutory holidays (excluding Bank holidays), a proportional number of sick days (using online Office for National Statistics data for 2018), and 2 days of work-based training per individual in the period under scrutiny. These figures give a high level of wardening effort. Levels of visitor access at each point were derived from the visitor model (see Appendix 1). Group visits per hour were scaled up at each access point to cover a 12 hour daily visit window, before being multiplied across the 6.5 month SPA bird breeding season.

2.20 A cap of 3.59 warden-visitor interactions per hour was applied under each scenario, with the exception of scenario 5 (where it was doubled). This figure was then adjusted for visit rate, as at some access points the number of groups visiting during the period that the warden was present was lower than the maximum number of possible warden-visitor interactions. The overall percentage of groups across all access points which could be spoken to were then calculated under each of the scenarios.

2.21 Note that the scenarios do not take into account frequency of group visit and assume that the wardens are constantly interacting with visitors on site, where access levels allow. The scenarios also do not intrinsically allow for multiple interactions with the same individual visitor/group across the 6.5 month period.

Table 2: Maximum percentage of groups which wardens would be able to speak to across all TBH access points during the SPA bird breeding season (1st March to 15th September) under 8 different staffing scenarios. The dashed line indicates the break between those scenarios incorporating 12 and 15 wardens, respectively, with the largest two column values either side of the break indicated using dark (largest) and light (second largest) grey.

Scenario	Number of wardens deployed	Number of wardens per site	Warden-hours allocation	Distribution of wardens	A - Number of groups accessing point in SPA breeding bird season (6.5 months)	B - Number of groups accessing sites where/when warden present	C - Maximum number of warden-visitor interactions	D - Actual number of groups spoken to adjusted for access rate per access point	E - Overall percentage of groups spoken to ((D/A) x 100)
1	12	1	Equal hours	Equal distribution across all sites	1,790,560	11,102.57	39,350.35	37,972.79	2.1
2	12	1	Fixed shifts	Random distribution across subset of all sites	1,790,560	9,430.76	39,341.02	37,224.98	2.1
3	12	1	Fixed shifts	Allocated to busiest 98 sites accounting for 75% of hourly group access	1,790,560	84,271.63	39,342.27	39,342.27	2.2
4	12	1	Fixed shifts	Allocated to busiest 177 sites accounting for 85% of hourly group access	1,790,560	39,651.82	39,342.65	39,342.65	2.2
5	12	2	Fixed shifts	Allocated to busiest 98 sites accounting for 75% of hourly group access	1,790,560	63,211.17	78,684.54	78,684.54	4.4
6	15	1	Fixed shifts	Random distribution across all sites	1,790,560	12,368.21	49,179.41	45,927.88	2.6
7	15	1	Fixed shifts	Allocated to busiest 98 sites accounting for 75% of hourly group access	1,790,560	79,016.48	49,179.41	49,179.41	2.7
8	15	1	Fixed shifts	Allocated to busiest 177 sites accounting for 85% of hourly group access	1,790,560	49,565.89	49,179.41	49,179.41	2.7

2.22 With the exception of scenario 5, within which the number of wardens at a single access point were doubled, none of the scenarios resulted in warden interaction with >2.8% of visiting groups across all access points over 6.5 months. The use of fixed 3.5 hour shifts, rather than an equal allocation of staff hours, and the targeting of those access points with the greatest number of visitors, rather than a random distribution across all locations, led to the largest number of theoretical interactions. It is however noteworthy that the addition of 3 extra wardens only led to an increase in warden-visitor interactions of 0.55% under the stratified scenarios.

2.23 Ultimately the modelling suggests that the main limitation on warden-visitor interactions, after busier localities have been targeted, is posed by the use of single wardens at individual access points. It would potentially therefore be possible to reach a greater number of visitors by doubling up staff at busy locations, although this would also potentially lead to reduced geographic coverage.

Online engagement

2.24 The Thames Basin Heaths Partnership has a dedicated website[3], hosting their information about the project and the team, ways to get involved (including links to Heathland Hounds, the dedicated dogs project) and details of 'what's on'. A main page linked at the top of every page is the "how I can help" page. This details a bullet point list of responsible behaviour on the heaths. On this page the 6 most frequently used key words were: fire, bin (both 6 occurrences), paths (5), heathland (4), and dog (3).

2.25 The main social media avenues used in the SAMM engagement are Facebook, Twitter and Instagram. Social media was examined as of 18/06/2020.

2.26 The Thames Basin Heaths Partnership Facebook[4] page is a main mechanism, with 850 likes and 947 followers. A pinned post, uploaded the 26th May 2020 regarding BBQs on heaths, with a video showing the damage caused, reached approximately 29,900 people and had c.2,040 engagements. Another post at the start of the breeding season, (last day of February 2019) regarding ground nesting birds and dogs, reached around 34,000 people and

[3] https://www.tbhpartnership.org.uk/help/
[4] https://www.facebook.com/thamesbasinheathspartnership/

c. 2,150 engagements. These are the highest posts and others typically reach around 200-300 people. There are also links through to the Heathland Facebook page (a group with over 1,064 members). Membership of the Facebook page has grown steadily since 2017, with perhaps a slight indication of tailing off in recent months (Figure 5).

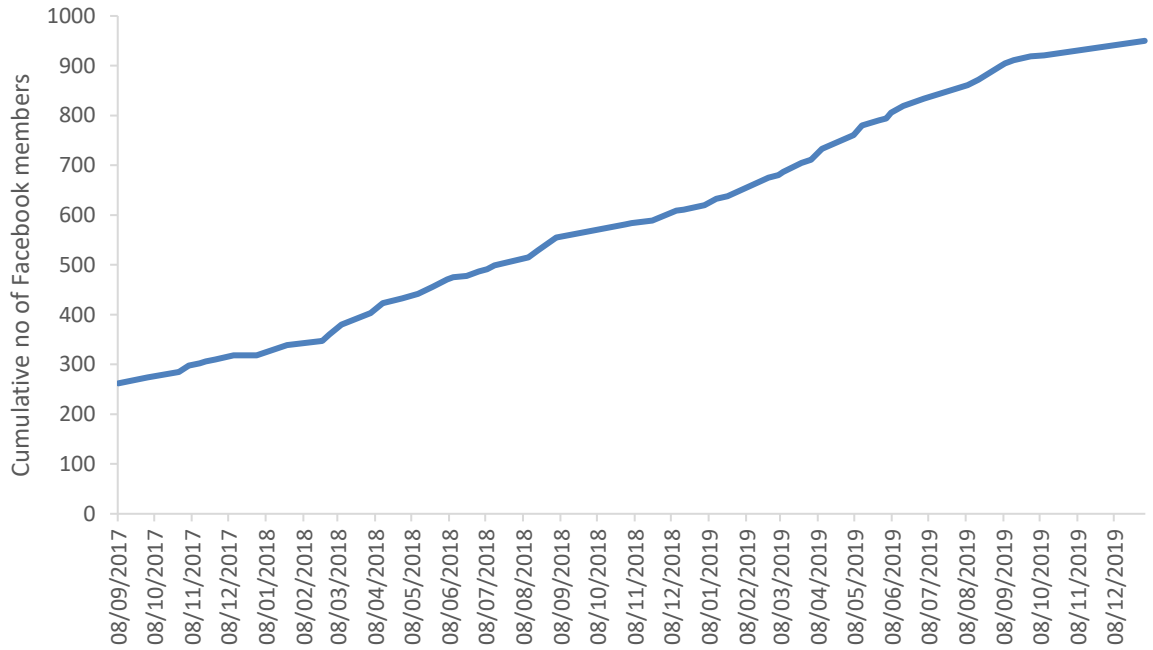


Figure 5: Increase in number of Heathland Hounds Facebook group members between September 2017 and December 2019

2.27 Social media is an increasing avenue for engagement. The partnership's Twitter has 608 followers (joined April 2015), and the Instagram was started only in February 2020 – with 202 followers (102 posts since then). The Heathland Hounds Instagram started at the same time and has gained 62 followers so far.

2.28 Some social media avenues could be expanded. For example, the Bird Aware Solent Instagram, running for around 3 years has 942 followers[5]. Their Facebook page has 1,288 likes and 1,424 followers and Twitter has 1,845

[5] https://www.instagram.com/bird_aware_solent/

followers. The Instagram of Dorset Dogs, running for around 4 years, has 721 followers.

2.29 Social media provides a means to extend the reach of the warden team, spread key messages and help reinforce existing messaging (e.g. Wheaton et al., 2016). There is however little evidence to show what level of interaction is necessary to change targeted behaviours. In one example, a study of food waste among supermarket shoppers in the UK (Young, Russell, Robinson, & Barkemeyer, 2017), a significant change in behaviour was found among those that received messages via social media or via an e-newsletter, while no significant change was found among those who received a printed newsletter. Of particular note however was the finding that the control group, whose interaction was only face-face at the supermarket, also changed their behaviour to the same degree. The inference is therefore that social media can extend reach but does not necessarily replicate enough of the effect of 'face-to-face' interaction to further change behaviour.

2.30 The current maximum reach from the Thames Basin Heaths Partnership social media is over 30,000 people – however this may include several individuals from the same household and members who do not even visit or live within the area. Nevertheless, the total is not far off the number of different groups that might visit the SPA over the course of a year[6]. Given the clear upwards trend and growing use of social media by the Partnership, there is a very important role for social media to play and it should feature prominently in the Thames Basin Heaths Partnerships future outreach work. Our findings would however suggest that there is perhaps little opportunity to further expand social media beyond the levels of current use and current trajectory. There may of course be new opportunities as new platforms emerge.

Education work

2.31 An education officer was appointed in October 2018 and their role covers:

[6] Our model estimates around 2,487,110 visits per annum to the SPA (i.e. visitor groups, not people). Interview data (Southgate, Brookbank, Cammack, & Mitchell, 2018) provides frequency data that can be used to estimate the number of individuals. For example, 35.2% visited daily, assuming 'daily' might equate to around 300 visits then, of the 2,487,110 visits, 876,313 would be made by 2,921 'daily' visitor groups. Extending this across all the frequencies gives a total of around 32,000 visiting groups.

- Curriculum-linked heathland focussed education (with sessions both in school and on the heaths). These started at primary level and link with a range of National Curriculum themses across Key Stage 1 and 2.
- Wildfire sessions (in consultation with the local fire service) with a standalone assembly and a session deliverable in PHSE lessons (both aimed at year 8).
- Promotion of alternative greenspace and encouraging local communities to get involved in connecting with local sites, e.g. through volunteering.
- Opportunities to engage with local community groups including Scouts, Beavers, etc.

2.32 Checks against the national schools database on the Department of Education website[7] indicates there are at least 282 primary schools and 90 secondary schools within 5km of the Thames Basin Heaths SPA. Postcode from 2020 data indicates there are also around 333,000 residential properties within 5km of the SPA. Assuming an occupancy of 2.4 this would suggest just under 800,000 people living within 5km of the SPA. These figures would suggest there is scope for outreach and potential to expand the level of community engagement and outreach.

Heath Week

2.33 The flagship event for the Partnership is Heath Week which runs at the end of July to tie in with the start of the school holidays. Dates are synchronised with the South-east Devon Habitats Regulations Partnership who run a similar event and use the same logo. The week includes a wide range of guided walks, children's activities and events across the Thames Basin Heaths area and involving a wide range of organisations. Examples and background to the week (including the virtual heath week in 2020) can be viewed on the Partnership website[8]. In 2019 there were 21 different events of a 7 day period. These included 14 guided walks, 6 themed activities and self-guided bingo trail. The walks/events covered botany, nightjar walks, a reptile roadshow with live animals (Amphibian & Reptile Conservation), moth trapping, arts & crafts for kids, K9 Fire Patrol, Heathland Hounds pitstops and free advice for dog walkers, conservation grazing, wildfire awareness.

[7] Data on all schools and colleges in England from .gov.uk website
[8] https://www.tbhpartnership.org.uk/heath-week/

What locations could benefit from an expansion of the wardening, education or communication service?

Wardening

2.34 In the previous section our modelling of different wardening scenarios indicated that there was potential to increase the level of warden coverage and that the number of visitor interactions would be maximised if wardens were paired (or increased their time) at busier sites. There is also an indication that the balance of time during the day could be shifted more towards the afternoon.

2.35 It is possible to consider the spatial distribution of engagement in more detail. The warden team log their time based on a broad location. These are shown in Map 2. In Maps 3 and 4 we show the level of warden time at each broad location, with the darker blue points indicting those locations with more wardening effort. Map 3 and 4 are similar, however Map 3 also shows current levels of housing and Map 4 shows housing change 2015-2020, with the darker shading indicating more housing or more housing change. Two further maps show wardening effort in relation to our model of current visitor distribution (Map 5) and bird data (Map 6). The modelling approach and background to the bird data are explained in Appendix 1, but in summary the visitor model spreads visitors across the site based on the data on how far people typically roam from access points. Finally Map 7 shows the levels of engagement by site.

2.36 The data are also summarised in Table 3, which gives the figures by site for mean visitor density, mean number of bird territories (per 50m cell used in our model) and various engagement metrics such as the number of people spoken to.

2.37 From these maps and Table 3 we can draw the following:

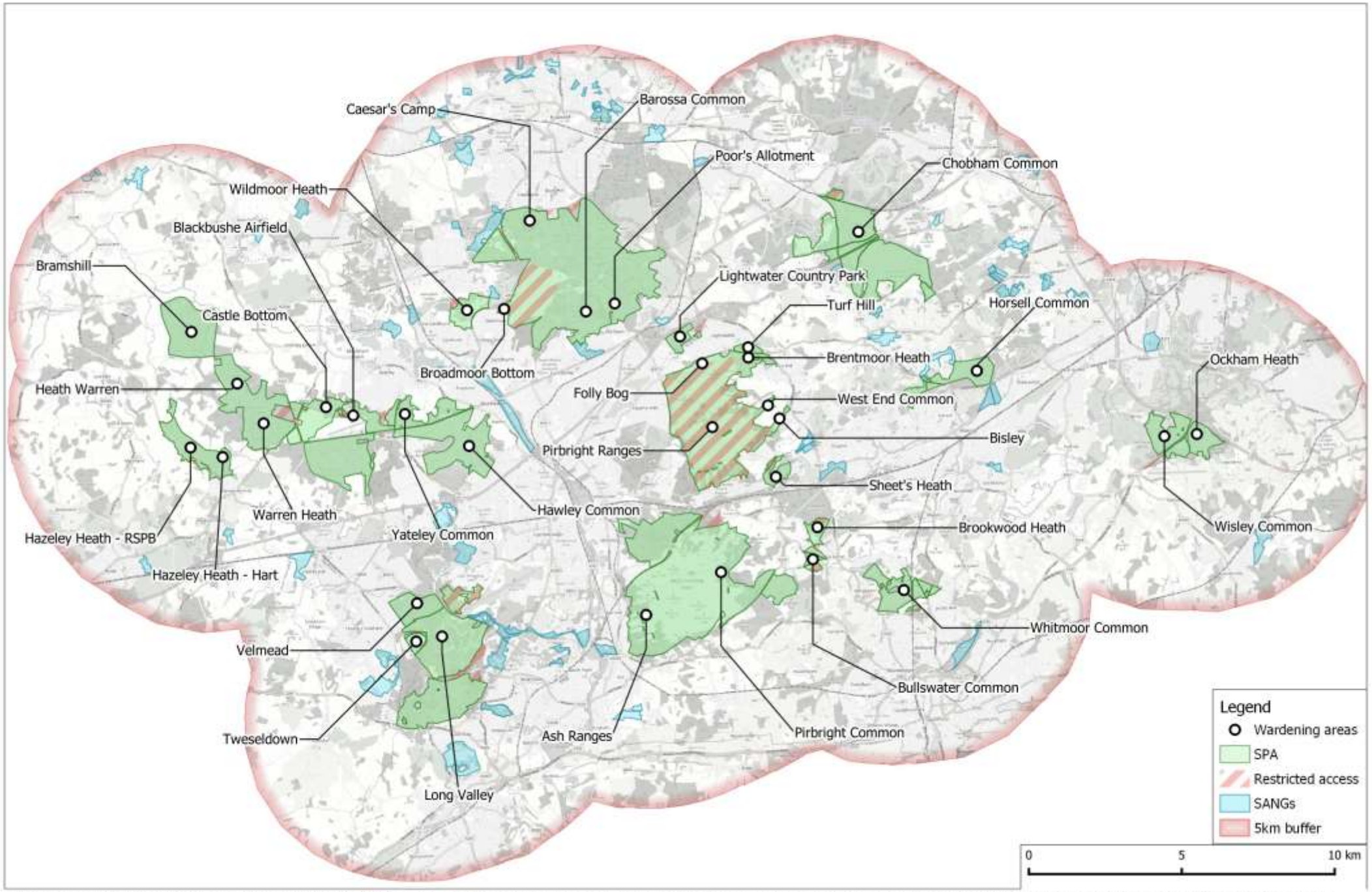
- Wardening time has been focussed in the areas with high densities of surrounding housing, for example Horsell Common, Caesar's Camp, and Crowthorne;
- Housing growth has been set back from the SPA (as would be expected given the 400m zone), so change in access will be diffuse, wardening effort seems to match the spatial distribution of change as far as can be expected;

- Generally, wardening effort seems to fit well with the spatial pattern of visitor footfall. Sites with few visitors and low densities have seen less warden effort (but have not been ignored), while the busy sites have seen the focus, and furthermore events and pit stops have been targeted at the busier locations. This fits with our modelling (which identified the merit in doubling up wardening effort at busy sites);
- However, there could be more refinement based on the exact relationship between the levels of access and warden time. For example, Broadmoor Bottom and Bisley Common have high levels of access, but little current warden time. While Bramshill and Warren Heath and to an extent Chobham have low levels of access, but a very large relative amount of warden time;
- It is interesting to consider warden time in relation to bird distribution as there is an argument that there is benefit to wardens spending time in areas with little or no bird interest (but otherwise suitable habitat) as these areas should be holding territories but we would expect wardening effort to be best targeted to areas with birds;
- In general wardening effort appears to tie in well with the distribution of birds, with sites such as Chobham Common (predicted as low access) that have fewer visitors than some other sites (but importantly high densities of birds) seeing high levels of warden coverage;
- Howeverthere is perhaps scope for refinement as, for example, Crowthorne Wood & Bagshot Heath stands out as having very high warden time, despite low bird densities. While, conversely at Yateley (south) & Hawley Common and Bullswater Common the bird densities are high, but warden time less than 100 hours;
- The ratio of people spoken to and people already spoken to across all sites clearly indicates that there are some repeat encounters but equally the level of 'new' interactions is always high. The site totals suggest that even at relatively quiet sites such as Hazeley Heath there are still plenty of 'new' people spoken to (and therefore potentially still further warden capacity).

2.38 There is scope for more detailed spatial analysis and modelling to derive the optimal spatial and temporal coverage for the wardening. In order to facilitate this in the future, we suggest that wardens should on occasion keep detailed logs of where they walk and how long they spend talking to different visitor groups in different locations. This could take the form of a GPS track and record for each visitor interaction in terms of the location, the activity of the visitor and the length of interaction. Such detailed data would only be

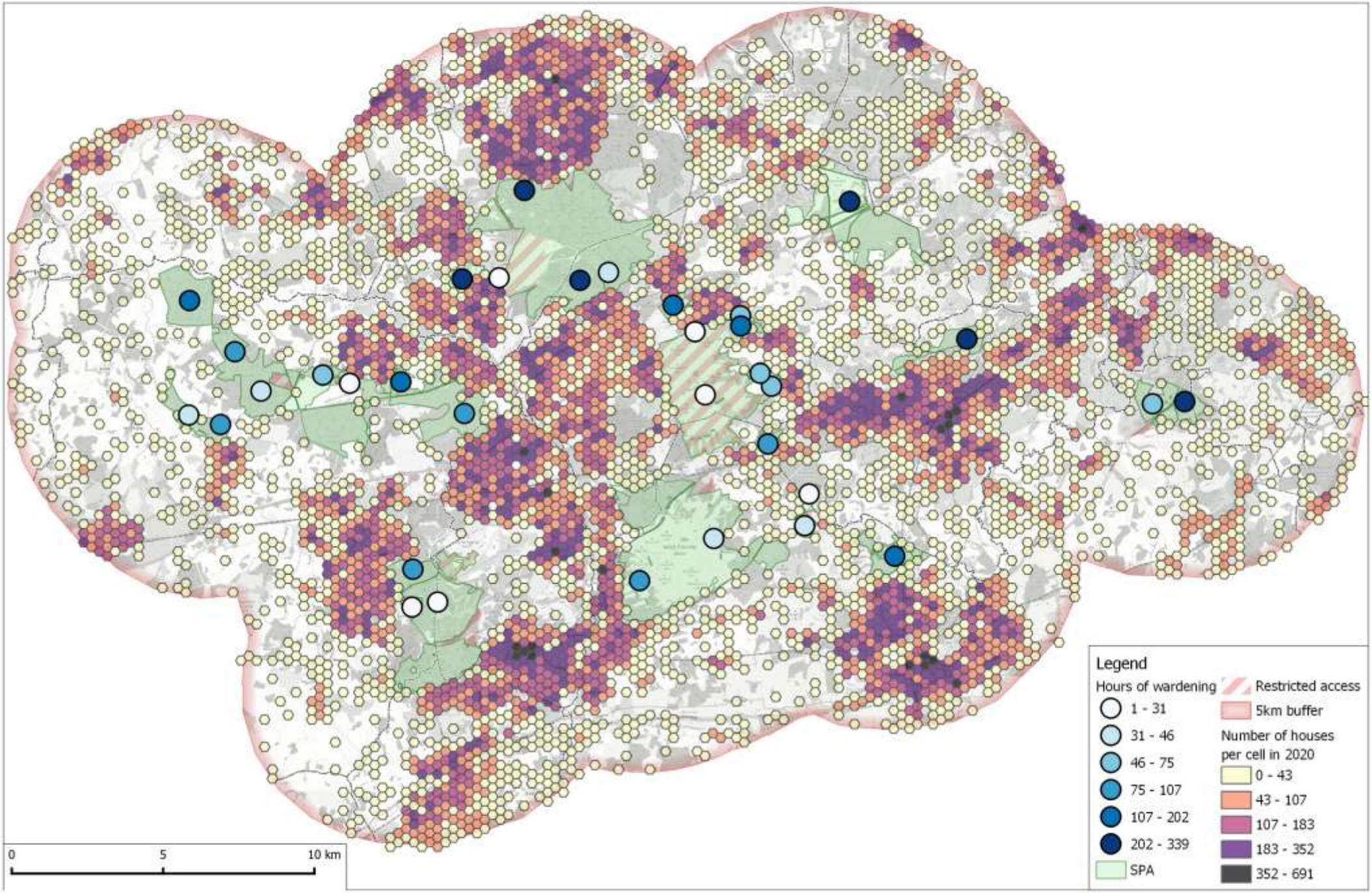
necessary for a sample of warden days, perhaps selected at random, and such data could be easily collected using a GPS unit or smartphone.

Map 2: Map of engagement areas in 2019. These relate to broad areas; discrete engagement points are not recorded and cannot be mapped.



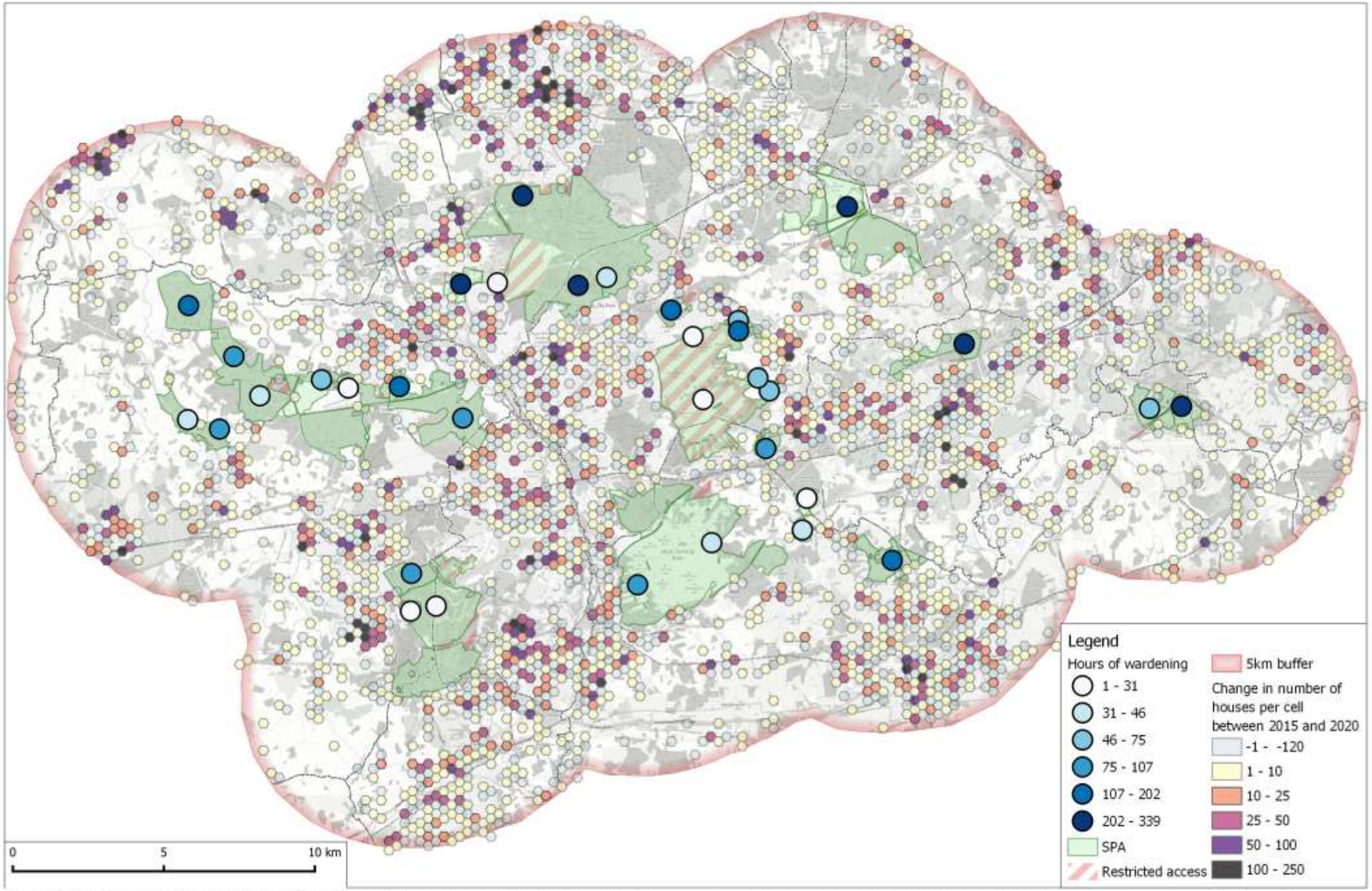
Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Map 3: Map of engagement areas in 2019, with symbols to indicate wardening level, overlaid with current housing levels.



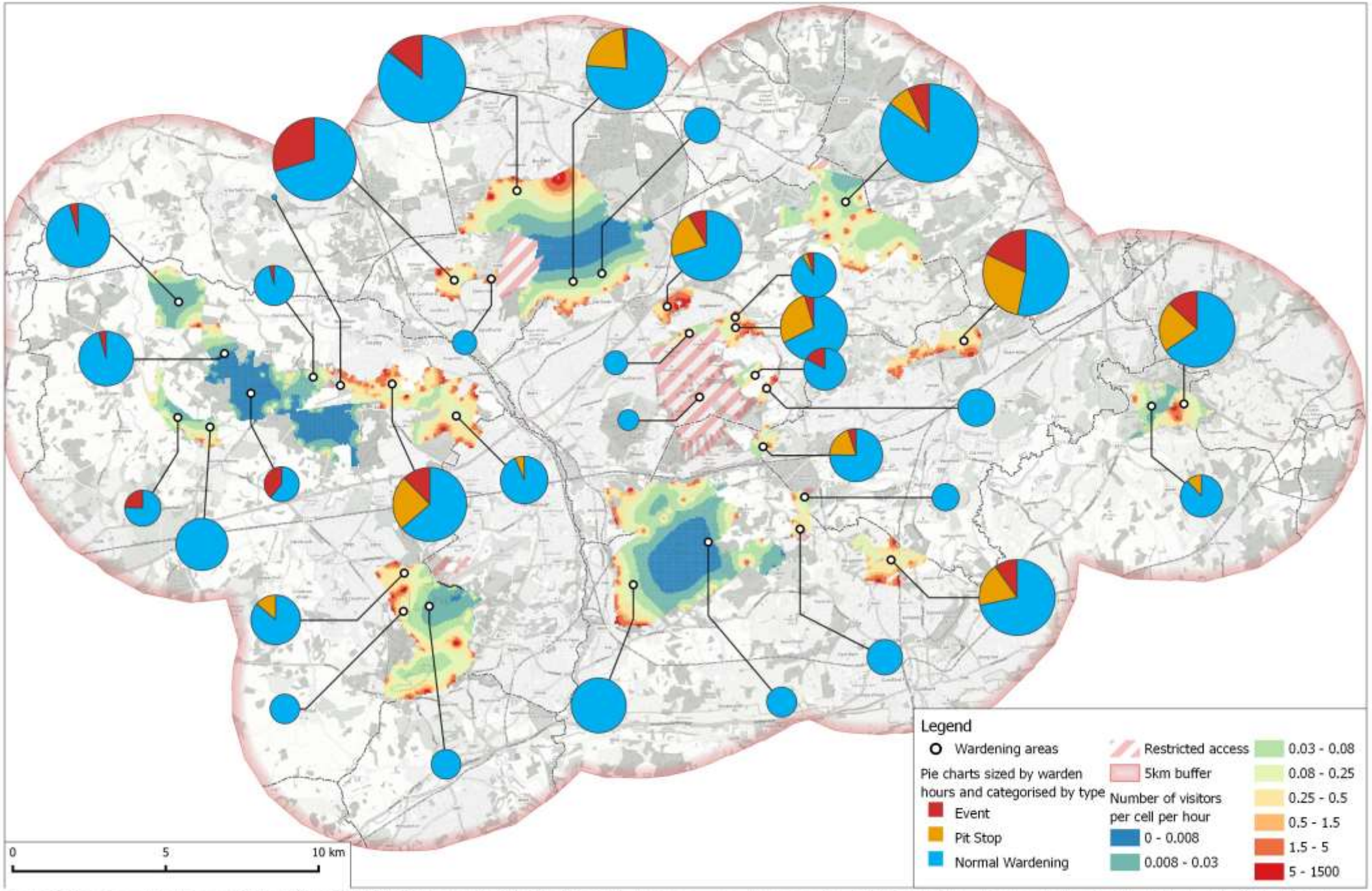
Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Map 4: Map of engagement areas in 2019, with symbols to indicate wardening level, overlaid with housing change in the last 5 years.



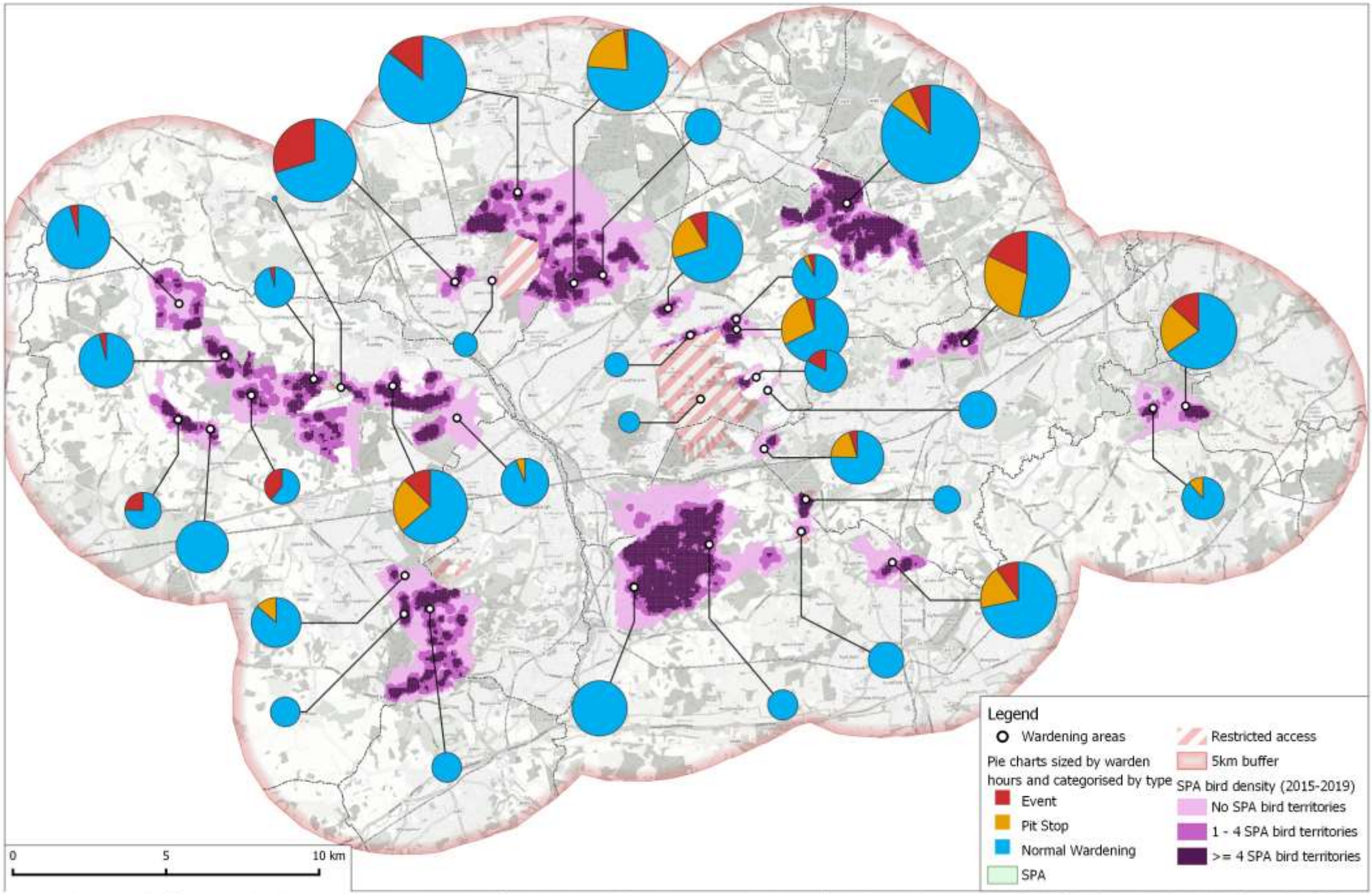
Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Map 5: Map of engagement areas in 2019, with pie charts to indicate wardening level and activities, overlaid on predicted visitor access levels.



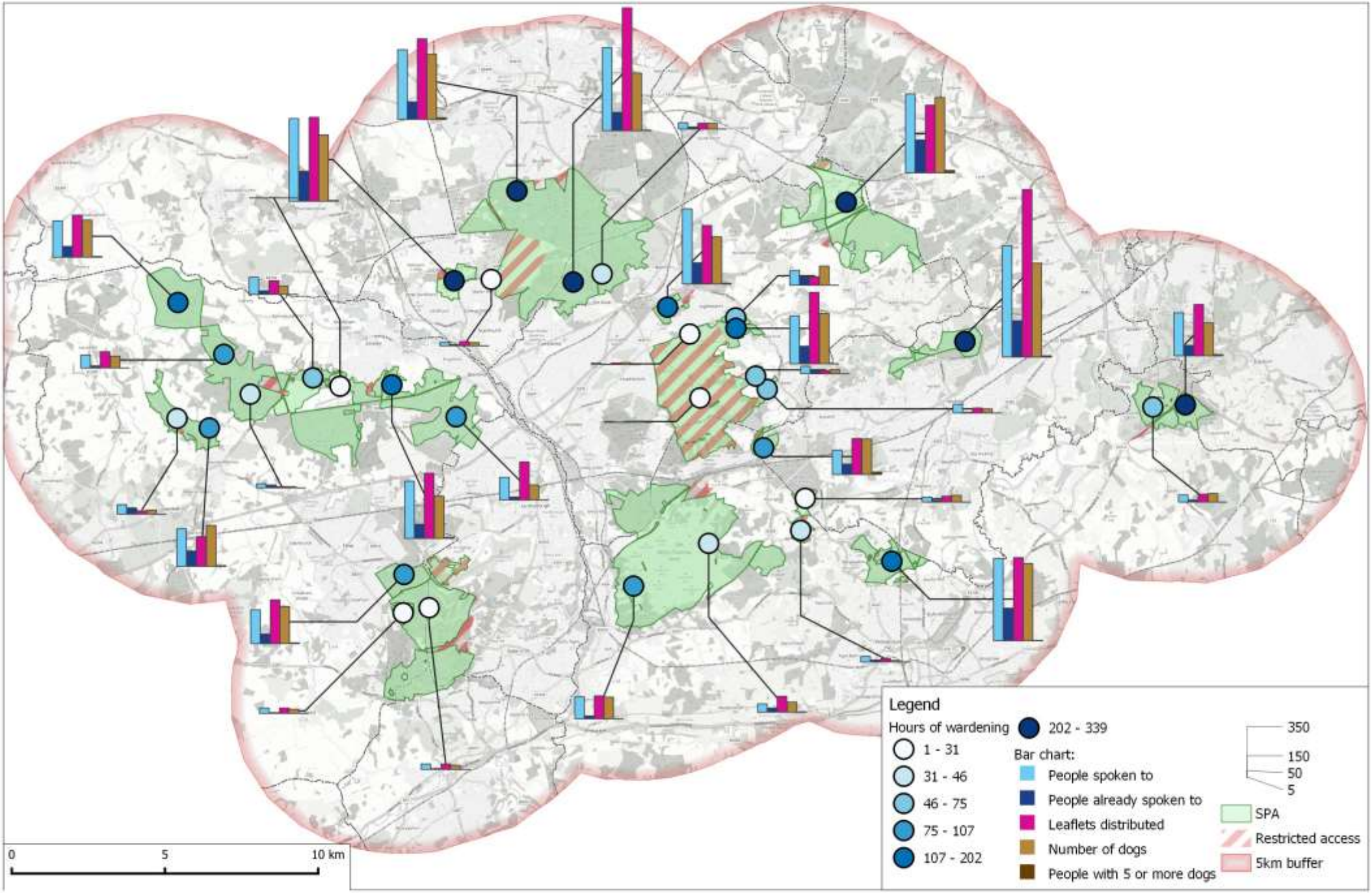
Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Map 6: Map of engagement areas in 2019, with pie charts to indicate wardening level and activities, overlaid SPA bird density.



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Map 7: Map of engagement areas in 2019, with bars to show various metrics of engagement.



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Table 3: Face-face engagement effort by 'patch', with visitor levels and bird territories. Red indicates highest three values in each column, blue indicates lowest three values. Patches are ranked by visitor density.

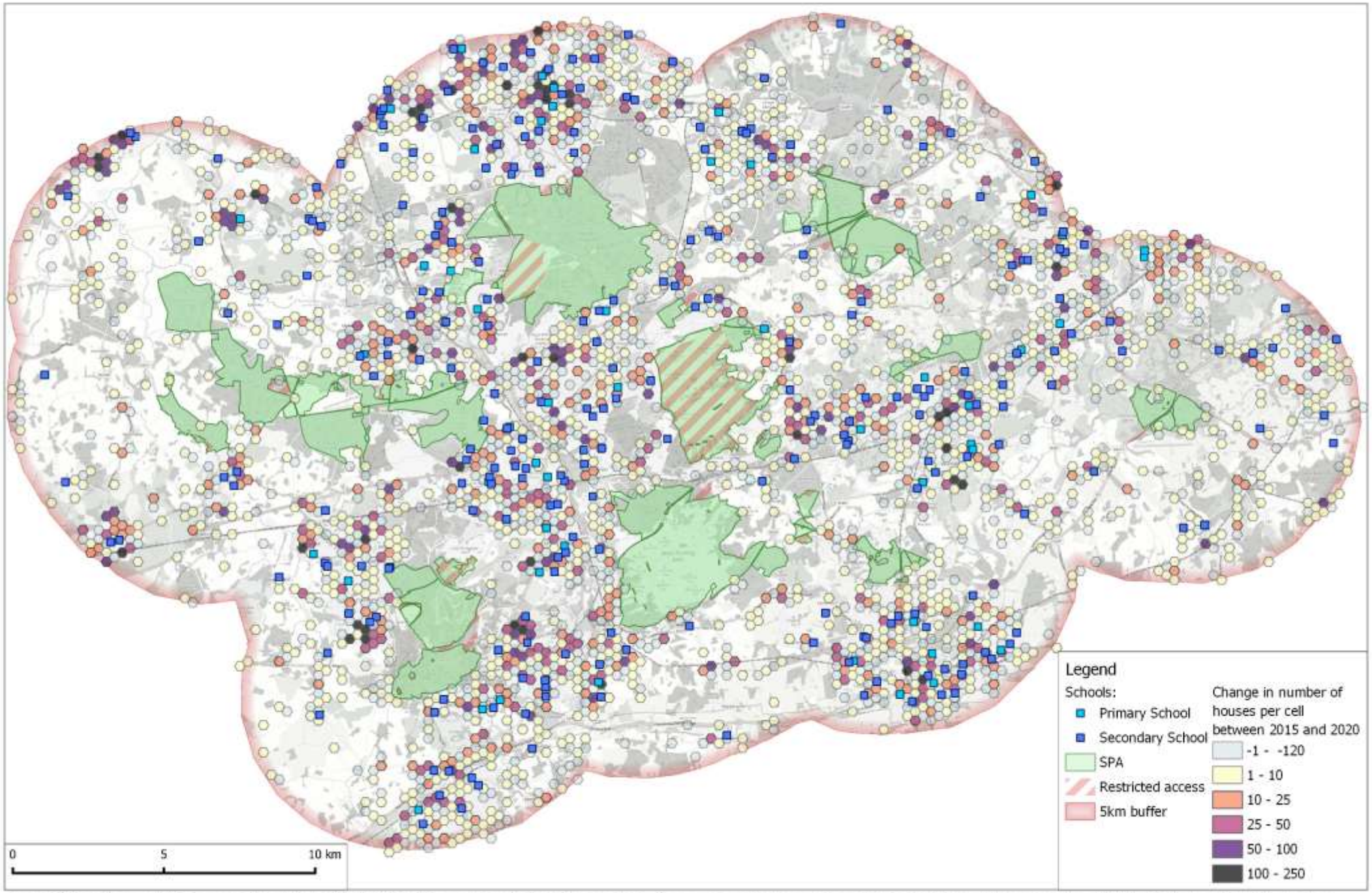
Patch ID	Patch Name	Mean visitors per cell per hour	Mean SPA bird territories per cell	Total hours wardened between Jan –Aug 2019	% hours as Pit Stops & Events	People spoken to	People already spoken to	Leaflets distributed	number of dogs	number of people with more than 5 dogs
4	Lightwater Country Park	**6.10**	1.74	174.9	30.0	516	148	402	325	6
3	Bisley Common	**2.70**	**0.00**	**48.5**	**0.0**	62	**8**	**35**	**31**	**0**
23	Lucas Green	**2.40**	1.97	**62.0**	16.9	**54**	25	**23**	**31**	**0**
19	Horsell Common	1.72	2.04	257.8	**46.9**	**768**	**251**	**1151**	**645**	10
22	Broadmoor Bottom	1.69	**0.00**	**21.0**	**0.0**	**24**	**11**	**29**	**23**	**0**
17	Ockham & Boldermere	1.33	1.76	201.8	**34.6**	298	72	354	229	10
11	Yateley Common (north)	1.29	2.61	191.3	**36.1**	396	100	454	290	11
1	Edgbarrow Woods (Owlsmoor)	1.17	1.46	241.3	29.8	**568**	209	**577**	458	8
14 / 15	Whitmoor Common*	1.05	1.60	201.3	28.3	567	225	573	**533**	4
12	Yateley Common (south) & Hawley Common	1.02	2.61	79.3	6.3	156	21	261	106	1
5	Cuckoo Hill	1.01	2.33	246.7	23.0	443	186	563	495	4
18	Crowthorne Wood & Bagshot Heath	0.87	2.05	**544.3**	17.0	**1095**	**265**	**1441**	**887**	**17**
7	Bourley & Long Valley	0.49	2.14	148.7	8.07	311	82	383	315	6
13	Bullswater Common	0.42	**3.53**	70.5	**0.0**	79	30	64	59	1
2	Sheet's Heath	0.40	1.26	99.0	24.8	167	74	249	246	**20**
20 / 21	Chobham Common*	0.36	**4.97**	**338.6**	14.6	542	**227**	465	518	**18**

Patch ID	Patch Name	Mean visitors per cell per hour	Mean SPA bird territories per cell	Total hours wardened between Jan –Aug 2019	% hours as Pit Stops & Events	People spoken to	People already spoken to	Leaflets distributed	number of dogs	number of people with more than 5 dogs
6	Pirbright Common & Ash Ranges	0.26	**3.41**	138.0	**0.0**	211	51	269	221	5
8	Hazeley Heath	0.17	**1.11**	62.8	12.0	**51**	**17**	55	63	2
16	Wilsey Common	**0.17**	2.64	141.8	7.9	327	151	230	313	8
9	Bramshill & Warren Heath	**0.08**	2.06	**348.5**	8.7	489	141	510	409	6
10	Yateley Heath Wood	**0.02**	1.48	174.9	n/a	n/a	n/a		n/a	n/a
	All sites	**0.63**	**2.57**	**3633.0**	**20.4**	**7130**	**2295**	**8096**	**6208**	**138**

Education work

2.39 Map 8 shows the locations of schools, from the Department of Education schools database, that lie within 5km of the SPA. Housing change over he past 5 years is also shown on the map (as also shown in Map 4). The map shows the wide spread of schools and the numerous opportunities for school work in close proximity to the SPA. Many of the schools are also clearly in areas where there has been new housing, suggesting potential for engagement work to reach residents in new housing.

Map 8: Distribution of schools, overlaid with housing change in the last 5 years.



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Whether specific aspects of the wardening, education or communication service could benefit from expansion and does this vary in different parts of the SPA?

2.40 The previous results indicate that there is scope for increasing the level of wardening effort. Wardens roaming sites is the best approach on quieter sites while at busy sites there is a likelihood benefit that having extra warden presence along with pit stops and events are likely to be effective.

2.41 One element of the wardening that is likely to be of increasing relevance and importance relates to fires. Wildfire is becoming more of a risk with climate change (anon, 2017; Jolly et al., 2015; Moffat & Gazzard, 2019), and there have been some devastating large fires on the Thames Basin Heaths in recent years. Wardening effort and communication around barbeques, stoves, campfires, discarded cigarettes etc. will be increasingly important and the on-site presence of wardens can help in emergency situations, such as directing emergency vehicles. Fire risk already features prominently in social media feeds and the Partnership website and there are the wildfire sessions in schools, however there is scope for fire related work to further increase. There may be opportunities for targeted work with local shops, garden centres etc (e.g. to ban disposable barbeques or give out printed warnings with any that are sold). Such expansion is likely to be relevant at an SPA-wide scale, however areas of heath (as opposed to forestry) are most vulnerable and risks will vary spatially over time. There is more potential for links with fire awareness projects in other parts of the country too. Fire management plans and additional resources for responding to fires may also be beneficial. Warden time could be increased (e.g. temporary seasonal staff) during high fire risk periods.

2.42 A further potential for expansion across the SPA, identified from the dog control study that accompanies this report, relates to the timing that mitigation is focussed on. Currently dogs are requested to be on the path from the 1st March and this coincides with when seasonal wardens are employed. The timing reflects the bird breeding season, however there is clear evidence for the timing to be shifted to include February, reflecting the period that Woodlarks settle on territory.

2.43 The dog control study also identified that there is potential for greater confidence (in terms of mitigation effectiveness) for SAMM if there is the

potential for enforcement. There are currently clear messages to dog owners to keep their dog on the path from 1st March – mid September and Thames Basin Heaths Partnership staff approach and target dog walkers whose dogs are out of control. However, there is no scope for the wardens to enforce and instead the approach is a positive one, of awareness raising, engagement and promoting good behaviour. On the whole this seems to be effective and working well.

2.44 Any change to this, giving enforcement power to wardens, would be a fundamental shift and have major implications for engagement. Visitors are likely to avoid the wardens rather than positively engage with them and as such this requires careful consideration. It may be that overtime, should there be a small number of people who repeatedly undermine the approach or refuse to keep their pets on the path, the power to address these individuals could add confidence that SAMM is able to cope with growing access levels and not be undermined. This could require greater warden resources, staff time and some changes to how the Thames Basin Heaths Partnership operates. It may require dedicated dog officers or similar who are clearly different from the wardens.

Whether there is a point at which expanding the wardening, education and communication service no longer increases the degree of mitigation?

2.45 Ultimately there will be a point at which there is little further benefit in additional mitigation as saturation has been reached. In the earlier section of this report (see Figure 3 and Figure 4) we modelled warden time against the number of interactions and this broadly suggested that at around 10,000 hours per year of warden time there was relatively less additional benefit from additional wardening effort.

2.46 This would imply that the size of the warden team could continue to increase. Currently we estimate around 11,000 hours are available, and data in Table 3 indicates around 3,700 hours warden time were achieved in 2019 up to the end of August. This would perhaps suggest that the warden team could even double in size before the number of interactions per ranger started to tail off.

2.47 In Figure 6 we show a further plot of warden effort in relation to level of engagement. Here, using the same approach as earlier in the report (Figure 3 and Figure 4), we consider the extent to which wardening might reach different types of visitor. As before we assume that there is the same likelihood that a warden could encounter a visitor anywhere in the SPA and that wardens speak to a group once only. In the plot we assume wardens could speak to 3.59 people per hour, roughly equivalent to the current maximum number of people spoken to per hour. We estimate from our model (see Appendix 1) that there are around 2,921 daily visits (i.e. groups or lone individuals that visit daily). It can be seen from our plot that around 2,000 hours of warden time is sufficient to encounter all those visitors who come daily and all those who come 2-3x per week. The plot highlights that it is the infrequent visitors that the wardening effort is potentially difficult to target. For example, for those visiting monthly, 10,000 hours of warden time does not appear sufficient to reach 15% of monthly visitors.

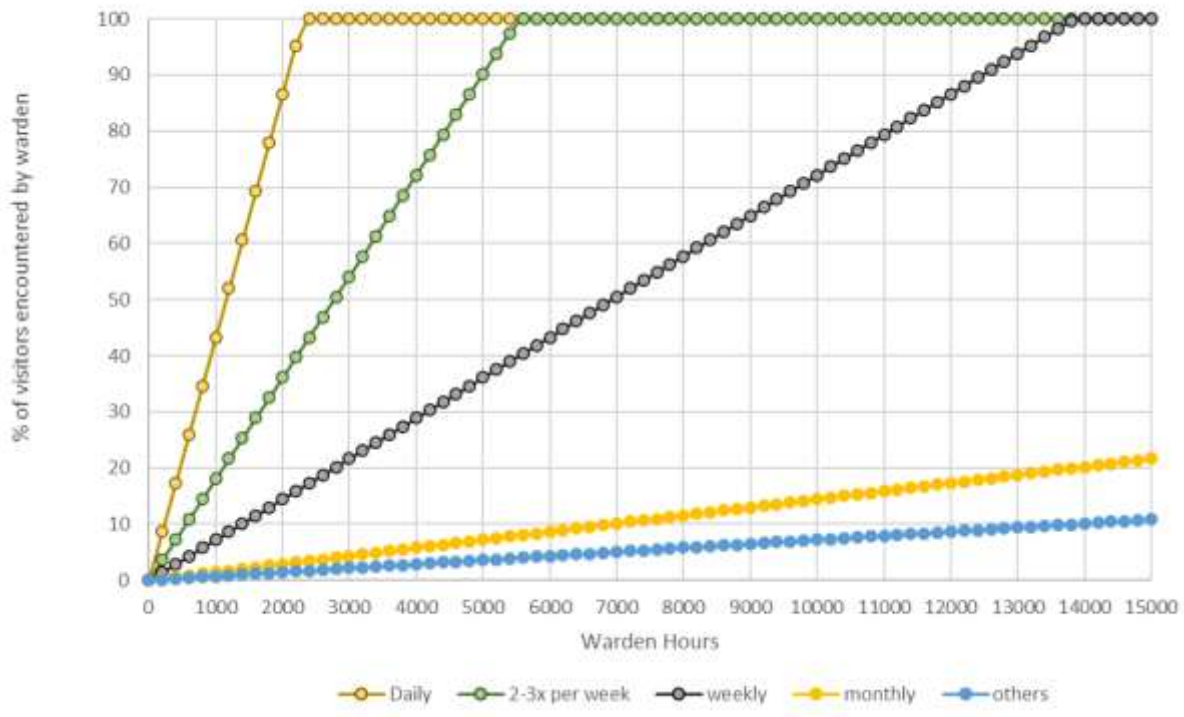


Figure 6: % of visitor groups engaged in relation to warden time (person days), by visitor type. Plot assumes wardens interact with 3.59 groups per hour and the target number of encounters is one per visitor group.

2.48 Our modelling is relatively simplistic and is based on the assumption that the wardens would be able to achieve a steady rate of interaction with visitors through the day and warden time would be spread to maximise visitor interactions. There is scope to undertake more sophisticated modelling, potentially combining our spatial models of visitor footfall, to work out more precisely how the warden time could be optimized. Ultimately however there is little evidence to indicate what proportion of visitors are necessary for a warden to interact with, and how many interactions with each visitor are necessary to influence visitor behaviour. As such there is clearly much uncertainty around the optimal level of wardening and what level what achieve the maximal benefit.

2.49 Nonetheless, drawing from Figure 6, it would seem likely that the current level of annual wardening effort, at around 5,000 hours, is sufficient to reach most regular visitors and more wardening time would result in the ability to reach the less frequent visitors or encounter the frequent visitors more than once. We have assumed the wardens are perfectly distributed in space and time to encounter visitors and can speak to 3.59 people per hour – these may be optimistic and more than one encounter per frequent visitor is likely to be ideal. As such there is scope to expand the wardening effort and achieve further mitigation.

2.50 There may be merit in the warden team varying in size over time, potentially employing extra summer rangers in some years and not others so that wardening effort is not predictable. There may also be merit in some areas having particularly high warden presence in pulses, such variation may help give a visitors a feel of a greater presence than is actually there. Such an approach could also work to provide a baseline of wardening that reaches the regular visitors and the pulses extending the reach to those who visit less frequently. Less frequent visitors may benefit from a different level of engagement compared to the more regular visitors and this may therefore provide a means to adjust and tailor mitigation more effectively. Evidence for the effectiveness of such variation is however lacking.

2.51 The Covid 19 pandemic has highlighted the importance of greenspaces and there has been a marked shift in how local residents use their nearby spaces. Various studies have shown marked increases in use (e.g. Day, 2020) during the pandemic. We do not know to what extent these elevated levels of use will continue, and with changing working practices (e.g. less people commuting and more working from home), it is possible they will remain

high. Furthermore, there is considerable uncertainty around how access patterns might change and shift in the future. This means that mitigation may need to adapt and there is particular uncertainty regarding what this might mean for future wardening and how wardens are best deployed.

Summary: How expansion of the existing SAMM project would be effective as a mitigation measure

The SAMM team currently deploys over 12 full-time equivalent staff undertaking ranger duties during the spring and summer and the ranger time averaged across the year is over 9 full-time equivalents. Warden time on-site is spread across the day but our analysis indicates there is scope for additional time to be focussed in the afternoon or current warden effort shifted to the afternoon in order to best match when visitors are present.

We estimate that around 5,000 hours warden time (the approximate current level) could result (if deployment were perfectly matched to visitor numbers and distribution) in around 28.4% of visitor groups coming into contact with a warden once and 19.8% if two encounters were the target. Current levels of wardening are such that a high proportion of very regular visitors are likely to be encountered over the year, but less frequent visitors (e.g. those visiting weekly or less) are likely to be missed. Modelling warden deployment based on current estimates of visitor numbers at different access points (and assuming wardens were deployed at or close to access points) suggests that focussing warden effort at busy access points is likely to result in the greatest number of visitor-warden encounters.

Use of social media indicates steady increase over time. The current maximum reach of social media is over 30,000 people, which is broadly equivalent to the number of individual groups that visit the SPA over a year. Social media clearly has an important role in extending the reach of the wardening team. However, there is perhaps limited scope to further expand given the current level and rising trajectory.

Education work is primarily through a dedicated education officer whose work includes work directly with schools (visits to schools and to heaths), wildfire session in schools, promotion of alternative greenspace and engagement with community groups. There are at least 282 primary schools and 90 secondary schools within 5km of the Thames Basin Heaths SPA. Postcode from 2020 data indicates there are also around 333,000 residential properties (potentially with 800,000 residents) living within 5km of the SPA. These figures would suggest there is clearly a large audience for such work and potential for extra staff resources to expand the current reach.

Expansion of the SAMM could include:

- More warden focus towards afternoons;
- Extending the bird breeding season focus to include February;
- Greater focus on wildfires;
- Potential for wardens to have powers to enforce (e.g. dogs on leads) if necessary;
- Refining warden time in relation to bird densities, visitor numbers and issues;
- More education work, reaching more schools.

There is scope for more detailed spatial analysis and modelling to derive the optimal spatial and temporal coverage for the wardening. In order to facilitate this in the future, we suggest that wardens should on occasion keep detailed logs with explicit spatial data recording where they walk and how long they spend talking to different visitor groups in different locations.

3. Aim 2 - To explore scope for implementing these measures

How the expansion of the project could be funded, and could funds be targeted to specific aspects of the project or particular parts of the SPA?

3.1 Mitigation is currently delivered as a package, involving a suite of measures. This provides greater certainty as to effectiveness, as the different parts of the package address different impacts, dovetail and complement each other. Placing greater emphasis on one element (such as SAMM) at the expense of another (SANG) will reduce that level of confidence and risks undermining the approach as a whole.

3.2 Currently SAMM is addressed SPA wide and warden time is allocated to ensure a good spread and adjusted/checked monthly. It would potentially be difficult to change this and implement having some areas that received a greater warden effort compared to others, because the SANG provision had been reduced. It is not straightforward to come up with a system that would provide confidence that adequate and effective mitigation had been achieved. SANG and SAMM are essentially inter-linked and complement each other; the effectiveness of one is likely to be compromised if the other is scaled back. Guidance on the Habitats Regulations (Tyldesley, Chapman, & Machin, 2020) is clear that, to be taken fully into account, at the appropriate stages of HRA, all mitigation measures should be effective, reliable and timely. Any doubts about effectiveness should be addressed by the competent authority before relying on such measures when applying the integrity test.

3.3 With these concerns and caveats in mind, we consider how the balance of SAMM/SANG could be determined and adjusted. One approach could be to use the spatial distribution of access – as shown in our models – to allocate warden time. Visitor change as a result of new housing could be added to the modelling and therefore it would be possible to predict where wardens should stand in relation to where visitors from new housing will go. This would result in a very complex means of deployment, particularly if housing in some areas was set to require different levels of wardening.

3.4 An alternative would be to allocate warden employment to broad areas, such that some areas had more staff than others. Such an approach would be a major departure from the current approach and have little merit, as it would risk losing the broad coverage and umbrella approach achieved to date. Having an SPA-wide approach that is managed with a broad remit provides the flexibility to move staff around, ensure coverage (e.g. when staff are sick or covering weekends and bank holidays effectively), for wardens to team up for events and locations be targeted as issues arise.

3.5 Some options for dedicated funding, that could be easily costed as separate and additional to the current 'baseline' SAMM could include:

- Access management infrastructure or other elements on the SPA or supporting areas that require significant one-off investment, for example art installations, cycling infrastructure, dog-related infrastructure;
- Temporary or seasonal, pop-up engagement material, such as mobile art installation or similar;
- Fire-related measures, for example fire management plans, hiring temporary fire wardens during fire risk periods or, as for example in Dorset mitigation money has been used to fund fire hydrants and similar infrastructure;
- Specific projects relating to particular parts of the SPA and adjacent areas, for example access management plans, that could target local issues and help to ensure effective dove-tailing of SANG, SAMM etc.

3.6 In some ways such thinking is akin to the situation in Dorset where mitigation delivery is split between SAMM type measures and infrastructure type measures, referred to as Heathland Infrastructure Projects ('HIPS')[9]. HIPs include SANG, but also measures like dedicated BMX facilities, on-site access management projects such as infrastructure to limit diffuse parking around the European site, provision of support areas connected to the European site but outside the boundary (spreading access), etc.

3.7 The simplest way to implement such options would be for some kind of option for elevated SAMM payments to be made in lieu of SANG in very specific circumstances where SANG options are impossible and there are

[9] See the Dorset Heathlands Planning Framework https://www.dorsetcouncil.gov.uk/planning-buildings-land/planning-policy/supplementary-planning-documents-and-guidance/all-of-dorset/dorset-heathlands-planning-framework.aspx

clear opportunities to enhance SAMM. Such an option is contrary to the current mitigation approach and could risk undermining the approach as a whole.

SAMM payments in context with SANG

3.8 There is clearly scope for increasing the SAMM provision; the detailed costs for this are set out later in the report (see para 3.20) and here we consider how the relative balance of SAMM vs SANG and other mitigation could be varied.

3.9 Current housing growth over the period 2015-2019 has been 16,840, i.e. an average of 3,368 dwellings per year, within 5km of the SPA[10].

3.10 Wardening has been implemented as part of a package, alongside SANG. We estimate warden costs at around £50,000 per staff member per year[11], so with the equivalent of 9 staff employed all year, the cost would be £450,000 per year. Given the level of housing growth (3,368 dwellings per year), we can estimate £133.61 as the spend attributed per dwelling to pay for wardening at the current level of provision. This of course does not take into account any scaling up for in-perpetuity costs of wardening. These calculations would suggest that each dwelling currently contributes the cost of a single day of employment for a warden.

3.11 This can be placed in further context using typical access levels associated with one dwelling. Typical levels of countryside access are 1.7 visits per person per week (this a national average, from O'Neill, 2019); for a household of 2.4 people this equates to 4.08 visits per household per week or 0.58 per day. Therefore, mitigation (through SANG and SAMM) that addressed the impacts from 0.58 person visits to the SPA per day would mitigate a single dwelling[12]. The calculations would therefore indicate that, based on current levels of provision, 1 day of warden time (alongside SANG

[10] These data extracted from national postcode data

[11] This is approximate but based on conversations with the Thames Basin Heaths Partnership, and reflects the rounded costs of employing a ranger for a year, including support costs, travel etc.

[12] Note that this 0.58 figure is over-precautionary as it relates to all countryside access, not all of which will be to the SPA

and other mitigation) is deemed adequate to address impacts associated with a potential for 0.58 countryside visits.

3.12 These calculations provide the potential to consider the relative contribution of warden provision as mitigation and how additional wardening time could be costed.

Could site-specific access assessments be used to target expansion of the project and/or define catchments for funding?

3.13 Site-specific access management assessments would involve detailed access management plans for particular parts of the SPA, setting out interventions such as:

- Path management and maintenance;
- Signage, interpretation and way-marking;
- Access infrastructure (for example seating, provision of viewpoints or other features, boardwalks, viewing screens, gates etc.);
- Parking management;
- Engagement and communication;
- Other measures, for example vegetation management, that might influence visitor use and experience.

3.14 A series of access management plans, covering the whole of the Thames Basin Heaths SPA were produced in 2007 by LDA design. These included measures such as restricting parking at Pirbright, establishing volunteer groups at Brookwood, rationalising path networks, limiting access for cycles and education work at Yateley Common. It would be useful to revisit these measures, checking on the ground to ascertain how effective they have been.

3.15 Access Management Assessments have been undertaken as part of strategic mitigation work at other European sites. For example, on the Solent[13], where the shoreline has been divided into discrete sections and the aim is to have a plan for each section. Plans summarise the bird interest, disturbance issues, constraints, opportunities and have been produced by consultants, working closely with the Bird Aware Solent team and relevant stakeholders. So far

[13] See the Bird Aware Solent strategy for background as to the role of these within the mitigation approach, https://solent.birdaware.org/media/29372/Bird-Aware-Solent-Strategy/pdf/Solent_Recreation_Mitigation_Strategy.pdf

Bird Aware Solent has commissioned the production of a few plans each year, using external consultants and selecting a range of diverse locations. In the longer term it is anticipated that the role of producing the plans might be taken over by the Bird Aware Solent team.

3.16 The advantages of site-specific access assessments are that they provide an opportunity to tailor mitigation to specific locations and can improve access and visitor experiences, and as such they are positive. There is potential for cost savings by ensuring the different threads of mitigation can be joined effectively, for example targeting warden presence to specific parts of sites. The assessments can draw on local knowledge, the expertise of stakeholders and those who access the site for recreation.

3.17 The disadvantages relate to the practicalities of having multiple plans that can rapidly become dated. The Thames Basin Heaths are owned and managed by a plethora of organisations, and these will have their own plans in place. For example, all RSPB reserves have a management plan that includes visitor management and infrastructure. Each organisation will set out such plans in a different way and they will cover different timescales. Site managers may struggle with additional plans that do not necessarily fit easily alongside existing plans. A further challenge is that plans may identify interventions that require consultation, planning permission, consent etc., and as require some delivery on the ground. This may mean the need for a dedicated member of staff to oversee implementation or a reliance on a range of bodies to deliver mitigation, which may not be ultimately achievable.

3.18 As such, the role of access assessments on the Thames Basin Heaths is likely to be an opportunistic one. Having a comprehensive series of assessments that are live and cover the whole SPA is likely to be too ambitious. We can however see merit in assessments where there are particular challenges or issues, for example around anti-social behaviour, parking or particular types of access (such as cycling or dog walking). Such assessments could be beneficial where there are different organisations responsible for managing access in a particular area, helping to ensure consistency of messaging or coherence. Assessments could therefore be flexible in their format and scope, providing an opportunity to bring in expertise or find consensus.

Are there particular areas where access management measures would be most effective?

3.19 There are a range of access management measures that can be targeted to particular locations and can be effective, alongside other access management approaches, to influence where people go and how they behave. Some examples from different sites are illustrated in Figure 7. In Table 4 we provide an overview of some different measures and the situations where they are most relevant or effective.

Table 4: Overview of a range of access management measures and situations where most effective

	Measure	Situations where effective
Signage and interpretation	Additional way-marking	Additional way-markers helpful in areas where path network confusing and to reinforce messaging to keep to main paths. Good where trying to separate users (e.g. bike trails).
	Temporary, pop-up interpretation	Changing interpretation and information works well for regular visitors who may ignore more traditional, permanent panels etc. Can be cost-effective as can be moved around and linked to engagement. Best deployed where high proportion of regular visitors and where issues in specific locations. Also useful in particular circumstances such as when high fire risk.
	Consistent clear messaging	Consistent messages for visitors are essential. Dogs on leads, close control or sticking to paths are common sources of confusion. Regular checks of messaging are important to ensure clear instructions for all users. Where there are different zones within sites these need to be clearly mapped and also clear on the ground.
	Information on grazing	Information on where grazing animals are can help avoid issues with some visitors. Live information on the location of grazing animals can be provided through apps or websites (e.g. if livestock have GPS collars). Temporary signs can also be used to indicate when stock are present. Only relevant on sites where grazing animals present and risks of conflict. Most relevant on large sites where animals can be roaming widely.
	Interpretation panels	Traditional form of information provision. Can have temporary/more dynamic content (e.g. seasonal panels to highlight seasonal importance and restrictions). Such panels at access points can provide an information point and help create an impression that visitors are welcomed but information important.
	Temporary signage to divert users	Signs that direct users along other routes helpful to reduce footfall in certain areas, best used where clear alternative and for short sections of path/track.
Infrastructure	Art installation/sculpture	Can be used to highlight particular messages (e.g. presence of birds/rare wildlife) and act as a focal point for visitors (e.g. linked to engagement). Another potential is to use to create sense of moving from one area to another, e.g. switch from conifer woodland to open heath. In such instances an arch or similar (potentially from natural materials) can help to create a sense of a change (and a change in behaviour required too).
	Viewpoint or similar feature	Creates a 'destination' within sites, helping to focus visitor use and footfall. Potentially useful as part of work to improve path network and focus visitors along particular routes/main paths.
	Dedicated areas for dogs to access water	Access to water can be an important draw for dog owners and many dogs enjoy access to water. Dogs in ponds and waterbodies can however be a conservation issue (Denton & Groome, 2017). Problems

	Measure	Situations where effective
		can be resolved by providing dedicated access or set locations. Barriers in the water can limit dog access within water bodies (see Denton & Groome, 2017 for details).
	Provision of wildlife viewing facilities	Screens, vantage points or similar can help reinforce messages that places support wildlife. Can be used for engagement.
Path-management	Dead-hedging to obstruct desire lines	Useful where numerous desire lines form or where routes just forming. Cut gorse, bramble and or larger branches can be used.
	Vegetation management	Evidence suggests that Dartford Warblers are less vulnerable to disturbance in gorse dominated areas (Murison et al., 2007) and allowing dense gorse to form alongside paths potentially effective at keeping people and dogs on paths.
	Path maintenance	Path maintenance in the form of boxing, steps etc. can help draw visitors along particular routes or make it clear which are the main paths. Board walks or similar can help keep visitors to paths and minimise the spread of paths. Path management needs to be undertaken with care to ensure no impacts for invertebrates, scarce plants etc.

Figure 7: Examples of access management measures: a) breeding bird sign; b) temporary sign; c) novel way-marking; d) viewing area by heathland pond to limit trampling; e) vegetation management to screen visitors from rare breeding birds (Stone Curlew); f) sculpture to raise profile of rare wildlife; d) locally distinctive gate architecture creating sense of place.

What are the potential costs of delivering these potential measures?

3.20 Costs for some of the access management measures are set out in Table 5. The costs are indicative and approximate, and many items are difficult to cost as they are likely to be very site specific or context specific. It could be a role for any access management assessments to provide costs for measures.

Table 5: Indicative costs for a selection of different access management measures. Where possible, costs have been drawn from examples of our work on other sites, for example specific plans or quotes that we consider broadly representative or useful examples.

Measure	Item costed	Cost	How cost calculated	Note
Wardening	1 warden FTE for a year, with support costs	£50,000	Rounded figure from TBH Partnership	Figure is approximate and includes proportion of costs for Project Manager
Access Management Assessment	Approximate cost for plan for set area	£6,000	Approximate, based on similar project in other locations	Assuming consultancy costs and some stakeholder engagement. Could be undertaken by SAMM staff.
New interpretation panel	Standard interpretation panel including timber frame and graphic panel, with costs including delivery and installation	£2,000	Approximate cost for A0 board with hardwood frame.	Potential for economies of scale. More novel interpretation, which is more engaging (e.g. with easy to change seasonal panels), could be a greater cost.
Finger post	1x hardwood finger post	£300	Rounded estimate based on examples from other sites.	Potential for economies of scale
Art/play installation	Installation similar to Figure 7f, involving multiple animals and play/climbing structure	£20,000	Rounded estimate based on examples from other sites.	Installations costs and design will be site specific
Pedestrian gate	1x timber pedestrian gate	£500	Rounded estimate based on examples from other sites.	More novel infrastructure, which is more engaging, could be a greater cost. Potential for economies of scale

Summary: Scope for implementation

Mitigation is currently delivered as a package, involving a suite of measures. This provides greater certainty as to effectiveness, as the different parts of the package address different impacts, dovetail and complement each other. Placing greater emphasis on one element (such as SAMM) at the expense of another (SANG) will reduce that level of confidence and risks undermining the approach as a whole.

Some options for dedicated funding, that could be easily costed as separate and additional to the current 'baseline' SAMM could include:

- Access management infrastructure or other elements on the SPA or supporting areas that require significant one-off investment, for example art installations, cycling infrastructure, dog-related infrastructure;
- Temporary or pop-up, seasonal engagement material, such as mobile art installation or similar;
- Fire-related measures, for example fire management plans, hiring temporary fire wardens during fire risk periods or, as for example in Dorset, mitigation money has been used to fund fire hydrants and similar infrastructure;
- Specific projects relating to particular parts of the SPA and adjacent areas, for example access management plans, that could target local issues and help to ensure effective dove-tailing of SANG, SAMM etc.

We see a role for site-specific access assessments to help identify projects on the ground and particular measures, but only in specific circumstances. A range of access management measures are identified, with context as to where they are likely to be effective and the costs of different elements.

4. Aim 3 - To consider the potential capacity of these measures

What would be the potential scale of mitigation achieved by expanding the SAMM project?

4.1 Previous sections have identified that wardening effort could be increased and achieve further mitigation. Cross-referencing to the figures in paras 3.9 - 3.12,

- Current housing growth over the period 2015-2019 has been 16,840, i.e. an average of 3,368 dwellings per year, within 5km of the SPA;
- Wardening is currently around 9 full-time equivalent staff;

4.2 An additional warden is therefore equivalent to around 374.2 dwellings (i.e. 3,368/9), on the assumption that the current level of provision is sufficient to mitigate the current levels of growth. This of course assumes the relationship between warden effort and number of people encountered is linear, and we know this is not the case.

4.3 Using our figures for ranger effort in relation to the number of people encountered (see Figure 8 below), it can be seen that a doubling of warden effort from 5,000 hours to 10,000 per year could result in an increase of around 6.6% in the overall number of visitors that are spoken to twice, i.e. a shift from 10% to 16.6% . In other words, doubling warden effort would result in less than double the number of people engaged with.

4.4 Furthermore, we already know from Figure 6 that the current level of wardening time is sufficient for a warden to speak once in the course of a year to all daily visitors and those visiting 2-3x per week (assuming warden coverage is perfect in relation to the distribution and timing of visitor patterns). Increasing the warden coverage therefore provides the potential to reach the less regular visitors, as well as the potential to speak to the regular visitors more than once.

4.5 Ultimately there is an element of guesswork in the scale of mitigation additional wardening might deliver. The mitigation benefits from wardening are hard to separate from the general awareness raising and other SAMM components and the impacts of additional greenspace and recreation

opportunities provided through SANG. There may be a point at which visitors do not engage any further, a proportion will simply want to walk their dog, run, ride or walk in peace. Targeted visitor survey work or experimental work (involving trialling different levels of SAMM engagement compared to control groups) are likely to be necessary to really get to the details of the optimum levels of mitigation and role of SAMM within that.

4.6 With these caveats in mind, we very cautiously suggest that there could be scope to increase the warden team by up to twice its current size. This would provide additional mitigation. Given the current provision is a single warden for 374 houses and the additional benefits are ever decreasing, an additional 9 wardens could perhaps deliver the SAMM component of mitigation for an additional 2,700 houses. This is simply based on extending the current wardening provision, which works alongside SANG and other mitigation measures as part of a package. It is important to note that the wardening component does not operate in isolation (and would be much less effective if it were) so these 2,700 houses would require additional mitigation alongside the wardening, equivalent to SANG etc. In other words, the additional mitigation achieved would be equivalent to current SAMM for a further 2,700 houses. That level of wardening provision (9 full-time equivalents) would cost around £450,000.

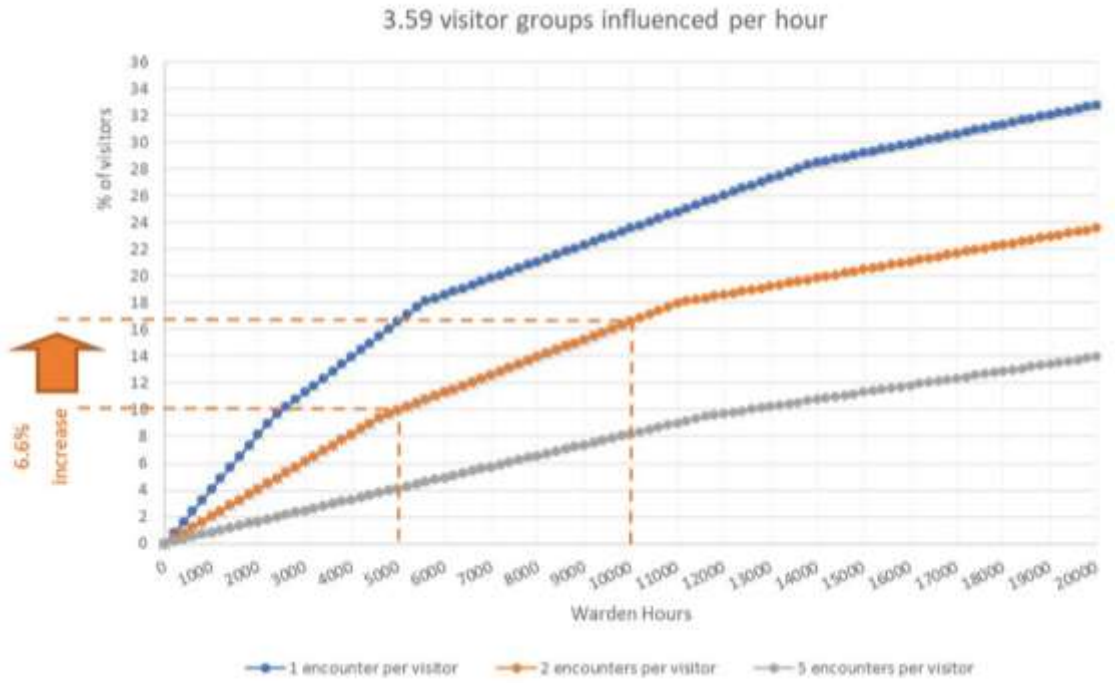


Figure 8: Predictions of increased levels of visitor encounters based on increasing warden hours (graph adapted from Figure 3).

4.7 The potential capacity that other mitigation options might generate is very difficult to estimate. While there is clearly scope for expansion to cover additional access infrastructure, art, fire-related measures etc. there is no clear way to equate these to a level of housing. For wardening, we can estimate capacity simply by extrapolating the current level of provision – i.e. a warden for every 375 new houses or so. There is no equivalent metric for measures such as those relating to fire or art. In terms of education, particularly with schools, the benefits relate to community links and long-term behaviour change. While such approaches are clearly very important and have a key role to play, there would seem little scope to expand those elements in isolation.

4.8 Ultimately, mitigation to date has functioned as a package of mitigation measures and it is the overall package that provides confidence that adequate mitigation is in place. A range of measures is the best way to ensure the full gamut and range of access impacts are addressed. Given the the marked changes in access and use of the countryside during the pandemic, Covid 19 has highlighted the importance of a 'package' of

measures to ensure any uncertainty and potential variations in use can be addressed.

Summary: Potential capacity

We very cautiously suggest that there could be scope to increase the warden team by up to twice its current size. Given the current provision is a single warden for 374 houses and the additional benefits are ever decreasing, an additional 9 wardens could perhaps be sufficient to provide SAMM type mitigation for an additional 2,700 houses. It should be noted that this is not necessarily the "complete' mitigation for those dwellings as the wardens do not work in isolation but rather are a component of SAMM and there is also SANG and each dwelling provides both SAMM and SANG.

5. References

anon. (2017). Spreading like wildfire. *Nature Climate Change*, *7*(11), 755. doi: 10.1038/nclimate3432

Clarke, R. T., Liley, D., & Sharp, J. (2008). *Assessment of visitor access effects and housing on nightjar numbers on the Thames Basin Heaths and Dorset Heaths SPAs*. Footprint Ecology / Natural England.

Day, B. H. (2020). The Value of Greenspace Under Pandemic Lockdown. *Environmental and Resource Economics*, *76*(4), 1161–1185. doi: 10.1007/s10640-020-00489-y

Denton, J., & Groome, G. (2017). Dogs and ponds: a case study from Headley Heath. *Conservation Land Management*, *15*(2), 4–8.

Fearnley, H. (2013). *Results from the June 2013 driving transects across the Thames Basin Heaths SPA*. Footprint Ecology / Natural England.

Jolly, W. M., Cochrane, M. A., Freeborn, P. H., Holden, Z. A., Brown, T. J., Williamson, G. J., & Bowman, D. M. J. S. (2015). Climate-induced variations in global wildfire danger from 1979 to 2013. *Nature Communications*, *6*(1), 1–11. doi: 10.1038/ncomms8537

Liley, D. (2015). *Visitor surveys of SANGs sites in and around Hart District*. Unpublished report by Footprint Ecology for Hart District Council.

Liley, D., & Clarke, R. T. (2003). The impact of urban development and human disturbance on the numbers of nightjar Caprimulgus europaeus on heathlands in Dorset, England. *Biological Conservation*, *114*, 219–230.

Liley, D., Clarke, R. T., Mallord, J. W., & Bullock, J. M. (2006). *The effect of urban development and human disturbance on the distribution and abundance of nightjars on the Thames Basin and Dorset Heaths*. Natural England/Footprint Ecology.

Liley, D., Panter, C., & Rawlings, J. (2015). *A review of suitable alternative natural greenspace sites (SANGs) in the Thames Basin Heaths area* [Unpublished Report].

Liley, D., Panter, C., & Underhill-Day, J. (2016). *East Devon Pebblebed Heaths Visitor Management Plan* [Unpublished report for East Devon District Council].

Mallord, J. W. (2005). *Predicting the consequences of human disturbance, urbanisation and fragmentation for a woodlark Lullula arborea population*. UEA, School of Biological Sciences, Norwich.

Mallord, J. W., Dolman, P. M., Brown, A. F., & Sutherland, W. J. (2007). How perception and density-dependence affect breeding Woodlarks Lullula arborea. *Ibis*, *149*(s1), 15–15. doi: doi:10.1111/j.1474-919X.2007.00650.x

Moffat, A., & Gazzard, R. (2019). Wildfire adaptation and contingency planning in south east England - implementation of current legislation and policy. *Quarterly Journal of Forestry*, *113*(3), 160–165.

Murison, G. (2002). *The impact of human disturbance on the breeding success of nightjar Caprimulgus europaeus on heathlands in south Dorset, England*. Peterborough: English Nature.

Murison, Giselle, Bullock, J. M., Underhill-Day, J., Langston, R., Brown, A. F., & Sutherland, W. J. (2007). Habitat type determines the effects of disturbance on the breeding

productivity of the Dartford Warbler Sylvia undata. *Ibis*, *149*(s1), 16–26. doi: doi:10.1111/j.1474-919X.2007.00660.x

O'Neill, R. (2019). *Monitor of Engagement with the Natural Environment – The national survey on people and the natural environment. Headline report 2019* (NECR No. 275). Natural England and the Office for National Statistics. Retrieved from Natural England and the Office for National Statistics website: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/828552/Monitor_Engagement_Natural_Environment_2018_2019_v2.pdf

Panter, C. (2017). *Analysis of Thames Basin Heaths SANG Visitor Survey data: Winter 2016/17* (Unpub. No. 421). Footprint Ecology / Natural England.

Panter, C. (2019). *Analysis of 2017 Thames Basin Heaths SPA Parking Transects and Counter Data* (Unpub. No. 501). Footprint Ecology / Natural England.

Southgate, J., Brookbank, R., Cammack, K., & Mitchell, J. (2018). *Visitor Access Patterns on the Thames Basin Heaths SPA: Visitor Questionnaire Survey 2018.* Ecological Planning & Research Ltd, Winchester.

Thames Basin Heaths Joint Strategic Partnership Board. (2009). *Thames Basin Heaths Special Protection Area Delivery Framework*. Retrieved from http://www.southeast-ra.gov.uk/documents/sustainability/thames_basin_heaths/delivery_framework_march2009.pdf

Tyldesley, D., Chapman, C., & Machin, G. (2020). *The Habitats Regulations Handbook*. DTA Publications. Retrieved from https://www.dtapublications.co.uk/handbook/

Wheaton, M., Ardoin, N. M., Hunt, C., Schuh, J. S., Kresse, M., Menke, C., & Durham, W. (2016). Using web and mobile technology to motivate pro-environmental action after a nature-based tourism experience. *Journal of Sustainable Tourism*, *24*(4), 594–615. doi: 10.1080/09669582.2015.1081600

Young, W., Russell, S. V., Robinson, C. A., & Barkemeyer, R. (2017). Can social media be a tool for reducing consumers' food waste? A behaviour change experiment by a UK retailer. *Resources, Conservation and Recycling*, *117*, 195–203. doi: 10.1016/j.resconrec.2016.10.016

Appendix 1: Technical details relating to models and how models constructed

5.1 We have used models to map visitor use across the SPA. These provide us with a way of checking the effect of different visitor management scenarios, and a way of checking how these might influence the number of people passing through bird territories.

Modelling datasets used

5.2 The approach taken considers a complex methodology using a wide range of datasets and previous models to consider the likely outcome from possible actions. Existing datasets and previous models used were:

- Existing data produced by Footprint Ecology on access points, restricted access areas and discrete accesible patch areas (Liley et al., 2006).
- Parking information and vehicle count data provided the Thames Basin Heaths Partnership.
- SPA bird data provided by 2Js Ecology.
- Existing model of the penetration distance for visitors into the sites produced by Footprint Ecology (Liley et al., 2006).
- Existing model of the relationship between number of visitors arriving on foot and the numbers of housing in close proximity produced by Footprint Ecology (Liley et al., 2006).
- Interview data of visitors on sites, most recently produced by EPR (Southgate et al., 2018).

SPA accessible area, patches and use of a 50m grid

5.3 The SPA has a large number of access points, which have been previously mapped, including by Footprint Ecology (Liley et al., 2006). These data were checked against the latest path OSM network and aerial images, resulting in a further 13 new foot only access points added -see Map A1.

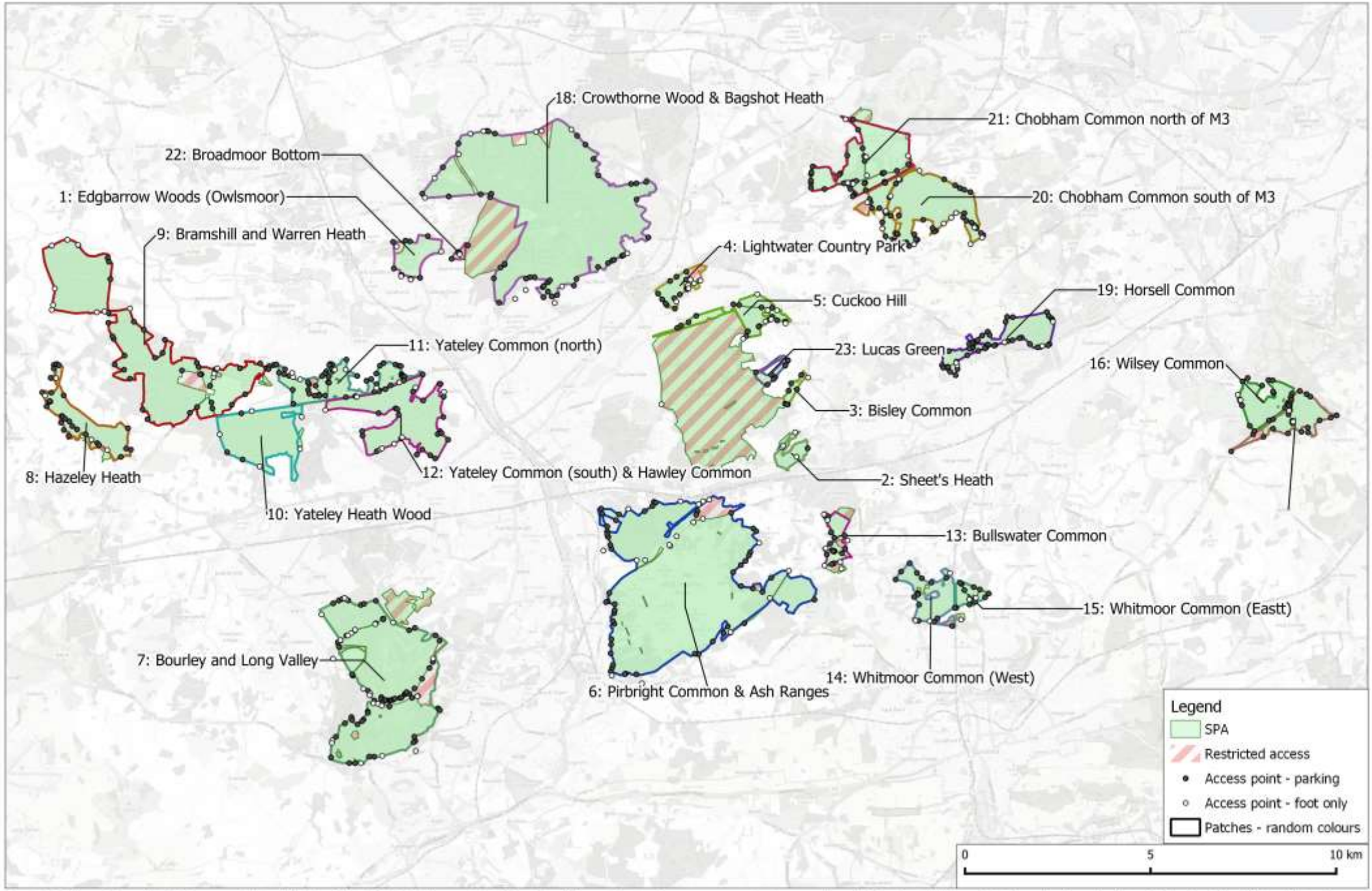
5.4 There are also a number of areas where there is no public access, for example due to military use, and these areas were also mapped previously in 2006 and are shown on Map A1.

5.5 As part of the work in 2006 we split the SPA into discrete patches that represented single discrete areas that are publicly accessible. Some of these

extend beyond the SPA boundary and the boundaries of patches were defined by barriers to access such as private land or major roads (e.g. Chobham Common, considered as two separate patches, north and south of the M3).

5.6 We used a 50m grid overlaid across the accessible patches as the basis for our models. This matches the grid used in previous work (Liley et al., 2006) and totalled 32,473 cells. However, it should be noted that a grid cell was classified as part of a patch based on any sized intersection, so a large number of peripheral grid cells are included based on just a small area of the patch included. Each grid cell was assigned to a patch. Where a grid cell covered more than 1 patch, the patch which formed the largest intersecting area was assigned to the whole cell.

Map A1: Map of the individual discrete access patches across the SPA used in analysis.



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Data on parking locations

5.7 The parking locations around the SPA were previously mapped by Footprint Ecology (see Liley et al., 2006 for details). This dataset is now maintained by the Thames Basin Heaths Partnership who undertake annual vehicle counts. These datasets include 160 main parking locations which provide access to the SPA. The explicit point location of these locations were mapped in GIS and assigned to a patch.

5.8 The capacity of each of these locations, in terms of the number of standard car parking spaces, has been estimated by TBHP staff. However, these estimates were made several years ago, and in recent years especially, in some parking locations the observed vehicles counts have exceeded their estimated capacity. We therefore re-evaluated capacities and for each parking location have used the maximum of either the original estimate, or maximum from the observed vehicle count data.

5.9 Counts of the number of vehicles in parking locations across the SPA were initially conducted by Footprint Ecology (Fearnley, 2013), but in recent years this has become part of the routine monitoring conducted by the Thames Basin Heaths Partnership staff (Panter, 2019). Data were provided for analysis for 2018 to 2019, but supported with additional data from our previous reporting for the TBHP of the 2017 data (Panter, 2019), collected by the TBHP staff.

5.10 Each year's data consisted of several counts spread over the year as summarised in Table 6. Two counts were always conducted in June, July and August. Typically, all 160 parking locations were counted, but this varied over time. For the later modelling approaches of parking distribution, we only used the spring/summer focus months (green rows in Table 6).

Table 6: Summary of the number of transect counts conducted in each month over the three years, with the number of parking locations to be surveyed given in brackets afterwards. Green rows highlight those survey months which are the focus of TBHP for the spring/summer and blue rows those outside this period.

Month	2017	2018	2019
January	1 [151]	1 [155]	1 [149]
February	1 [151]		1 [113]
March	1 [155]	1 [148]	1 [152]
April	1 [155]	1 [149]	1 [152]
May	1 [159]	1 [157]	1 [151]

Month	2017	2018	2019
June	2 [301]	2 [308]	2 [300]
July	2 [309]	2 [307]	2 [303]
August	2 [304]	2 [300]	2 [311]
September	1 [154]		
October	1 [155]		
November	1 [152]		
December	1 [155]		

SPA bird data

5.11 The SPA bird data for the three species (Dartford Warbler, Woodlark and Nightjar) were provided by 2Js Ecology, who conduct the annual bird monitoring. The data were provided as point locations for territory centres and covered the SPA and some peripheral areas for the five years, 2015-2019.

5.12 The point locations of territory centres were buffered to create polygons which could be used to consider a wider area and core part of the territory used by the birds. We used a variable distance buffer for each species; Dartford Warbler 50m buffer, Woodlark 100m, Nightjar 150m for a territory (in line with other similar modelling, e.g. Liley, Panter, & Underhill-Day, 2016).

5.13 Using the 50m grid of the SPA accessible patches, the number of territories intersecting each cell was counted. This provided a figure for the number of SPA bird species per 0.25 ha cell (50m x 50m grid squares). The overall average across all cells was 2.6 SPA birds per cell (see Table 7).

Table 7: Mean number of SPA bird territory areas counted within each 50m cell (cells are 0.25 ha) Bottom three values for each site are highlighted in blue and top three in red.

Patch ID	Patch name	Number of grid cells	Mean number of variable buffered SPA territories intersecting cell
1	Edgbarrow Woods (Owlsmoor)	427	1.5
2	Sheet's Heath	232	1.3
3	Bisley Common	99	**0.0**
4	Lightwater Country Park	314	1.7
5	Cuckoo Hill	571	2.3
6	Pirbright Common & Ash Ranges	6561	**3.4**
7	Bourley and Long Valley	3769	2.1

Patch ID	Patch name	Number of grid cells	Mean number of variable buffered SPA territories intersecting cell
8	Hazeley Heath	805	2.6
9	Bramshill and Warren Heath	3660	2.1
10	Yateley Heath Wood	1227	1.5
11	Yateley Common (north)	864	2.6
12	Yateley Common (south) & Hawley Common	1511	2.6
13	Bullswater Common	309	**3.5**
14	Whitmoor Common (West)	634	**0.5**
15	Whitmoor Common (Eastt)	193	2.6
16	Wilsey Common	525	**1.1**
17	Ockham and Boldermere	585	1.8
18	Crowthorne Wood & Bagshot Heath	6349	2.1
19	Horsell Common	717	2.0
20	Chobham Common south of M3	1623	**4.2**
21	Chobham Common north of M3	1291	**5.7**
22	Broadmoor Bottom	53	**0.0**
23	Lucas Green	154	2.0
			2.6

5.14 It should be noted that only the mapped bird data were used. There were gaps in survey coverage, and coverage differed between years, as summarised in Table 8.

Table 8: Gaps in survey coverage for Annex I birds by year and estimates of likely number of territories missed, information provided by 2Js Ecology.

Year	Note
2015	Ash to Brookwood: an additional two Woodlark territories estimated at Mytchett Place.
	Castle Bottom to Yateley and Hawley Commons: an additional five Nightjar territories estimated, comprising three on Yateley Heath Wood and two on peripheral sites.
	Whitmoor Common: an additional two Nightjar territories estimated.
2016	Whitmoor Common: an additional two Nightjar territories estimated
	Ash to Brookwood: two additional Nightjar and two Woodlark territories estimated to allow for non-coverage of Cobbett Hill.
	Castle Bottom to Yateley and Hawley Commons: two additional Nightjar territories estimated on peripheral sites.

Year	Note
	Colony Bog and Bagshot Heath: two additional Nightjar and six Dartford Warbler territories estimated to allow for non-coverage of Lightwater CP. Also four additional Woodlark and 38 Dartford Warbler territories estimated due to incomplete coverage of Pirbright Ranges.
2017	Colony Bog and Bagshot Heath: due to incomplete coverage of Pirbright Ranges these counts are too low by an estimated four Woodlark and 70 Dartford Warbler territories
	Whitmoor Common: parts of the common were not covered for Nightjars and a further two territories have been estimated.
2018	Ash to Brookwood: two Nightjars and one Woodlark have been estimated for non-coverage of Cobbett Hill.
2019	Ash to Brookwood: coverage of Nightjars was incomplete. A further ten territories were estimated for Ash RDA, two for Cobbett Hill and one for Mytchett Place.
	Colony Bog and Bagshot Heath: ongoing access restrictions resulted in coverage of all three species being incomplete on the RDA. A further five Nightjar territories, four Woodlark territories and 68 Dartford Warbler territories were estimated for the area.

Modelling access within sites

5.15 We generated models to distribute visitor use across our grid cells based on the data from visitor interviews on how far people roam from access points.

5.16 Our starting point was to predict the number of visitors entering our patches at each access point. We used the average number of vehicles from the car parking transect dataset and derived an estimate for the number of visitors on foot at every access point, based on local housing. This estimate was based on the modelled visit rates produced by Liley et al. (2006) which provide a formula based on the number of residential properties in a 2km distance band around the access point to estimate number of visitors accessing on foot.

5.17 To model how visitors may spread from each access point, we used the same approach as Liley *et al.* (2006). This was based on the distances visitors roam from access points as collected from visitor survey data, which provided a 'decay curve' of the percentage of visitors that reach different distances.

5.18 We then calculated the number of cells at each given distance from the access point in order to spread visitor use (as in Liley et al., 2006). This model

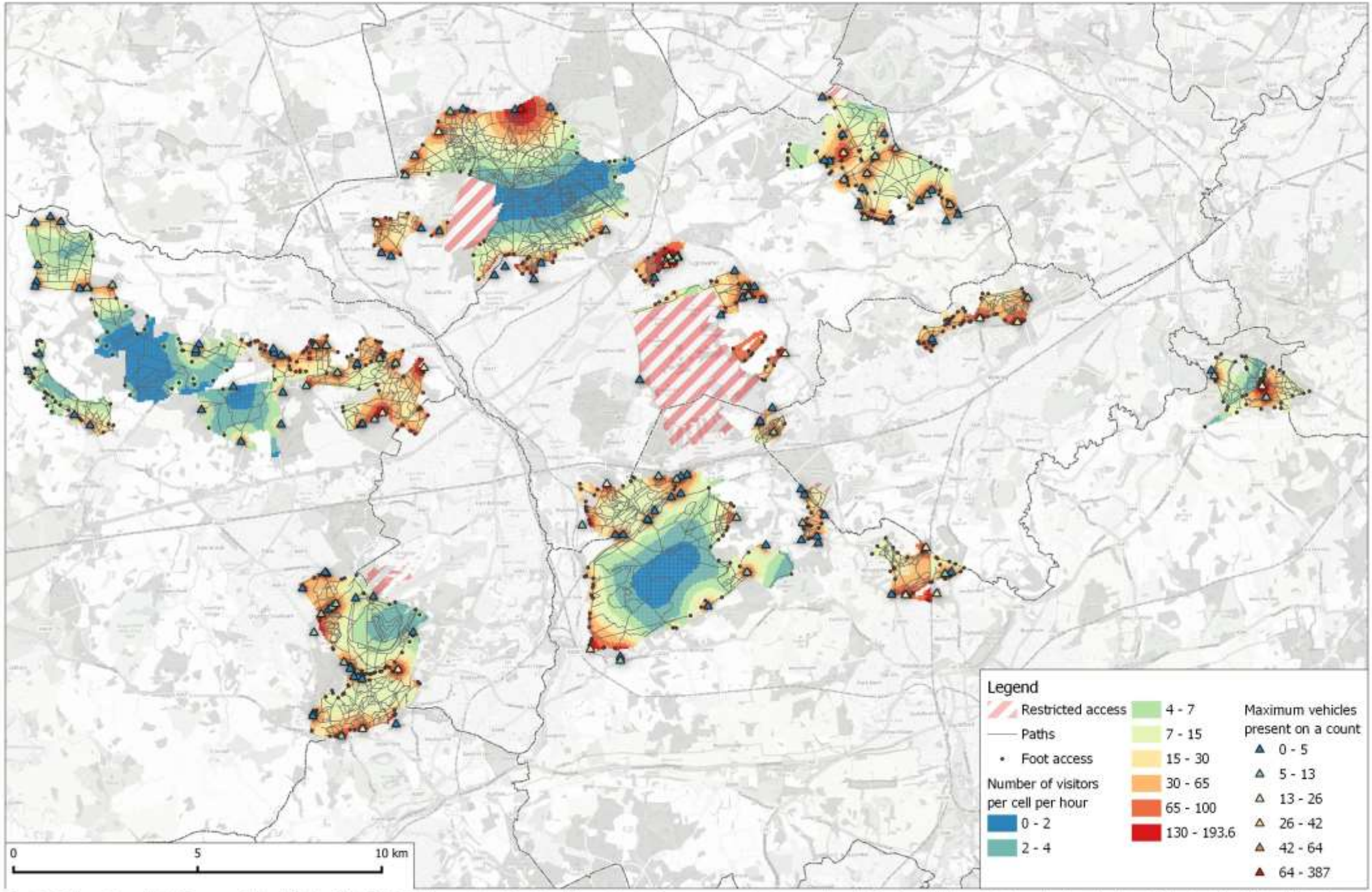
therefore assumes that visitors fan out from each access point in an even distribution, regardless of the path network, topography etc. It assumes all parts of the site are equally accessible.

Model predictions

5.19 The modelling was therefore set up such that changes to visitor numbers, changes to parking (numbers of spaces at different locations), and which parts of the site are accessible to visitors, could be manipulated and the resulting distribution of visitors within the site predicted.

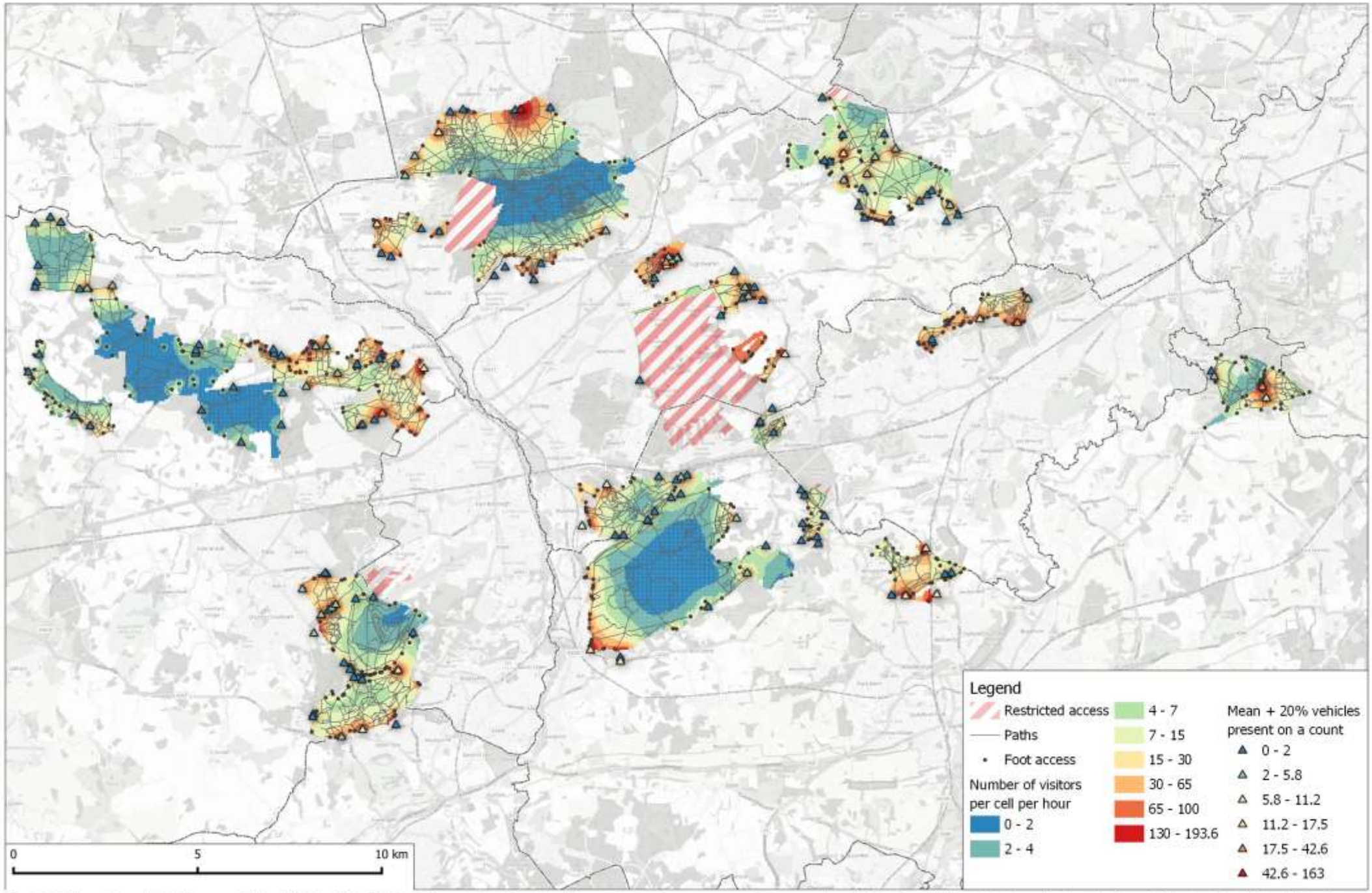
5.20 Three separate reports use these models. The dog control study considers the effect of reduction in visitor use or changes in distribution within sites (e.g. through zoning). In the parking report we consider the effect of changing parking locations and spaces. In the access management report we use our models to check ranger deployment and time.

Map A2: Predicted number of visitors per cell per hour based on maximum levels of access (from max count of vehicles).



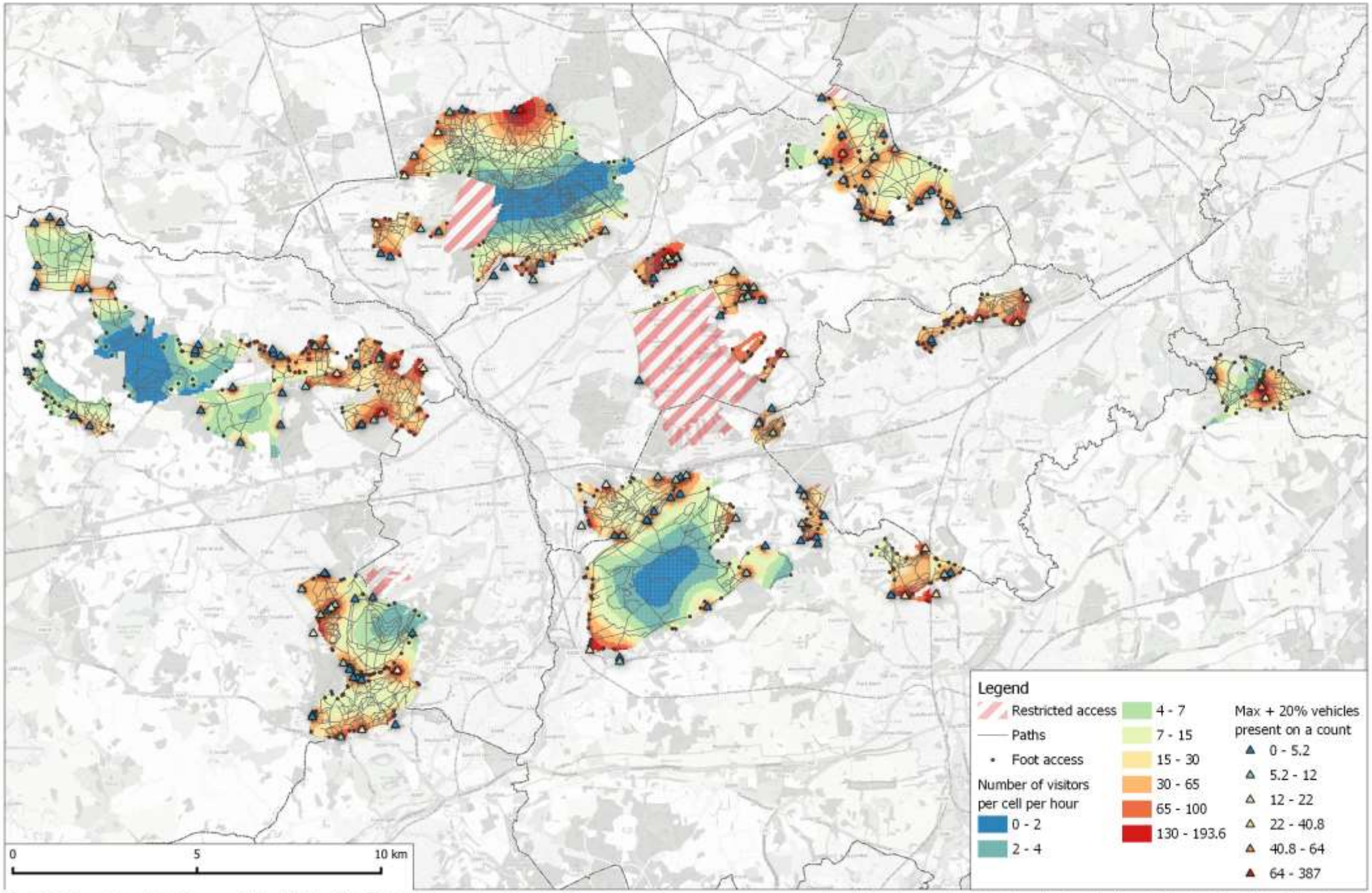
Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Map A3: Predicted number of visitors per cell per hour based on mean + 20% levels of access (from mean + 20% count of vehicles).



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Map A4: Predicted number of visitors per cell per hour based on maximum + 20% levels of access (from max + 20% count of vehicles).



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.