Title: Assessing challenges and opportunities for schools' access to nature in England

Author names and affiliations:

Elizabeth WALKER[a], Dimitrios BORMPOUDAKIS[a], Joseph TZANOPOULOS[a,b]

[a] Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, University of Kent, Canterbury CT2 7NR, UK

[b] Kent's Interdisciplinary Centre for Spatial Studies (KISS), School of Anthropology and Conservation, University of Kent, Canterbury CT2 7NR, UK

Email addresses: lizw@hotmail.co.uk; bormpd@gmail.com; j.tzanopoulos@kent.ac.uk

Corresponding author: Elizabeth WALKER, The Waterloo Foundation, 46-48 Cardiff Road, Cardiff, CF5 2DT (present address); lizzie.walker@waterloofoundation.org.uk (e-mail address); +44 74323600237 (telephone number)

Funding: This work was supported by the Durrell Institute of Conservation of Ecology (DICE) at the University of Kent.

Highlights:

- Children's declining contact with nature can be mitigated by school trips
- One factor limiting access is distance between schools and green spaces
- However, the majority of schools have access to nearby green spaces
- Access is also limited by social and cultural factors
- There is a need for multifaceted solutions to improve children's access to nature

Abstract: Regular access to natural environments has been shown to have beneficial effects on children's health, development and academic attainment. This study assesses the current capacity for English primary schools to provide access to nature, and the opportunities and challenges of doing so. Using a mixed-methods approach combining questionnaires delivered at schools across England, semi-structured interviews with school staff, and GIS and cloud-based distance analysis between schools and nearby green spaces we found that children's access to nature through trips to off-site locations is limited by several factors, including the cost of transport. Even when schools are within walking distance to green spaces or had access to such spaces on the school site, factors such as the pressure of delivering the National Curriculum and teachers' lack of engagement with outdoor learning may limit opportunities to access nature. These findings suggest that urban planning initiatives to create more urban green spaces should be accompanied by measures to reduce the non-spatial limitations to access.

Keywords: Nature, children, green spaces, distance analysis, planning strategies

1. Introduction:

There is a wide evidence base for the beneficial impacts of green spaces in supporting urban ecological and social systems, particularly in relation to health and wellbeing (Gascon et al., 2018; Yao, Zhang & Gong, 2021). For children, there is evidence that regular access to natural environments has considerable beneficial effects on their health and development, particularly in reducing or coping with stress (Corraliza, Collado, & Bethelmy, 2017), improving mental health (McCormick, 2017), and providing opportunities for physical activity and exercise (Bikomeye, Balza, & Beyer, 2021; Matisziw et al., 2016). Outdoor learning, including fieldwork and outdoor educational visits, offers children opportunities to learn and develop skills that are valuable to their academic attainment (Kuo, Barnes & Jordan, 2019; Malone and Waite, 2016). Time spent outdoors is also linked to children's cognitive and behavioural development and their ability to concentrate and self-discipline (Ardoin & Bowers, 2020; Scott et al., 2018; Wallner et al., 2018). Li & Sullivan (2016) found that views onto green landscapes from school windows significantly increase students' attention restoration and recovery from stress, while Ulset et al. (2017) found a positive correlation between children's attention and time spent outdoors in preschool.

The amount of time children spend in nature has decreased sharply in the last few decades (Hand et al., 2018; Rigolon, 2017; Soga & Gaston, 2016). A 2009 survey compared the use of natural spaces by children with adults' perceptions of their use of natural spaces in childhood. It found that fewer than 10% of children regularly played in wild places compared to 40% of adults when they were young, and less than a quarter of children visited a local "patch of nature" compared to over half of the previous generation (Natural England, 2009). These figures represent a generational shift away from outdoor, nature-based recreation activities towards indoor, sedentary and screen-based activities (Soga & Gaston, 2016; Louv, 2005), a trend amplified by changes in societal and parental attitudes (Hand et al., 2018; Soga et al., 2018), urbanisation and loss of local green spaces (Colding, Gren & Barthel, 2020; Cox et al., 2018). Children from low-income urban environments have especially limited access to nature (Bates, Bohnert & Gerstein, 2018). Research suggests that reduced opportunities for spending time in green spaces will have long term impacts on the quality of life of children, particularly in regards to their mental and physical health and wellbeing.

In the last decade, there has been an increasing focus on schools as facilitators of access to green spaces, for both teaching and play activities (e.g. Bates, Bohnert & Gerstein, 2018; Bikomeye, Balza & Beyer, 2021; Harris, 2017; Tan & Atencio, 2016). Schools have three

main options for providing direct experiences with nature within well-maintained sites that are relatively safe: (1) creating areas of natural environment within school grounds, (2) visiting nearby urban green spaces, or (3) taking children on school trips to nature reserves or similar sites away from the school site. These three categories vary primarily in terms of distance from the school, but can also vary in regards to the typical features and management style of the site. School-based and urban green spaces are often more manicured settings, while nature reserves are typically more unstructured and 'wild'. There is limited research into how the characteristics of natural environments impact children's development, but there is a growing body of evidence that increasing the amount of greenery in more managed environments provides benefits to children's physical activity and socioemotional health (Bikomeye, Balza & Beyer, 2021; Souter-Brown, 2014). Local green spaces are also beneficial in that they provide regular experiences of nature which have long-term impacts on health and development (Scott et al., 2018).

Providing first-hand experiences of natural environments has long been practiced within UK schools. Prior to the introduction of the National Curriculum in England and Wales in 1988, much science education for primary-school pupils involved trips to nearby natural environments to view and collect samples of nature. However, this type of fieldwork has decreased substantially, replaced by more prescriptive classroom-based investigations (Tilling, 2004; Lock, 2010). More recently, the UK Government has become more aware of the connections between access to nature and health and wellbeing, leading to high investment in schools and local parks between 2005 and 2007, and inclusion of school greening programmes within the Government's 25-Year Plan to Improve the Environment (2018). Forest Schools are also growing in popularity in the UK following the model of Scandinavian countries (Smith, Dunhill & Scott, 2017). However, access to nature has not reached the level of more environmentally conscious countries such as Denmark, where over 10% of preschools are located in forests or other natural settings (Stasiuk, 2016) and at least 28% of schools undertake outdoor learning weekly or bi-weekly (Bentsen et al., 2010). Data is lacking on current levels of access to nature through UK primary schools, although Fisher (2001) found that, at Key Stage 3, 50% of surveyed schools did not do any outdoor field science. This study will attempt to fill this gap in knowledge by assessing English schools' current and potential provision of access to nature.

2. Methods:

Studies have shown that researchers interested in access and use of nature spaces should integrate qualitative and quantitative methods to understand more fully the factors shaping use and access (Higgs, Fry, & Langford, 2012; Ives et al., 2017). In designing this piece of research, we determined that neither quantitative nor qualitative methods alone would be sufficient to answer the research questions. We wanted to explore both quantitative and qualitative types of sub-questions, so chose to collect and analyse relevant data and use quantitative and qualitative findings to inform each other.

The strengths and weaknesses of a mixed-methods design have been widely discussed by researchers (e.g. Creswell & Plano Clark, 2007; Greene, Caracelli, & Graham, 1989). In such a design, issues of priority, implementation and integration of the quantitative and qualitative methods need to be carefully considered (Ivankova, Creswell & Stick, 2006). In the data collection and analysis process we chose to give equal priority to quantitative and qualitative methods. The first, quantitative, phase focused primarily on how children have access to nature through schools, while the second, qualitative, phase explored the reasons why this access is or is not facilitated. Both aspects were equally important to the study and in answering the research questions. We performed a complementary thematic analysis of the quantitative and qualitative results and triangulated the results to increase their validity. Using different methods for different components of the study also expanded the range of the research to consider multiple factors that may influence children's access to nature.

In deciding the sequence of data collection and analysis we were also influenced by the research questions. The principal research question was what are the main opportunities and challenges of schools providing:

a) Access to nature through visits to natural environments
b) Access to nature through school-based natural environments and activities.

To collect this data, we first collected and analysed quantitative data (questionnaire) to allow the drawing of generalised descriptions from a large sample of primary schools across England. Then, in the second phase of the research, qualitative data (interviews) were collected and analysed to explain and further explore the themes in the quantitative data. The results of the data analysis in the first phase of the study informed the design of the second phase's data collection protocols.

From the initial results of the interviews and questionnaires, it became clear that distances between schools and natural environments was a limiting factor in the number of visits made by children to these sites. To explore this theme, we then formulated two further research questions using another qualitative method (distance analysis):

c) What are the distances between schools and natural spaces?
d) Are there differences between rural and urban areas in the provision of walkable access to nature?

In this case, a mixed methods approach allowed us to capture both the physical reality of the landscapes in which schools are located and the social and cultural reality that incorporates these human institutions. According to the literature, both of these factors contribute to use of green spaces. The results from the quantitative and qualitative research methods were integrated during the discussion of the outcomes of the study. Figure 1 shows a visual model of the sequence of data collection, analysis and integration.

2.1. Questionnaire

We designed an online questionnaire using www.surveymonkey.co.uk to produce quantitative data on how schools currently provide access to nature for their pupils (see Appendix).

When answering questions about children's opportunities to experience access to nature, respondents were asked to think of one specific class of pupils with which they were familiar, in order to normalise the results as the amount of access may vary substantially across different year groups (Waite, 2010). The first section of the questionnaire focused on school-organised visits to off-site locations over the 2016/17 academic year. Questions included:

- In the current school year (2016-17) how many opportunities will pupils in this class have to experience school-organised visits to off-site location (i.e. fieldtrips and similar trips out)?
- Of these visits to off-site locations, how many will be to sites under the following categories:
    - Visits to natural sites whose main purpose is nature conservation and where pupils can experience direct contact with nature (e.g. nature reserves, national parks)

- Vitis to sites whose main purpose is not nature conservation, but where pupils can still experience direct contact with nature (e.g. parks, beaches, historic monuments in natural settings)
- Visits to nature education sites where pupils can experience indirect contact with nature (e.g. zoos, museums, aquariums).

These categories follow Kellert's (2002) theory of forms of interaction with nature by specifying whether the experience of nature is direct or indirect. Direct experience with nature (physical contact between children and natural features and/or non-human species in natural environments) has a greater impact on children's development than indirect experience (physical contact in more restricted and managed contexts such as zoos and or museums) or 'vicarious' experience (contact with representations of nature, such as on television or in books) because of the richness and diversity of natural environments (Abrams & Savahl, 2017; Kellert, 2002). Distinguishing between sites whose main purpose is nature conservation and sites with a different main purpose also allowed us to make inferences about the availability of access to different types of natural site. Following questions asked respondents about other opportunities for pupils to learn about or interact with nature through direct, indirect and vicarious experiences. Each response was categorised by its region in England (South, Midlands or North). Data were analysed using a coding system and we calculated the proportion of respondents answering for each category of question.

A potential limitation of this method is that responses may be more likely to come from staff members who already have an interest in nature. However, the use of interviews with complementary questions allowed triangulation of results to avoid bias in the conclusions.

2.1.1. Questionnaire participants

Invitations to participate in the questionnaire were emailed to a random selection of 4,000 primary schools across the whole of England, receiving 295 responses (7.4% response rate). Following removal of responses from duplicate schools (n=35) and those with insufficient data (n=25), a total of 235 responses were used in the analysis.

Questionnaire responses were from 41% head teachers, 14% other senior management roles, 33% teachers and teaching assistants, and 12% administration roles and other school roles. The regional locations of questionnaire responses were roughly proportional to the population of different regions of England (Table 1).

2.2. Interviews with school staff members

We conducted semi-structured interviews with staff members at 20 different schools in the English counties of Devon and Kent. The aim of this component of the study was to complement data from the questionnaire and allow more detailed investigation of the opportunities and challenges of accessing nature through schools. Schools were randomly selected from lists provided by Devon and Kent county councils, and interviewees approached via email. Each staff member provided written consent to be interviewed and all interviews were audio-recorded. Respondents were asked a series of open questions about their school's provision of access to nature through the three categories of sites used in the questionnaire, the school's policies in terms of school trips and on-site natural environments, as well as the interviewee's own personal attitudes towards providing access to nature. Questions were structured to complement the questionnaire questions to allow for comparison between the two methods. Interviews were transcribed and coded using NVivo 11 software to analyse the responses. Data were coded using relevant headings based on the questionnaire data and a framework was developed to support the analysis of the data. The framework allowed the identification and comparison of key opportunities and challenges of access to nature through schools.

2.2.1 Interview participants

Interview responses (N=20) had equal numbers from Devon and Kent. 10% of responses were from head teachers, 35% from other senior management roles, 50% from teachers and teaching assistants, and 5% from other roles.

2.3. Distance analysis

To assess the potential for schools to take trips to natural environments, we calculated distances between schools in Kent and various types of nature spaces within 30 km of the county borders, using ArcGIS 10.4 and R (Version 3.3.2, R Development Core Team, 2016). School and nature spaces (National Nature Reserves, Local Nature Reserves, Royal Society for the Protection of Birds (RSPB) reserves, public parks and public gardens) distribution data were obtained from online resources. For schools, we used a database published after Freedom of Information Requests to the UK Department for Education that contains coordinates for each school in England (Department for Education 2016). National Nature Reserves and Local Nature Reserves GIS files were obtained from HM Government's open data website (https://data.gov.uk). RSPB reserves GIS files were obtained from the society's

website (https://www.rspb.org.uk/our-work/conservation/conservation-and-sustainability/mapping-and-gis/). GIS files of Public parks and public gardens were obtained from Ordnance Survey (https://www.ordnancesurvey.co.uk/opendatadownload/products.html#OPGRSP). This data shows the size and location of green spaces accessible to the public including public parks or gardens, play spaces, allotments, sports areas, churchyards and burial sites.

2.3.1 Nature reserves

Within National Nature Reserves, Local Nature Reserves and RSPB reserves we created 10 random points from which to measure the shortest distance to each school. We then calculated the mean of these distances to give a representative estimate of the distances between schools and these types of green spaces. Distance calculations for National Nature Reserves, Local Nature Reserves and RSPB reserves were made using the Open Source Routing Machine (OSRM) with the R package OSRM (Giraud, Cura & Viry, 2017), a route planning software that utilises OpenStreetMap data to calculate the shortest paths in road networks. Coordinates of each random point within reserves were transformed into WGS84 coordinates for use in OSRM, then the routing algorithm calculated the driving path between schools and these points.

2.3.1.1. Sample size for Nature reserve distance analysis

In total, 402 schools were assessed in terms of their distance to nature reserves, and for each school the route with the shortest distance was selected for descriptive analysis. For National Nature Reserves, Local Nature Reserves and RSPB reserves no minimum size was used, as they were all larger than the 5000 m^2 (0.5 ha) suggested by the World Health Organisation (WHO 2016).

2.3.2. Public parks and gardens

For public parks and gardens, we used a different approach. Public parks and gardens are usually located in urban areas, or at least close to settlements, and interview respondents also identified them as sites where children had direct access to nature, usually on foot. Thus, we assessed whether schools could access them on foot. We calculated how many schools have access to a public park or garden within three km, setting three km as the tail end of the possible walking distance based on the questionnaire and interview results. We used the Google Maps API with the R package gmapsdistance (Melo & Zarruk, 2016) to calculate

walking distance from each school to all the nearest entrance of all public parks and gardens that were within three km (Euclidean distance) and are larger than 5000 m^2 (0.5 ha) (*per* WHO 2016). The Google Maps API is a route planner that calculates shortest paths in road networks, taking advantage of Google Maps' road and footpath mapping.

3.2.2.1. Sample size for public parks and gardens distance analysis

358 schools were assessed, of which 314 (87.7%) had public parks or gardens within three km walking distance.

3.2.3. Strengths and weaknesses

A strength of this methodology is the number and diversity in types of public green space covered in the analysis, as the Ordinance Survey Greenspace data provides comprehensive coverage of green spaces in the UK that are publicly accessible. However, where vehicle transport is necessary to reach these green spaces, no consideration is given to whether there is suitable access or parking facilities for schools to visit. Furthermore, both Google Maps and Open Street Maps have limitations when it comes to walking short-cuts, alternative routes, mapping of roads with sidewalks etc. Despite their limitations, both provide widely used distance calculations (e.g. Chen et al., 2019; Zhou and Kim, 2013), that are relatively accurate (Haklay, 2010).

2.3.1 Comparing urban versus rural areas for walking access

We assessed whether schools in rural or urban areas differ in potential access to nature spaces. Using the map of the Rural Urban Classification of Lower Super Output Areas (produced by the Office for National Statistics), we classified all schools as falling into the following classes: rural town and fringe; rural village and dispersed; urban city and town; and urban major conurbation. We then performed one-way Analysis Of Variance (ANOVA) tests with post-hoc Tukey pairwise comparison tests (significance level 0.05 for both tests) to identify if there are differences in the average distance to conservation areas and public parks and gardens across the schools in four rural-urban classes.

3. Results

3.1 Questionnaire:

3.1.1 Access to nature through school trips to natural environments

The number of school trips to off-site locations in the 2016/17 school year varied considerably between schools, but most schools (60.0%) took five or fewer school trips over the year (Table 2). Of these trips, questionnaire responses suggest that most trips have a natural element as 72.1% of trips gave children opportunities to experience direct or indirect contact with nature. More precisely, 29.0% of trips were to sites whose main purpose is nature conservation and where pupils can experience direct contact with nature (i.e., nature reserves), 31.9% were to other sites where children could experience direct contact with nature, and 11.1% were to sites where the contact with nature was indirect (such as zoos or museums). The majority of schools (68.2%) provided at least one school trip to a nature reserve, but 89.0% of these schools provided fewer than 4 trips over the year, suggesting that this method of providing access to nature is not regular.

3.1.2. Limiting factors for access to nature through school trips

Lack of budget for taking pupils on school trips was the most commonly mentioned factor limiting the number of school-organised visits to sites where pupils can experience direct contact with nature, mentioned by 60.4% of respondents (Fig. 2). Other limiting factors included lack of time to visit sites and school curriculum requirements which meant that nature-based trips were not a priority for the school. This question was further explored through interview data.

3.1.3. Children's access to nature through school-based natural environments and activities

The most common school-based opportunity for children to have direct contact with nature was through school-based natural environments such as nature trails, natural playgrounds or forest schools (93.2% of schools). Schools also commonly provided direct contact with nature through interaction with domesticated nature (72.8%) and extra-curricular activities (60.0%) (Table 3). Questionnaire data showed that access to nature through on-site natural environments was generally frequent, with 37.6% of them being used every day, and 89.0% being used at least a few times per month (4**Table**).

3.2. Interviews

3.2.1. Priorities for choosing locations for school trips

Interview respondents were asked about their school's priorities for choosing locations for school trips. Only 17.6% of references were about providing access to nature. The most common reason for choosing particular sites was the need to fulfil or support curriculum objectives (64.7%), with the most commonly mentioned sites being formal education sites where children could learn about animals and their habitats as part of their science curriculum. Of the 20 schools interviewed, 16 took trips to zoos or wildlife parks. Other common locations included farms (5 schools), aquariums (4 schools), and other education centres such as the Eden Project in Cornwall (4 schools). Trips to nature reserves were more likely to be associated with outdoor activities such as bushcraft or camping rather than directly fulfilling curriculum objectives, despite their relevance to science curriculum objectives such as "identify and name a variety of plants and animals in their habitats" (Key Stage 1) or "identify how animals and plants are adapted to suit their environment" (Key Stage 2) (Department for Education, 2015).

3.2.2. Limiting factors for access to nature through school trips

In concurrence with the questionnaire responses, lack of budget was the most commonly mentioned limiting factor for interview respondents, mentioned by 60.0% of respondents (Fig. 2). However, interview respondents emphasised that this limitation referred predominantly to the cost of transport hire, necessary to travel to sites not accessible by walking. One interviewee explained:

"Schools just don't have any funding at the moment to give children those opportunities if we don't live there. If we were just around the corner, and could just walk there, it would be fine. And we have no train, we have no public transport, so we have to do it by coach" (Interviewee 13)

This suggests that the distance between schools and natural environments is also a limiting factor, as distances beyond about three km from the school site are only accessible through motorised transport (see also Maas et al. 2006 on the three km boundary). The impact of distance between schools and natural environments is further explored through the results of the distance analysis below.

3.2.3. Limiting factors for school site-based access to nature

The most commonly mentioned limiting factor for school-based access to nature is that the pressures of the curriculum mean there is limited time for outdoor learning (60% of interview respondents). Several respondents expressed the opinion that in recent years the national curriculum has become more demanding on both children and teachers, and standardised testing means classroom-based learning has become prioritised:

"A lot of it comes down to time, there's a lot of time constraints on teachers, a lot to fit in. It's a packed curriculum and the easiest thing to do is just to be inside, it's more controllable" (Interviewee 7)

Other limitations include teachers' lack of confidence or engagement with outdoor learning as a concept (55% of respondents) and worries about health and safety (40% of respondents). A large percentage (55%) of respondents felt that they did not receive sufficient training in taking children outdoors, with one teacher commenting:

"I wouldn't ever take a child into the forest and build dens because I know there are so many dangers… poisonous plants, dog mess, tripping over sticks… as a profession we need more training to use outdoor areas in order to feel confident in keeping children safe" (Interviewee 10)

A common theme in interviews was that teachers with a particular interest and passion for outdoor learning have to provide the impetus to ensure it is included in the timetable. Several mentioned that the importance of access to nature is not recognised or prioritised in the primary school curriculum or on teacher training courses.

3.3. Distance analysis

Analysis of the distances between schools and nature reserves (n=402) shows that although 76.1% of schools analysed were within 10 km of a nature reserve, only 23.6% were within the tail end of the walking distance (three km) (Fig. 3) Overall, the mean walking or driving distance between schools and their nearest nature reserve was 7.8 km. The type of nature reserve most likely to be the closest to schools was Local Nature Reserves (which were a mean of 8.7 km from schools), followed by Country Parks (21.2 km), National Nature Reserves (22.3 km) and RSPB reserves (31.3 km).

3.3.1. Green spaces within walking distance of schools

In comparison, public parks and gardens were an average of 1.6 km from schools, with 87.7% (n=358) of schools having a public park or garden within reported tail end of the walking distance (three km) and more than 1/3 within one km (n = 137) (Fig. 4). This implies that schools generally have good non-vehicular access to public parks and gardens as from questionnaire data, we know that 41.2% of trips to sites where pupils can experience direct contact with nature were within 3.2 km of the school. However, only a little more than 10% of the schools have access to green spaces at less than 300m walking distance, which is the threshold suggested by WHO (2016) for population wide assessments. The difference between the percentage of schools who report taking pupils to local green spaces and the percentage of schools able to access these spaces suggests that there are other factors apart from distance that limit schools' use of local green spaces.

3.3.1. Differences between rural and urban areas in the provision of walkable access to nature

ANOVA suggests that there were no statistical differences between the four school classes along the rural-urban continuum and distance to National Nature Reserves and RSPB reserves. Urban schools are on average significantly closer than rural schools from public parks and gardens in Kent. Analysis of variance (ANOVA) indicated significant differences between the urban and rural groups, $F(3, 357) = 26.85$, $p < 0.05$. A post-hoc Tukey test indicated significant differences ($p < 0.05$) between the rural groups and the two urban groups (Fig. 5 and Table 5), with urban groups having closer potential access to public parks and gardens. Also, schools in cities and towns but not major conurbations are closer to Local Nature Reserves than schools in rural areas (ANOVA test, $F(3, 419) = 11.21$, $p < 0.05$). A post-hoc Tukey test showed that schools in the ONS classification 'Urban: city and town' are closer to Local Nature Reserves than schools in rural areas and major conurbations (Fig. 6 and Table 6).

4. Discussion

Access to nature is important for children, for reasons of education, personal development, health and wellbeing. The results of this study suggest that school staff do not underestimate

the importance of providing access to nature for their students; however, the opportunities for schools to provide this access are limited.

The majority of primary schools in England do provide children with opportunities to experience direct contact with nature through school trips to nature reserves, accessing local green spaces, and through activities on the school site. A major factor preventing schools from accessing off-site nature reserves and similar was the distance between schools and natural environments, due to the monetary cost of transport hire. Schools are limited by a lack of funding, as real-terms per pupil funding for mainstream schools decreased by 8.0% between 2014 and 2015, and is set to decrease by a similar amount between 2019 and 2020 due to cost pressures (National Audit Office, 2016). With 95.7% of schools' income coming from government grants in 2014-15, lack of government spending on education can be seen as a major constraint on schools' access to nature in England.

Schools do have a high potential to access local natural environments that can be used to provide a "wild" experience close to or within the school site, which do not necessarily require motorised transport or take a lot of time out of the school day. 93.2% of schools surveyed provided access to school-based natural environments, such as a nature trail or natural playground. Distance analysis found that 87.7% of schools were within tail end of the walking distance of a public park or garden (three km), while 23.6% of schools were within walking distance of a site specifically designated for nature conservation (three km).

Nevertheless, very quick and cheap access to nature such as the 300 m threshold as suggested by the WHO (2016) or Natural England (i.e. a five-minute walk) is rare. Regarding nature conservation sites, there are no RSPB, National or Local nature reserves at 300 m from a school. However, two points have to be made here that limit the usefulness of the 300 m threshold: a) it is not designed for schools but for population-wide assessments; and b) our results suggest that schoolchildren often undertake longer walking trips and excursions as part of the curriculum.

Interestingly, schools in broadly-defined urban areas have better potential access to public parks and gardens and some areas designated for nature protection (Local Nature Reserves). As we can see in Fig. 7, in Kent, broadly defined urban areas have larger concentrations of public parks and gardens and Local Nature Reserves, and this explains this perhaps counterintuitive finding. While this indicates that urban areas are not as nature-poor as sometimes commonly perceived (Haaland et al. 2015), still, as mentioned above biodiversity-

rich conservation areas are statistically equally far from rural and urban schools. Furthermore, it is probable that many rural areas are richer in non-designated green spaces such as small woodlands or traditional pastoral landscapes, as in the case of the High Weald Area of Outstanding Natural Beauty in SW Kent. Thus, the key message from our finding is not that urban areas have better potential access to green spaces than rural areas, but that urban areas are not radically worse than rural areas in terms of distance to generic green space.

With an increasingly urban population, town planners and environmentalists alike should promote the creation of new green spaces like parks and gardens where children can explore independently (Derr & Lance, 2012). Town planners could also ensure that new or existing schools are provided with space for natural environments within the school site. These environments would be easily accessible for schools, saving both time and money, and would allow for frequent visits.

Despite the majority of schools having access to green sites on or close to the school sites, schools still struggle to provide time for children to visit these sites. This suggests that there are underlying factors preventing access. Our results found that a major limitation on children's access to nature through both local and more remote environments is lack of time. Teachers feel that the pressure of delivering the National Curriculum means there is limited time for nature-based activities, which are seen as less essential than subjects assessed in standardised testing such as English and Maths. Due to the increasing standards expected of teachers many choose to take a more direct classroom-based approach to teaching rather than utilising the outdoors (Tilling, 2018). Planning agendas which decrease the amount of natural space in urban areas alongside increased curriculum pressures mean ecological learning is mainly taught through books and videos, rather than direct contact with nature (Barker, Slingsby, & Tilling, 2002). Reducing the high burden of learning material and the amount of standardised testing required by schools could allow teachers more time and energy to devote to activities such as taking children into nature.

Another factor preventing access is teachers lack of engagement and confidence with outdoor learning, which may also be partially attributed to the need for quick and effective learning. The same cultural and societal factors that have shaped the generational shift away from nature-based recreation towards indoor recreation are likely also influencing teachers and school Senior Leadership Teams (SLTs) in their decisions over how to structure teaching time. This 'performativity agenda' of modern teaching and teachers' fear of losing control

has created a model of classroom-based learning that is now so ingrained in teachers' methods it can be difficult for them to break away and try something new (Glackin, 2018; McClintic & Petty, 2015; Waite, 2010). Our findings support those of Scott et al (2014) who write that barriers to teaching outdoors can be grouped into two main areas: school culture and teacher confidence. Teachers have limited training in teaching outdoors and need support from school senior leadership teams to overcome barriers such as practical challenges and a risk-averse culture (Waite, 2010) Many of the teachers interviewed felt that they were not given sufficient training in taking children outdoors, and many were nervous about doing so, despite recognising how valuable this was for the pupils. Kendall et al (2006) report that the amount and quality of training in education outside the classroom varies substantial across teacher training courses and institutions, and that some teachers may be inadequately prepared for outdoor teaching as a result. On average, trainee teachers spend just a few days training in taking pupils off-site during a one- or two-year training course.

In some of the schools visited for interviews, SLTs had made an effort to remove barriers to taking children outdoors, for example by providing waterproof boots and coats for pupils and designating time in teaching schedules for teaching outdoors. But this is rare, and relies on the commitment and enthusiasm of SLTs and available time and budget in an already stretched school environment. To enable children to access nature regularly in all schools, there needs to be both greater investment in schools to provide budget to overcome barriers, and more training in outdoor learning to equip teachers and prospective teachers with the knowledge, skills and behaviours required to teach outside.

5. Conclusion

In conclusion, children's access to nature through primary schools in England is partially limited by spatial factors, namely the distance between schools and natural environments. However, even when schools are in walkable proximity to natural environments (including parks and gardens) other factors, such as pressure of delivering the National Curriculum and teachers lack of engagement with outdoor learning, may limit the opportunities for student's direct contact with nature. Thus, in order to improve children's access to nature, planning initiatives to create more natural environments close to school sites should be accompanied by measures to reduce the non-spatial limitations to access, such as the pressures of curriculum requirements and funding.

References

Abrams, S., & Savahl, S. (2017) Nature as children's space: A systematic review. *The Journal of Environmental Education,* 0, 1-31. doi – 10.1080/00958964.2017.1366160

Ardoin, N., & Bowers, A. W. (2020) Early childhood environmental education: A systematic review of the research literature. *Educational Research Review*, 31, 100353. doi – 10.1016/j.edurev.2020.100353

Barker, S., Slingsby, D., & Tilling, S. (2002). *Teaching biology outside the classroom. Is it heading for extinction?* Report for Field Studies Council and British Ecological Society. Field Studies Council, Shrewsbury, United Kingdom.

Bates, C. R., Bohnert, A. M., & Gerstein, D. E. (2018) Green schoolyard in low-income urban neighbourhoods: natural spaces for positive youth development outcomes. *Frontiers in Psychology*, 9, 805. doi – 10.3389/fpsyg.2018.00805

Bentsen, P., Jensen, F. S., Mygind, E., & Randrup, T. B. (2010). The extent and dissemination of udeskole in Danish schools. *Urban Forestry & Urban Greening*, 9(3), 235-243. doi – 10.1016/j.ufug.2010.02.001

Bikomeye, J. C., Balza, J., & Beyer, K. M. (2021) The impact of schoolyard greening on children's physical activity and socioemotional health: a systematic review of experimental studies. *International Journal of Environmental Research and Public Health,* 18(2), 535. doi – 10.3390/ijerph18020535

Chambers, J.M., Cleveland, W.S., Kleiner, B. & Tukey, P.A. (1983). Graphical Methods for Data Analysis. Wadsworth & Brooks/Cole.

Chen, Y. N., Coker, D., Kramer, M. R., Johnson, B. A., Wall, K. M., Ordóñez, C. E., McDaniel, D., Edwards, A., Hare, A. Q., Sunpath, H., & Marconi, V. C. (2019). The impacts of residential location on the risk of HIV virologic failure among ART users in Durban, South Africa. *AIDS and Behavior,* 23(9), 2558-2575.

Colding, J., Gren, Å., & Barthel, S. (2020) The incremental demise of urban green spaces. *Land,* 9(5), 162. doi – 10.3390/land9059162

Corraliza, J.A., Collado, S., & Bethelmy, L. (2017). Effects of Nearby Nature on Urban Children's Stress. *Asian Journal of Environmental-Behaviour Studies,* 2(3), 37-46. doi - 10.21834/aje-bs.v2i3.186

Cox, D. T. C., Shanahan, D. F., Hudson, H. L., Fuller, R. A., & Gaston, K. J. (2018) The impact of urbanisation on nature dose and the implications for human health. *Landscape and Urban Planning*, 179, 72-80. doi – 10.1016/j.landurbplan.2018.07.013

Creswell, J. W., & Plano Clark, V. L. (2007) *Designing and conducting mixed methods research.* Thousand Oaks, California: BMJ Publishing Group

Department for Education. (2015). *Statutory guidance: National curriculum in England: science programmes of study.* London, United Kingdom. Available from: https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study/national-curriculum-in-england-science-programmes-of-study (accessed August 2017).

Department for Education. (2016) Reply to Peter Ramsey's Freedom of Information request. Available at https://www.whatdotheyknow.com/request/locations_of_all_uk_primary_and, accessed 1 May 2018.

Derr, V., & Lance, K. (2012). Biophilic Boulder: Children's Environments That Foster Connections to Nature. *Children, Youth and Environments,* 22(2), 112-143. doi - 10.7721/chilyoutenvi.22.2.0112

Fisher, J. A. (2001). The demise of fieldwork as an integral part of science education in United Kingdom schools: a victim of cultural change and political pressure? *Pedagogy, Culture and Society.* 9(1), 75-96. doi - 10.1080/14681360100200104

Gascon, M., Sánchez-Benavides, G., Dadvand, P., Martínez, D., Gramunt, N., Gotsens, X., Cirach, M., Vert, C., Molinuevo, J. L., Crous-Bou, M., & Nieuwenhuijsen, M. (2018). Long-term exposure to residential green and blue spaces and anxiety and depression in adults: A cross-sectional study. *Environmental Research,* 162, 231-239. Doi – 10.1016/j.envres.2018.01.012.

Glackin, M. (2017). 'Control must be maintained': exploring teachers' pedagogical practice outside the classroom. *British Journal of Sociology of Education,* 39(344), 61-76. doi – 10.1080/01425692.2017.1304304

Green, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed method evaluation designs. *Educational Evaluation and Policy Analysis*, 11, 255-74. doi – 10.3102/01623737011003255

Haklay, M. (2010). How good is volunteered geographical information? A comparative study of OpenStreetMap and Ordinance Survey datasets. *Environment and Planning B: Planning and Design,* 37(4), 682-703

Haaland, C., & van Den Bosch, C. K. (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: A review. *Urban Forestry & Urban Greening*, *14*(4), 760-771.

Hand, K.L., Freeman, C., Seddon, P.J., Recio, M.R., Stein, A., & Heezik, Y. (2018). Restricted home ranges reduce children's opportunities to connect to nature: Demographic, environmental and parental influences. *Landscape and Urban Planning,* 172, 69-77. doi - 10.1016/j.landurbplan.2017.12.004

Harris, F. (2017). Outdoor learning spaces: The case of forest school. *Area,* 50, 222-231. doi – 10.1111/area.12360

Her Majesty's Government (2018). A Green Future: Our 25 Year Plan to Improve the Environment. Available at www.gov.uk/government/publications/25-year-environment-plan, accessed 8th March 2021

Higgs, G., Fry, R., & Langford, M. (2012). Investigating the implications of using alternative GIS-based techniques to measure accessibility to green space. *Environment and Planning B: Planning and Design*, 39, 326-343. doi - :10.1068/b37130

Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: from theory to practice. *Field Methods,* 18(1), 3-20. doi – 10.1177/1525822X05282260

Ives, C. D., Oke, C., Hehir, A., Gordon, A., Wang, Y., & Behessy, S. A. (2017) Capturing residents' values for urban green space: mapping, analysis and guidance for practice. *Landscape and Urban Planning,* 161, 32-43

Kellert, S.R. (2002). Experiencing nature: Affective, cognitive, and evaluative development. Pages 117-153 In: Kahn, P. Kellert, S. (eds) *Children and nature: Psychological, sociocultural, and evolutionary investigations*. Cambridge: MIT Press.

Kendall, S., Murfield, J., Dillon, J., & Wilkin, A. (2006). *Education Outside the Classroom: Research to identify what training is offered by initial teacher training institutions.* Nottingham: DfES Publications.

Kimbell, A. R., Schuhmann, A., & Brown, H. (2009). More kids in the woods: Reconnecting Americans with nature. *Journal of Forestry*, 107(7), 373-377. doi - 10.1093/jof/107.7.377

Kuo, M., Barnes, M., & Jordan, C. (2019) Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. *Frontiers in Psychology, 10, 305. doi* – 10.3389/fpsyg.2019.00305

Li, D., & Sullivan, W. C. (2016) Impact of views to school landscapes on recovery from stress and mental fatigue. *Landscape and Urban Planning*, 148, 149-158. doi - 10.1016/j.landurbplan.2015.12.015

Lock, R. (2010) Biology fieldwork in schools and colleges in the UK: an analysis of empirical research from 1963 to 2009. *Journal of Biological Education*, 44(2), 58-64. doi – 10.1080/00219266.2010.9656195

Louv, R. (2005). *Last Child in the Woods*. Chapel Hill, NC: Algonquin Books.

Maas, J., Verheij, R. A., Groenewegen, P. P., De Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: how strong is the relation?. *Journal of Epidemiology & Community Health*, *60*(7), 587-592.

Malone, K., & Waite, S. (2016). *Student Outcomes and Natural Schooling.* Plymouth, United Kingdon. Available from http://www.plymouth.ac.uk/research/oelres-net (accessed July 2020).

Matisziw, T.C., Nilon, C.H., Wilhelm Stanis, S.A., LeMaster, J.W., McElroy, J.A., & Sayers, S.P. (2016). The right space at the right time: The relationship between children's physical activity and land use/land cover. *Landscape and Urban Planning*, 151, 21-32. doi - 10.1016/j.landurbplan.2016.03.006

McClintic, S., & Petty, K. (2015). Exploring early childhood teachers' beliefs and practices about preschool outdoor play: A qualitative study. *Journal of Early Childhood Teacher Education*, 36(1), 24-43. doi – 10.1080/10901027.2014.997844

McCormick, R. (2017) Does access to green space impact the mental well-being of children: a systematic review. *Journal of Pediatric Nursing*, 37, 3-7. doi – 10.1016/j.pedn.2017.08.027

Melo, R.A., & Zarruk, D. (2016). Package "gmapsdistance". R Package version 3.3.

National Audit Office. (2016). *Financial sustainability of schools.* London, United Kingdom. Available from: www.nao.org.uk/report/financial-sustainability-in-schools (accessed August 2017).

Natural England. (2009) *Report to Natural England on Childhood and Nature: A survey on changing relationships with nature across generations.* Cambridgeshire: UK. Available at http://publications.naturalengland.org.uk/publication/5853658314964992, accessed 8th March 2021

R Development Core Team (2017). R*: a language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria, www.R-project.org.

Rigolon, A. (2017). Parks and young people: An environmental justice study of park proximity, acreage, and quality in Denver, Colorado. *Landscape and Urban Planning,* 165, 73-83. doi - 10.1016/j.landurbplan.2017.05.007

Scott, G. W., Boyd, M., Scott, L., & Colquhoun, D. (2014). Barriers to biological fieldwork: what really prevents teaching out of doors. *Journal of Biological Education*, 49(2), 1-14. doi – 10.1080/00219266.2014.914556

Scott, J. T., Kilmer, R. P., Wang, C., Cook, J. R., & Haber, M. G. (2018) Natural environments near schools: potential benefits for socio-emotional and behavioural development in early childhood. *American Journal of Community Psychology*, 62(3-4), 419-432. doi – 10.1002/ajcp.12272

Smith, M. A., Dunhill, A., & Scott, G. W. (2017) Fostering children's relationship with nature: exploring the potential of Forest school. *Education 3-13,* 46(5), 525-534. doi – 10.1080/03004379.2017.1298644

Soga, M., Gaston, K. J. (2016). Extinction of experience: The loss of human-nature interactions. *Frontiers in Ecology and the Environment,* 14(2), 94-101. doi - 10.1002/fee.1225

Soga, M., Yamanoi, T., Tsuchiya, K., Koyanagi, T. F., & Kanai, T. (2018) What are the drivers of and barriers to children's direct experiences of nature? *Landscape and Urban Planning,* 180, 114-120. doi – 10.1016/j.landurbplan.2018.08.015

Souter-Brown, G. (2015) *Landscape and Urban Design for Health and Well-Being.* Abingdon, Oxon: Routledge

Stasiuk, P. (2016) Early nature lessons in Denmark's forest preschools. The Official Website of Denmark. Available at http://denmark.dk/en/meet-the-danes/ forest-preschools, accessed 8th March 2021.

Tan, Y. S. M., & Atencio, M. (2016) Unpacking a place-based approach – "What lies beyond?" Insights drawn from teachers' perceptions of Outdoor Education. *Teaching and Teacher Education*, 56, 25-34. doi – 10.1016/j.tate.2016.02.001

Tilling, S. (2004). Fieldwork in UK secondary schools: Influences and provision. *Journal of Biological Education*, 38(2), 54-58. doi - 10.1080/00219266.2004.9655902

Tilling, S. (2018). Ecological science fieldwork and secondary school biology in England: does a more secure future lie in Geography? *The Curriculum Journal*, 29(4), 538-556. doi – 10.1080/09585176.2018.1504315

Ulset, V., Vitaro, F., Brendgen, M., Bekkhus, M., & Borge, A. I. H. (2017) Time spent outdoors during preschool: Links with children's cognitive and behavioral development. *Journal of Environmental Psyhology*, 52, 69-80. doi - 10.1016/j.jenvp.2017.05.007

Wallner, P., Kundi, M., Arnberger, A., Eder, R., Allex, B., Weitensfelder, L., & Hutter, H. (2018) Reloading pupils' batteries: impact of green spaces on cognition and wellbeing. *International Journal of Environmental Research and Public Health*, 15(6), 1205. doi – 10.3390/ijerph15061205

Waite, S. (2010). Losing our way? The downward path for outdoor learning for children aged 2-11 years. *Journal of Adventure Education and Outdoor Learning*, 10(2), 111-126. doi - 10.1080/14729679.2010.531087

World Health Organisation (WHO), (2016). *Urban green spaces and health*. Copenhagen: WHO Regional Office for Europe. Available at https://www.euro.who.int/__data/assets/pdf_file/0005/321971/Urban-green-spaces-and-health-review-evidence.pdf?ua=1, accessed 21 July 2020.

Yao, W., Zhang, W., & Gong, Q. (2021) The effect of exposure to the natural environment on stress reduction: A meta-analysis. *Urban Forestry and Urban Greening*, 57, 126932. doi – 10.1016/j.ufug.2020.126932

Zhou, X., & Kim, J. (2013). Social disparities in tree canopy and park accessibility: A case study of six cities in Illinois using GIS and remote sensing. *Urban Forestry & Urban Greening,* 12(1), 88-97.

List of Tables

Table 1. Regional locations of online questionnaire responses compared to population of English regions (n=235)

Region of England	Percent of total English population (%)	Percent of questionnaire responses (%)
Southern England	58.1	63.5
The Midlands	11.8	13.1
Northern England	30.1	23.5

Table 2. Number of school trips taken in the school year 2016-2017 (n=235)

Number of school trips taken in the school year 2016-2017	Frequency	Percent (%)
0	1	0.4%
1-5	140	59.6%
6-10	47	20.0%
11-15	12	5.1%
16-20	11	4.7%
21-25	5	2.1%
26-30	9	3.8%
31+	10	4.3%

Table 3. Schools' provision of opportunities for pupils to learn about or interact with nature (n=235)

School-based opportunities for pupils to learn about or interact with nature	Frequency	Percent (%)
School-based natural environment(s) where children can have direct contact with nature (e.g. nature trail, natural playground, forest school)	219	93.2
Classroom-based nature education through activities, books, videos etc.	201	85.5

Interaction with domesticated nature (e.g. keeping chickens gardening)	171	72.8
Special events or visits from environmental educators to teach about nature at the school	135	57.4
Extra-curricular activities that provide opportunities to experience direct contact with nature	141	60.0
Other	13	5.5

Table 4. Regularity of use of school-based natural environments (n=218)

How regularly the school-based natural environment is used by pupils	Frequency	Percent (%)	Cumulative percent (%)
Daily	82	37.6	37.6
At least a few times a week	63	21.5	66.5
At least a few times a month	49	16.7	89.0
At least a few times a year	24	11.0	100.0

Table 5. Summary statistics: distance of schools from public parks and gardens. The number of schools is lower than the total number of schools because some schools in rural areas do not have a public park of garden at a distance < 3000 m.

Rural/Urban class	N	Mean (m)	sd	se
Rural town and fringe	47	2355.8	1289.6	188.1
Rural village and dispersed	58	2264.6	1448.2	190.1
Urban city and town	205	1371.9	853.8	59.6
Urban major conurbation	48	967.6	599.9	86.5

Table 6. Summary statistics: distance of schools from Local Nature Reserves.

Rural/Urban class	N	mean	sd	se
Rural town and fringe	73	7695.0	4017.6	470.2
Rural village and dispersed	104	8459.8	3531.9	346.3
Urban city and town	200	5670.4	5103.0	360.8
Urban major conurbation	46	7719.7	2326.7	343.0

List of Figures

Figure 1: Visual model for the mixed-method design

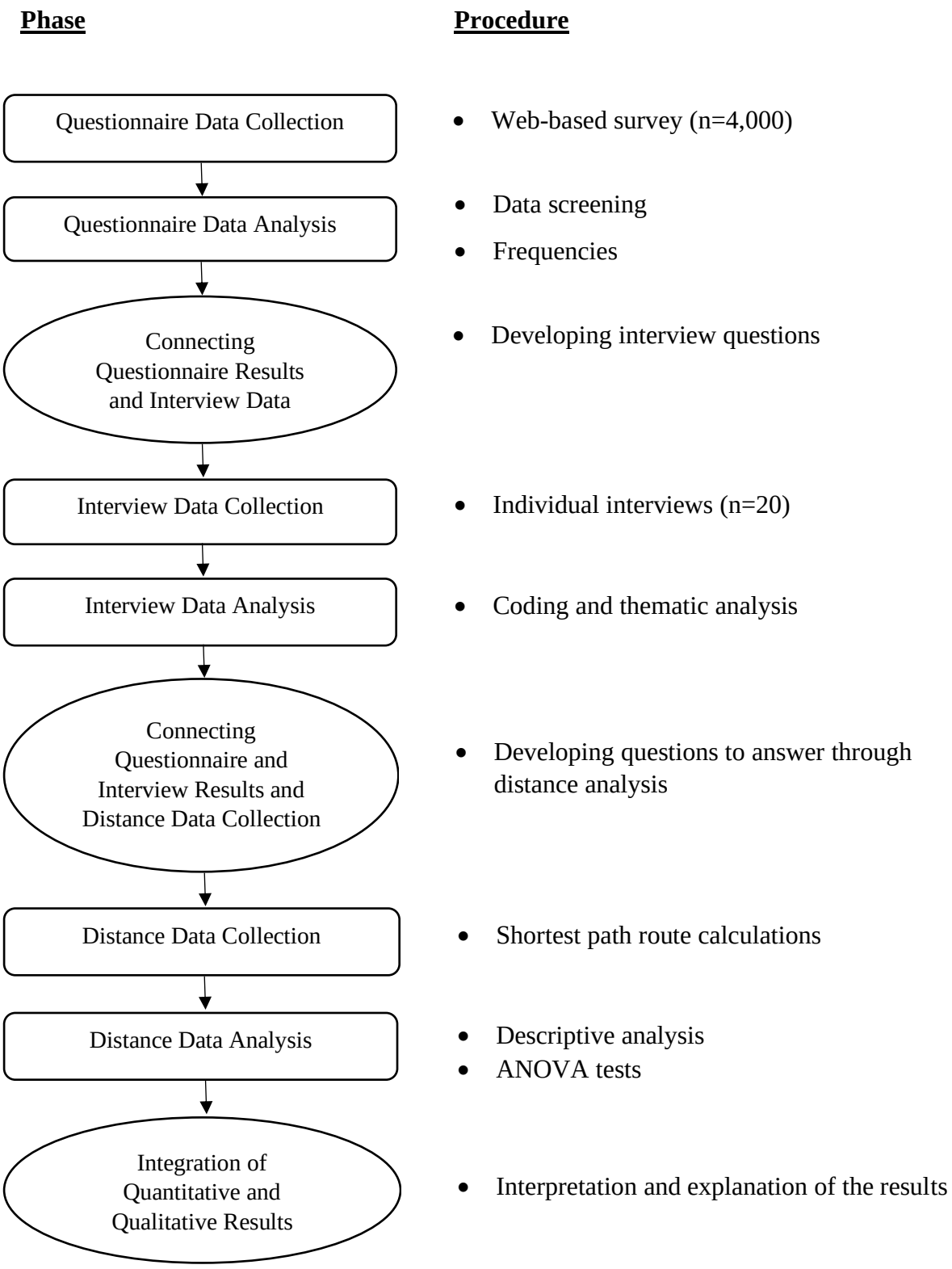

Figure 2: Factors which limit the number of school trips to sites where pupils can experience direct contact with nature

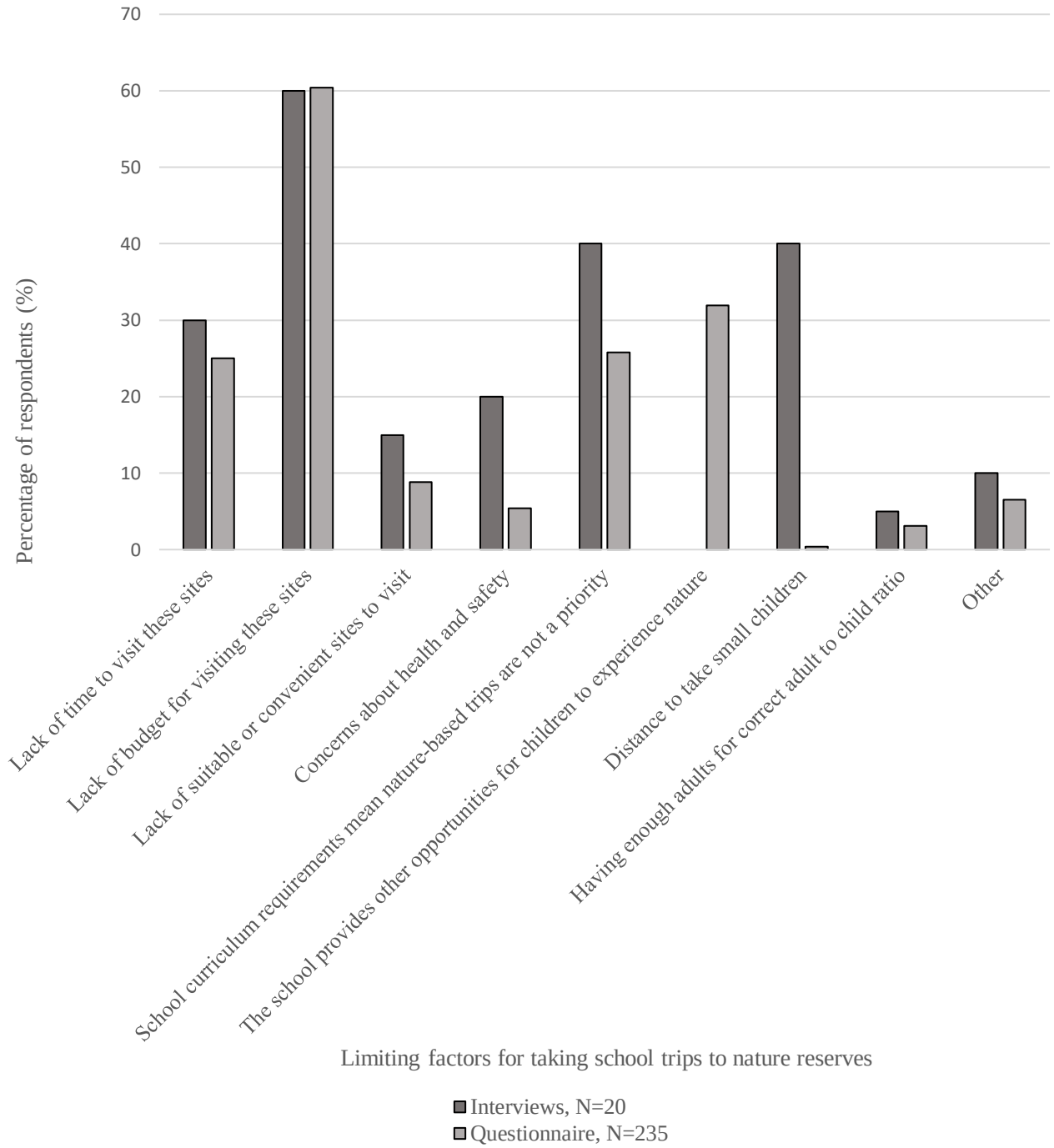

Figure 3: Minimum distances between schools and nature reserves (n=402)

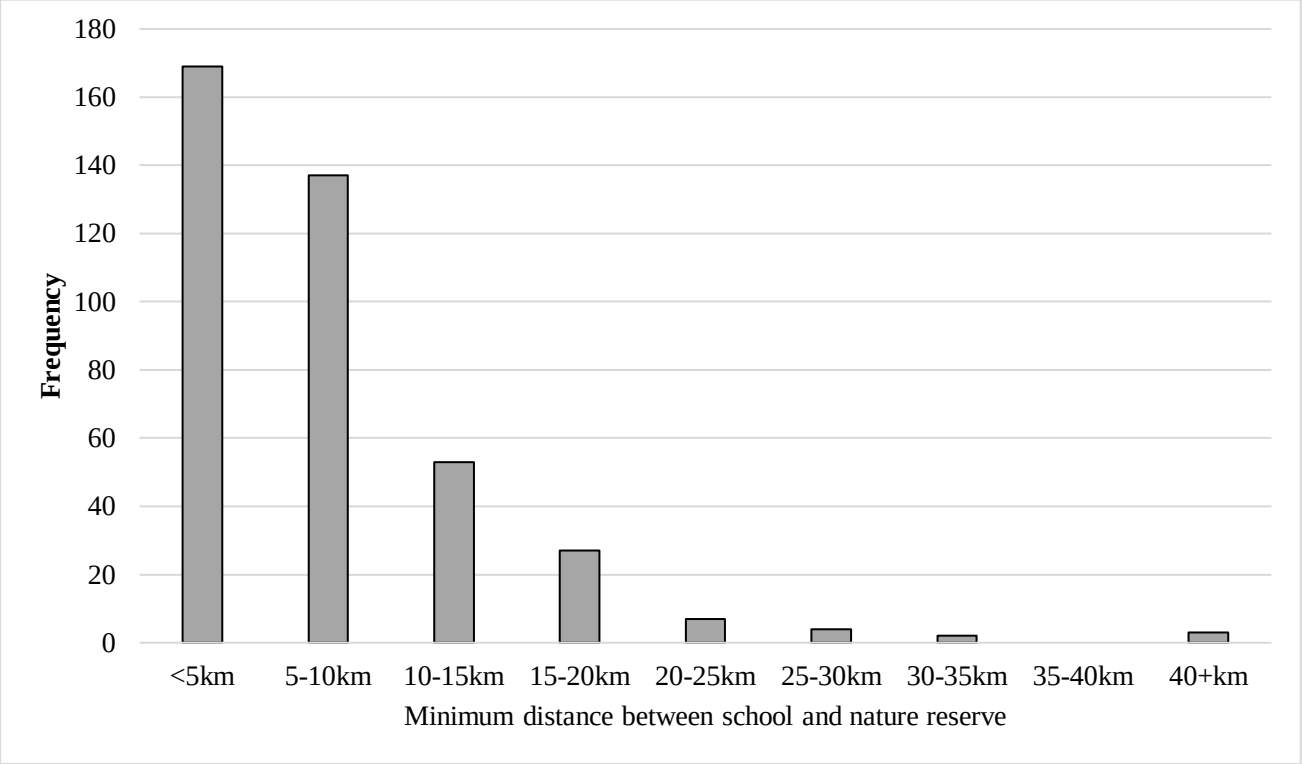

Figure 4: Minimum distances between schools and public parks and gardens (n=358).

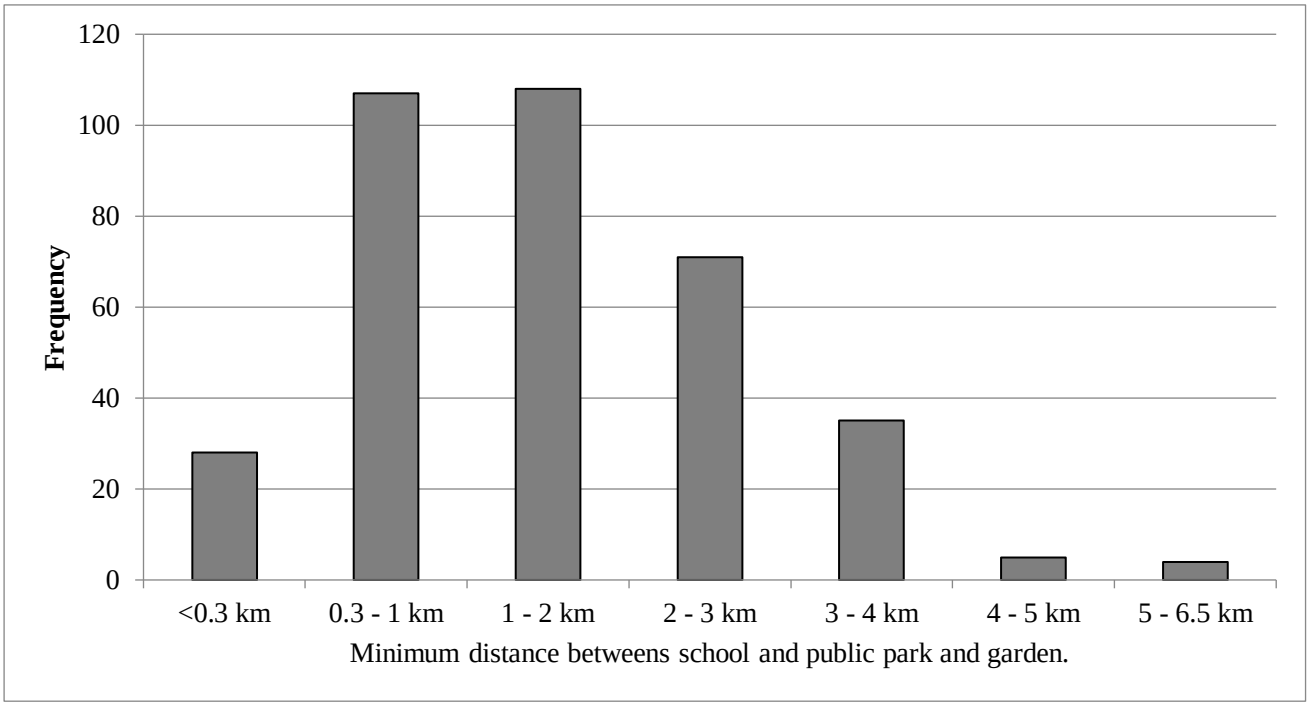

Figure 5. Mean distance to public parks and gardens for the four major types of rural-urban classification produced by the UK Office for National Statistics. The lower and upper extremes of the notch represent confidence intervals calculated as in Chambers et al. (1983).

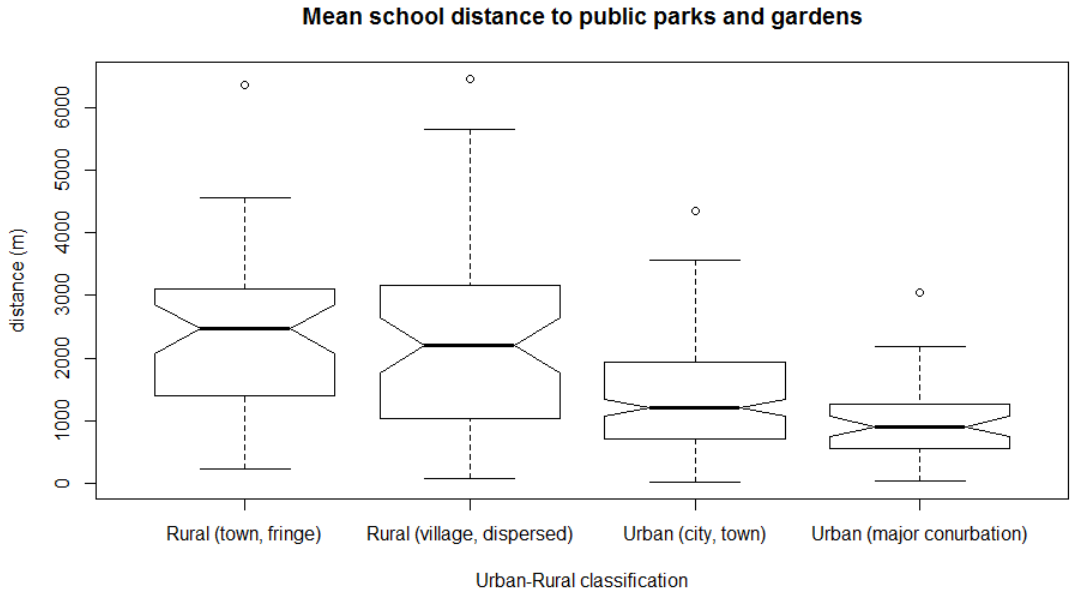

Figure 6. Mean distance to Local Nature Reserves for the four major types of rural-urban classification produced by the UK Office for National Statistics. The lower and upper extremes of the notch represent confidence intervals calculated as in Chambers et al. (1983).

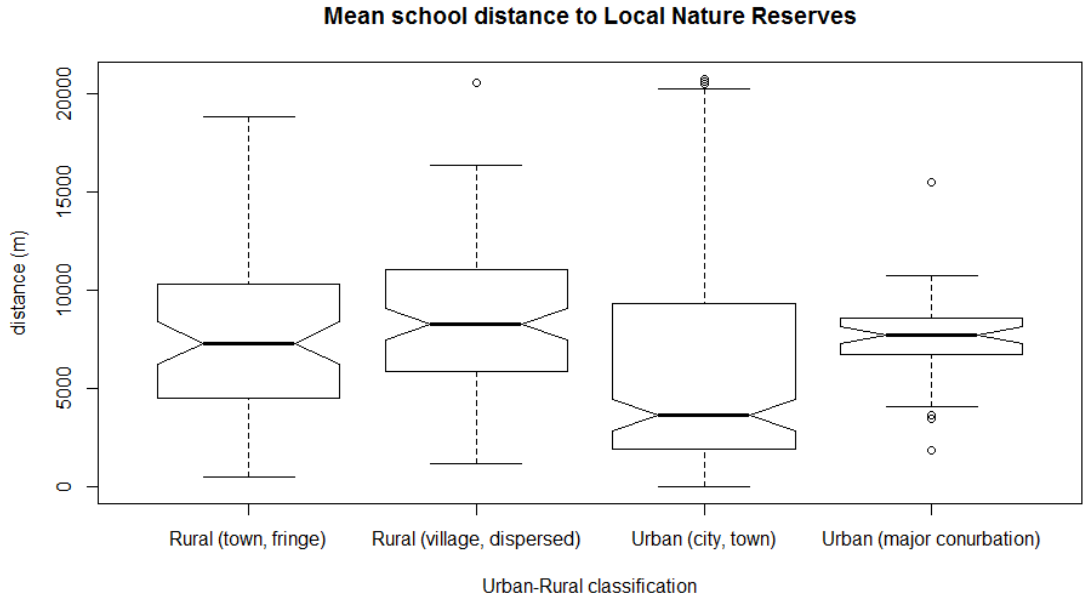

Figure 7. Map of Kent, classified into the four categories along the urban-rural continuum.