**The unrealised potential of school grounds in Britain to monitor and improve biodiversity**

Deborah J. Harvey1, Alan C. Gange1 and Hannah Harvey2

*1School of Biological Sciences, Royal Holloway University of London, Egham, England, 2Department of Psychology, Royal Holloway University of London, Egham, England*

Corresponding author: Dr Deborah Harvey, d.harvey@rhul.ac.uk

**Funding details:** This work was supported by the Woodspring Trust, under grant IMPS: KTG/62258.1 to ACG.

**Disclosure statement:** The authors declare no potential conflict of interest.

**The unrealised potential of school grounds in Britain to monitor and improve biodiversity**

**Abstract**

In this study, we aimed to understand the state of school grounds across Britain and how they are being used to support biodiversity conservation and pupils’ environmental education. We carried out an opt-in survey of schools across Britain, asking staff to report on habitats in their grounds and how they are used for learning. Our results showed that schools are under-using their grounds to provide habitats and environmental education. Realising the potential of these spaces could be a vital tool in the future success of species diversity. This could be done through changes to the national curricula and teacher training.

Keywords**:** Biodiversity; Schools; Habitats; School grounds; Learning; Environmental education

**Introduction and background to the study**

Many children spend little time outside in nature (Wheeler, Cooper, Page, & Jago, 2010); with potentially detrimental effects on their emotional self-regulation and wellbeing (Jenkin, Frampton, White, & Pahl, 2018)**.** At a time when crises in child mental health and biodiversity are frequently reported, it is important to understand how far school grounds are currently being used for biodiversity and education in this way. One way of increasing their contact with nature would be by ensuring that school grounds were environments which integrated nature, participatory and play areas (Danks, 2014). This could benefit not only children’s wellbeing, but also their educational outcomes, and the health of the environment.

***Decline in Biodiversity***

Biodiversity - the range and genetic diversity of species, habitats, and ecosystems in an area - is in a worrying state of decline. We are facing the Earth’s sixth mass extinction, comprising both reduced distribution and total loss of many species, which will impact on ecosystems vital for sustaining civilisation (Ceballos, Ehrlich, & Dirzo, 2017). In the UK, recent reports state that 56% of species have declined since 1970 and 13% of species of conservation concern are at risk of extinction (Hayhow et al., 2016; IUCN, 2018). Losses are also expected for more common species including hedgehogs (Wilson & Wembridge, 2018); common frogs (Grooten & Almond, 2018); birds (Sullivan, Newson, & Pearce-Higgins, 2015); and invertebrates (Eisenhauer, Bonn, & Guerra, 2019; Fordyce & Shapiro, 2003).

To address this crisis, ongoing assessment and monitoring is required (Chen & Cowie, 2013; Schmeller et al., 2015). Such work can be costly and, for species that have no economic impact, little funding is available; even for those that are rare (Chandler et al., 2017). There is also a need to raise public awareness of these declines (Eisenhauer et al., 2019), and to create new habitats (Petrovan & Schmidt, 2016; Wilson & Wembridge, 2018). Developing citizen science programmes focussed on increasing and monitoring biodiversity in existing spaces could provide a low-cost answer to all of these issues.

***Human contributions to the biodiversity decline***

Many factors contributing to the deteriorating state of global biodiversity, are influenced by pressures from population growth, migration, poverty, and consumerism – issues which can often seem insurmountable (Wood, Stedman-Edwards, & Mang, 2000). These factors, including urbanisation, pollution, and industrialisation, bring anthropogenic changes to natural environments, which can be directly or indirectly affected by our own attitudes and behaviours (Beckage et al., 2018). A lack of interest and engagement in protecting the environment and maintaining or improving levels of biodiversity is well-documented and has serious implications for the health of our planet (Beckage et al., 2018; Schultz, 2011).

The ‘extinction of experience’, a phrase coined by Robert Pyle almost 30 years ago to describe increasing disengagement from the natural world (Pyle, 1992, 1993), is often invoked as a matter of pressing concern both in the public and academic scientific domains (e.g. Soga & Gaston, 2016). Given the evidence that attitudes to the environment and engaging with nature are largely forged in childhood (Asah, Bengston, & Westphal, 2011; Gifford & Nilsson, 2014), the importance of starting to tackle this problem with the younger generations seems self-evident.

***School grounds***

The need to educate children means that schools are perfectly positioned to provide geographically wide and long-term phenological data. Such a dataset would be of wide interest as the impact of climate change on the state of biodiversity becomes an increasing concern (Lepetz et al., 2009). School grounds could therefore be an ideal place to start to tackle the declines in biodiversity. These are relatively protected spaces, with grounds in state-maintained schools covered by section 77 of the 1998 Schools Standards and Framework Act (Department for Education, 2011; UK Government, 1998). They are also populated by pupils who must spend at least 1.5 (primary school) to 3 hours (secondary school) per week learning about science (according to government guidelines; Department for Education, 2002; Qualifications and Curriculum Authority, 2002). Schools should therefore, theoretically, provide a motivated and readily available source of volunteers, with well-educated adult supervision, to monitor and maintain biodiversity in an area.

Furthermore, government recommendations for state-maintained mainstream primary and secondary schools suggest that 0.5m2 per pupil place should be dedicated to ‘habitat areas’ (defined as “grounds developed for a range of supervised activities, for instance meadowland, wildlife habitats[..], gardens and outdoor science areas”; Department for Education, 2014, p.40). Based on the number of schools and average pupils per school, this would mean 8km2 in England was dedicated to school habitat areas alone (exclusive of nursery, special, and private schools, and of additional land such as playing fields). This constitutes a resource of protected land in which to study and improve biodiversity; and human habitation patterns (with a median population density of Britain of 500 people per km2) result in a relatively clustered distribution of schools. The resulting network of areas (likely surrounded and linked by the homes of potential parents) can serve as wildlife corridors; which promote the mobility, and thus gene flow, of species (Gilbert-Norton, Wilson, Stevens, & Beard, 2010).

***Outdoor learning and education***

In addition to benefits for biodiversity, thoughtfully-designed school grounds could provide an opportunity for children to access the benefits of being outdoors. The negative effects of the extinction of experience phenomenon are well-established (see Soga & Gaston, 2016), and the benefits of outdoors ecological learning are wide-ranging: findings suggest gains in science attainment (Hamilton-Ekeke, 2007; Lindemann-Matthies, 2006; Prokop, Tuncer, & Kvasničák, 2007; Scott & Boyd, 2014), interest in science-related careers (Prokop et al., 2007), and more peripheral areas including well-being (Chawla, Keena, Pevec, & Stanley, 2014; O’Brien, 2009), health and fitness (Wells, Myers, & Henderson, 2014), environmental attitudes in adulthood (Asah et al., 2011; Gifford & Nilsson, 2014), and literacy (Scott & Boyd, 2012, 2014).

When considering school as a learning environment, classrooms are often seen as key, with the grounds as a peripheral resource (Bowker & Tearle, 2007). However, research has demonstrated that poor environmental conditions in schools are detrimental to pupil performance (Clark, 2002; Flutter, 2006). Titman (1994) recognised that management of school grounds had a major influence on children’s attitudes and behaviours, observing that many children are restricted in their access to the external environment outside of school, due to parental fears of strangers and traffic.

Rickinson et al. (2004) suggested that using school grounds as a resource for outdoor learning not only provides exposure to nature for children that have lost access outside of school, but also provides links to the community and environmental science. Furthermore, school grounds can serve as a bridge towards more complex outdoor learning experiences (Rickinson et al., 2004) and help motivate children who find it hard to concentrate in the classroom (Dyment, 2008). Moreover, Marchant et al. (2019) reported that outdoor learning improved pupil concentration, engagement with learning, and behaviour, as well as increasing teachers’ job satisfaction.

Malone and Tranter (2003) describe school grounds as important places for children to develop their cognitive skills, providing a ‘rich resource for formal learning’ where experiencing nature first-hand can allow the conceptualisation of aspects including biodiversity, life cycles and food webs. They reflected that where the school grounds do not match what is taught in the classroom about the importance of the natural world, the delivered message is one of ‘saying one thing and doing another’.

***Barriers to outdoor education in schools***

In view of the evidence around the benefits of outdoor education, it seems counterintuitive that it is not built into school curricula. Some of the reasons for this absence may include: teachers’ concerns about pupil safety; their confidence and expertise in outdoor teaching and learning practice; the needs of the school curriculum; shortage of time and resources; and changes within the education sector, including larger classes and a ‘back-to-basics’ approach (Evans, Whitehouse, & Gooch, 2012; Rickinson et al., 2004). Dyment (2008) found that neither pupil safety nor shortages of time and resources restricted outdoor learning, except for that which is carried out away from school grounds (Barker, Slingsby, & Tilling, 2002; Comishin, Dyment, Potter, & Russell, 2004); instead, teacher confidence, school curriculum and transitions across educational stages presented the greatest hurdles. A possible solution to the issue of teacher confidence, highlighted in both of these reports, is to increase provision for such training during and after qualification (Dyment, 2008; Marchant et al., 2019). This may also help to address another major barrier identified by an evaluation of environmental education practice in New Zealand, of a lack of leadership and buy-in from some school staff (Eames, Cowie, & Bolstad, 2008). However, the issues of curriculum and resource constraints are less easily addressed.

***Aims and research questions***

Given the weight of the evidence in favour of the use of school grounds to monitor and improve the state of biodiversity, surprisingly little is known about how they are used. This exploratory study therefore aimed to survey schools throughout Britain to investigate how far they already use their grounds as habitat areas, and how much they work actively in these areas to engage pupils in conservation.

We wished to address the following research questions:

1. To what extent do schools in Britain have areas in their grounds appropriate for using to engage pupils in biodiversity and conservation?
2. Where schools do have appropriate grounds areas, to what extent do they ensure that there are specialised habitat areas for a range of species and maintain them appropriately?
3. To what extent do schools use their grounds in lessons and extracurricular activities to engage their pupils in biodiversity and its conservation?

**Methods**

Our investigation utilised an online survey asking staff to report on the size of their grounds, which wildlife-friendly areas they had, and whether they used their grounds for teaching ecology. We felt that the online survey methodology would give us the best opportunity to reach the largest and most representative sample of schools. The survey was developed to be brief in order to maximise response rate, but provided the information needed to address our three research questions, and scope for respondents to provide any additional relevant information. We selected 12 common habitat areas which we had seen when surveying local schools. The habitats chosen were: ponds, trees, hedgerows, planted borders, designated gardening areas, logpiles, compost heaps, bird houses, bird tables, bat boxes, wildflower meadows, and untreated grassed areas (not playing fields that are sprayed with weed-killer). Respondents were also asked to list any other habitat areas. It was not realistic for us to confirm the actual grounds area for each responding school, so we asked respondents to provide the approximate area. To address our final research question, we asked whether schools used their grounds to teach ecology, and/or ran any ecology-focussed extracurricular clubs. We provided an opportunity for respondents to provide information about any additional provision for environmental education which they felt was not captured in the survey.

The survey was deployed using the SurveyMonkey platform (SurveyMonkey Ltd., CA), and the link emailed to all schools in England, Scotland, and Wales. (details obtained via freedom of information requests). It was also advertised on Twitter and the Times Educational Supplement teacher forums. We received 1301 complete responses. Where more than one person at a school had responded to the survey, responses were checked for consistency (found in all cases). Four duplicates were removed. Of these responses, 1172 schools were in England, 22 in Wales, and 103 in Scotland (see Figure 1 for a distribution map of responding schools, and Table 1 for respondent characteristics). Schools reported on their funding mechanism (academy, private [fee-paying], state, voluntary-aided, combined) and stage of education provided (early years/primary, secondary, Sixth Form/FE college, through [all years], special school).

The number of habitat areas reported was compared across school types using between-subjects analyses of variance (ANOVAs). Whether schools reported using their grounds to inform learning (both in formal teaching and extracurricular clubs) was analysed using chi-squared tests. Open question responses were inspected for mention of other habitat areas and learning activities, to identify examples of particularly good or poor provision, since this could be informative for schools wishing to improve their own provision in this area.

[Figure 1 around here.]

[Table 1 around here.]

**Results**

***School grounds and habitat areas***

Unfortunately, approximately half of respondents indicated that they were unsure of the area of their grounds. For those reporting area (621), mean size of school grounds was 132,316m2; varying from 12-23,030,000m2 (SD 972,624m2). However, given the uncertainty of the other respondents who did not provide this information, we advise caution in taking this as a reliable measurement. However, as would be expected given the legal requirements, all respondents indicated that they had access to at least a small grounds area, and the majority of respondents answering this question (76%, 474 respondents) indicated that they had access to more than 1,000m2.

Of the schools surveyed, the most commonly reported feature was trees (82%), with 74% having planted borders, 69% hedgerows , 65% dedicated gardening areas and 52% untreated grass areas. However, fewer schools reported having more specialised habitat areas (which require more direct effort to establish and maintain). Less than half of the schools reported having: compost heaps (47%), bird houses (47%), ponds (44%), logpiles (41%), bird tables (32%), wildflower meadows (30%), and bat boxes (14%); see Figure 2.

[Figure 2 around here.]

Of mainstream school types (primary, secondary, sixth form/FE, or through), through schools (i.e. those with pupils across the full range of school years) were most likely to report having 8 out of 12 of the listed habitats; only gardening areas, logpiles, bird houses, and bird tables were marginally more common in early years/primary schools. This finding can likely be attributed to the overrepresentation of privately funded schools in this category, with 86% reporting private funding. This is supported by consideration of reported habitat areas by funding type: when considering the three most well-represented funding types (academies, state-funded, and privately funded), a higher proportion of private schools report specialised habitat areas within their grounds for all except compost heaps, bird tables, wildflower meadows, and untreated grass areas. This may be since private schools need to appear attractive to prospective parents and therefore may dedicate more resources to additional aesthetic features such as bird houses and logpiles to achieve this.

Summing across all habitat types, there was a significant main effect of school type on the number of areas reported *F*(4, 1268) = 11.61, *p* < 0.001, with significantly more areas reported by primary and through schools than secondary schools or colleges. This effect was moderated by an interaction between school type and funding source, *F*(18, 1268) = 1.66, *p* = 0.04. This was somewhat difficult to interpret due to the low numbers (and in some cases, no responses at all) from certain funding models across the different types of school. However, pairwise comparisons indicated that state-funded primary and through schools reported significantly more habitat areas than secondary schools and colleges; voluntary-aided through schools had significantly more habitats than primary or secondary schools in this sector; whilst there were no differences between school types for academies, private schools, and schools with a combination of funding sources.

***Teaching and learning practice***

Disappointingly, only 58% of schools reported using their grounds to teach ecology. A chi-squared test indicated significant differences between school types on this factor; χ2(4) = 20.57, *p* < 0.001. Post-hoc tests indicated that primary and through schools were significantly more likely use their grounds for this purpose than secondary schools or colleges; likely due to the greater flexibility in the primary curriculum. A similar analysis for schools by funding type found no difference between groups in their use of grounds for teaching ecology; χ2(5) = 9.10, *p* = 0.11. Unsurprisingly, schools reporting that they used the school grounds to teach ecology also reported significantly more habitat areas; 7.8 (SD 2.4) vs. 3.1 (SD 3.2), W = 46041, *p* < 0.001, suggesting that engagement of pupils with practical ecology beyond that required by syllabuses could be a viable way to improve biodiversity in UK schools. It is of course possible that the direction of this relationship is such that schools with more diverse grounds felt encouraged to use them more in teaching. However, not all schools using their grounds for teaching had very diverse grounds, and engaging pupils in more practical ecology in their school grounds would lead to their becoming more diverse; therefore this solution should have the desired effect regardless of the direction of this relationship.

***Examples of practice***

509 respondents commented in the open-ended response box around additional habitat areas or learning provision. One theme picked up in some of the comments was that there had been schemes in the past to develop the grounds or use them for teaching, but they were no longer running – e.g. *“used to have chickens’*, “*used to observe wildlife and grow plants for the garden area*”, “*It used to have an owl box but that fell down years ago*”. In some cases, this was explained by having been tied to a specific member of staff who had since left the school; *“We did have a very popular gardening club but the staff member retired.”*

Some respondents also highlighted that time and funding was an issue; *“We did have a gardening club but this was shelved due to funding and time constraints. We have also had eco college status in the past, but this has lapsed for the same reason”.*

Some schools were currently involved in schemes run by external bodies including Learning Through Landscapes, Froglife, Woodland Trust. Whilst this engagement is clearly a positive thing, there may be an issue in encouraging participants to maintain their engagement with the issue after the end of the specific project. Sixty-seven schools reported that they held *Forest School* sessions, although these comments often focussed on activities such as den-building.

Encouragingly, some schools acknowledged that current practice could be improved, and in some cases, there were plans to improve on it:

*“We have beautiful grounds that are used a lot within our teaching but I am sure we could use them much more.”; “We have a small stream that flows within our boundary and a wooded area currently underdeveloped, but which I have plans for.”; “Plans for small wildflower meadow, turtle dove food plots in conjunction with RSPB/Operation Turtle Dove.”; “We've got some forested area that I'd like to use more to teach in, camera traps etc.”; “We are interested in creating more areas.”; “We are about to develop a 'Science Garden' for use as a teaching resource.”*

Finally, although there was a wide range of grounds area and provision available, from schools with a small backyard to those attached to working farms and large woodlands, there were some respondents at the more modest end of the range who highlighted innovative approaches to which could serve as inspiration to other schools. A school reporting 100m2 of grounds had 6 small tyre ponds in the playground, and another said *“We do not have any grass and are restricted in terms of space. We are about to develop a 'Science Garden' for use as a teaching resource.”* Other schools with similar or less space made good use of nearby community spaces including parks, an estuary, woodlands, and allotments. Finally, one mainstream state primary school showed that some schools are successfully embedding outdoor learning into the curriculum for regular teaching; *“We teach every class in the whole school outdoors for half a day every single week all year every year for the time they are in school (6-7 years).”*

**Discussion**

It is clear from our survey that, in line with the DfE recommendations (Department for Education, 2011; UK Government, 1998), almost all schools have areas that can be considered as natural habitats, and all have access to at least some grounds area that could be used more often to encourage biodiversity and engage pupils in environmental education. Schools with small grounds areas noted that they were able to use the area that they did have for some engagement and also to source alternative local venues for environmental education such as parks and woodlands.

Most schools reported having at least some of the listed habitats asked about; however, the majority of respondents had only the less specialised features that require less hands-on specialised management, such as trees, hedgerows, and planted borders. Less than half of the schools reported having compost heaps, bird houses, ponds, logpiles, bird tables, wildflower meadows, and bat boxes. Despite this, the wide range of specialised habitat areas reported across the survey, including some not listed in our original prompts (e.g. owl boxes and turtle dove food plots) demonstrated the potential to develop these areas in school grounds.

Discouragingly, some of the schools reporting these features mentioned that a previous teacher had set the area up but subsequently left the school, with the feature becoming neglected. This may suggest that the environmental knowledge and interest of staff within a school is one of the main contributing factors in determining the ecological health of its grounds; something which may require a change in the focus on outdoor learning in teacher training programmes if this limitation is to be overcome.

In general, only a little over a half of responding schools reported using their grounds for learning. Again, the comments from some schools showed the great potential for doing this, with many examples of good practice reported, including: involvement in externally-organised schemes such as Polli:nation and the Green Tree Award; school chickens and gardening plots; and Forest Schools. Our results suggest that schools for younger children generally reported a greater number of specialised habitat areas and were more likely to be using their grounds for teaching or extra-curricular clubs. This may be attributable to the increased focus on examination-led teaching in secondary education (West, Edge, & Stokes, 1999).

This may be supported by previous research which has suggested that teachers sometimes report finding it difficult to make outdoor learning curriculum-relevant and therefore view it as having limited value (Comishin et al., 2004; Waite, 2010). However, as discussed previously, environmental education not only has an important role in formal scientific education, but also has wider implications for driving pro-environmental attitudes and behaviour in later life, and leads to improvements in a range of psychological, physical, and educational outcomes (e.g. Dirzo et al., 2014; Dyment, 2008; Harrington et al., 2019; Jenkin et al., 2018; Lewis & Maslin, 2015). Furthermore, Potvin and Hasni (2014) show that pupils in secondary education report declining interest in school-based science but not in informal science outside of this setting. This suggests that moving away from the prioritisation of formal classroom-based learning in the secondary science curriculum to include alternative provision – such as experiential learning in their school grounds - may help pupils to maintain an interest in this area. This would be best co-ordinated by curriculum change at a national level and could include reintroduction of science assessment into the primary curriculum, development of a formal secondary qualification in natural history, and reinstatement of practical fieldwork (including work to be carried out in school grounds) into secondary school curricula (see Supplementary Table 1 for more barriers and possible solutions identified by this study). Gayford (2000) reported that senior school science teachers are acutely aware of the biodiversity crisis and that, in addition to the formal teaching of biodiversity, which is currently largely focussed on global topics, they feel other aspects should be considered including grounds and estate management. It would therefore seem that the time is now right for school grounds to become part of the battle against declining biodiversity.

***Limitations***

There may be a response bias in our sample such that schools with a more environmental focus may have been more likely to complete the survey. However, if this is the case, our assessment of the current state of school grounds and provision for environmental education in schools is likely, if anything, to be overly optimistic. Another sampling issue is that the majority of schools responding were primary state schools; although this is, at least in part, a reflection of the make-up of schools in the UK (with these representing the most common type of schools).

Finally, many schools either did not attempt to provide the size of their school grounds or may have been inaccurate in their estimations. Independently measuring this e.g. via a mapping tool such as Google Earth may be possible in the future, however this would be a substantial task which is beyond the scope of the current report. Furthermore, it would not be possible in this way to identify habitat areas, and a larger school grounds does not necessarily guarantee more habitat provision; evidenced by the fact that, in our study, primary schools reported more habitat areas, despite overwhelmingly being smaller in area (with primary schools in general taking a smaller cohort of pupils than secondary schools).

***Future directions***

To follow this paper, an updated survey of teachers to determine their attitudes to greening their grounds and using them as part of the curriculum would be useful. In addition, there are many small to medium scale projects in the UK, including the Green Tree Award (Woodland Trust) and Wild Challenge Awards (RSPB), but long-term evaluation has not been reported on any of these. It is therefore difficult to judge their impact; either in terms of outcomes for the participating children, or for the biodiversity of the area where the project has taken place. The development and evaluation of short-term initiatives, such as biodiversity surveys, in school grounds may demonstrate the potential for supporting scientific learning via environmental education, as well as supporting the use of the grounds as areas to promote biodiversity and create wildlife corridors for the dispersal of species.

**Conclusion**

This survey provides a baseline of the state of school grounds across the United Kingdom. Less than half of schools report provision of many important habitats such as logpiles and bird tables, despite these requiring very little expertise to site and maintain. Our findings reporting habitat levels are particularly low for secondary and further education providers indicates a worrying neglect of the importance of environmental health for this older age group. This may have knock-on effects on the consideration they give to biodiversity and conservation-focussed careers. Less than 60% of schools report using their grounds for practical ecology at all; our results suggest that use of the grounds in this way is associated with increased targeted habitat areas. Improving the provision for environmental education in schools is therefore a possible way to address the decline in biodiversity. This could be achieved via national curriculum change, across all stages of education, and could include: the reintroduction of science assessment into the primary curriculum, development of a formal secondary school qualification in natural history, and the reinstatement of practical fieldwork into senior school curricula.

**Acknowledgements**

We would like to thank the anonymous reviewers for their very helpful feedback on earlier versions of this manuscript.

**References**

Asah, S. T., Bengston, D. N., & Westphal, L. M. (2011). The influence of childhood: Operational pathways to adulthood participation in nature-based activities. *Environment and Behavior*, *44*(4), 545–569. https://doi.org/10.1177/0013916510397757

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

Beckage, B., Gross, L. J., Lacasse, K., Carr, E., Metcalf, S. S., Winter, J. M., … Hoffman, F. M. (2018). Linking models of human behaviour and climate alters projected climate change. *Nature Climate Change*, *8*(1), 79–84. https://doi.org/10.1038/s41558-017-0031-7

Bowker, R., & Tearle, P. (2007). Gardening as a learning environment: A study of children’s perceptions and understanding of school gardens as part of an international project. *Learning Environments Research*, *10*(2), 83–100. https://doi.org/10.1007/s10984-007-9025-0

Ceballos, G., Ehrlich, P. R., & Dirzo, R. (2017). Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(30), E6089–E6096. https://doi.org/10.1073/pnas.1704949114

Chandler, M., See, L., Buesching, C. D., Cousins, J. A., Gillies, C., Kays, R. W., … Tiago, P. (2017). Involving Citizen Scientists in Biodiversity Observation. In M. Walters & R. J. Scholes (Eds.), *The GEO Handbook on Biodiversity Observation Networks* (pp. 211–237). New York: Springer. https://doi.org/10.1007/978-3-319-27288-7

Chawla, L., Keena, K., Pevec, I., & Stanley, E. (2014). Green schoolyards as havens from stress and resources for resilience in childhood and adolescence. *Health & Place*, *28*, 1–13. https://doi.org/10.1016/j.healthplace.2014.03.001

Chen, J., & Cowie, B. (2013). Developing “Butterfly Warriors”: A case study of science for citizenship. *Research in Science Education*, *43*(6), 2153–2177. https://doi.org/10.1007/s11165-013-9349-y

Clark, H. (2002). *Building education: the role of the physical environment in enhancing teaching and research*. London: Institute of Education, University of London.

Comishin, K., Dyment, J. E., Potter, T. G., & Russell, C. L. (2004). The development and implementation of outdoor-based secondary school integrated programs. *Applied Environmental Education & Communication*, *3*(1), 47–53. https://doi.org/10.1080/15330150490270631

Danks, S. G. (2014). *The Green Schoolyards Movement: Gaining momentum around the world*.

Department for Education. (2002). *Designing the Key Stage 3 curriculum*. London.

Department for Education. (2011). *Standards for School Premises*. London.

Department for Education. (2014). *Area guidelines for mainstream schools*. London.

Dirzo, R., Young, H. S., Galetti, M., Ceballos, G., Isaac, N. J. B., & Collen, B. (2014). Defaunation in the Anthropocene. *Science*, *345*(6195), 401–406. https://doi.org/10.1126/science.1251817

Dyment, J. E. (2008). Green school grounds as sites for outdoor learning: Barriers and opportunities. *International Research in Geographical & Environmental Education*, *14*(1), 28–45. https://doi.org/10.1080/09500790508668328

Eames, C., Cowie, B., & Bolstad, R. (2008). An evaluation of characteristics of environmental education practice in New Zealand schools. *Environmental Education Research*, *14*(1), 35–51. https://doi.org/10.1080/13504620701843343

Eisenhauer, N., Bonn, A., & Guerra, C. A. (2019). Recognizing the quiet extinction of invertebrates. *Nature Communications*, *10*(1), 50. https://doi.org/10.1038/s41467-018-07916-1

Evans, N., Whitehouse, H., & Gooch, M. (2012). Barriers, successes and enabling practices of education for sustainability in Far North Queensland schools: A case study. *The Journal of Environmental Education*, *43*(2), 121–138. https://doi.org/10.1080/00958964.2011.621995

Flutter, J. (2006). ‘This place could help you learn’: student participation in creating better school environments. *Educational Review*, *58*(2), 183–193. https://doi.org/10.1080/00131910600584116

Fordyce, J. A., & Shapiro, A. M. (2003). Another perspective on the slow-growth/high-mortality hypothesis: chilling effects on swallowtail larvae. *Ecology*, *84*(1), 263–268.

Gayford, C. (2000). Biodiversity Education: A teacher’s perspective. *Environmental Education Research*, *6*(4), 347–361. https://doi.org/10.1080/713664696

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: a review. *International Journal of Psychology*, *49*(3), 141–157. https://doi.org/10.1002/ijop.12034

Gilbert-Norton, L., Wilson, R., Stevens, J. R., & Beard, K. H. (2010). A meta-analytic review of corridor effectiveness. *Conservation Biology*, *24*(3), 660–668. https://doi.org/10.1111/j.1523-1739.2010.01450.x

Grooten, M., & Almond, R. E. (2018). *WWF. 2018. Living Planet Report - 2018: Aiming Higher.*

Hamilton‐Ekeke, J. (2007). Relative effectiveness of expository and field trip methods of teaching on students’ achievement in ecology. *International Journal of Science Education*, *29*(15), 1869–1889. https://doi.org/10.1080/09500690601101664

Harrington, S. C., Stack, J., & O’Dwyer, V. (2019). Risk factors associated with myopia in schoolchildren in Ireland. *The British Journal of Ophthalmology*, bjophthalmol-2018-313325. https://doi.org/10.1136/bjophthalmol-2018-313325

Hayhow, D., Burns, F., Eaton, M., Al Fulaij, N., August, T., Babey, L., … Gregory, R. (2016). *State of Nature 2016. The State of Nature partnership*. London.

IUCN. (2018). *The IUCN Red List of Threatened Species. Version 2018-2.*

Jenkin, R., Frampton, I., White, M. P., & Pahl, S. (2018). The relationship between exposure to natural and urban environments and children’s self-regulation. *Landscape Research*, *43*(3), 315–328. https://doi.org/10.1080/01426397.2017.1316365

Lepetz, V., Massot, M., Schmeller, D. S., Clobert, J., Lepetz, V., Schmeller, Á. D. S., … Massot, M. (2009). Biodiversity monitoring: some proposals to adequately study species’ responses to climate change. *Biodiversity & Conservation*, *18*, 3185–3203. https://doi.org/10.1007/s10531-009-9636-0

Lewis, S. L., & Maslin, M. A. (2015). Defining the Anthropocene. *Nature*, *519*(7542), 171–180. https://doi.org/10.1038/nature14258

Lindemann‐Matthies, P. (2006). Investigating nature on the way to school: responses to an educational programme by teachers and their pupils. *International Journal of Science Education*.

Malone, K., & Tranter, P. J. (2003). School Grounds as Sites for Learning: Making the most of environmental opportunities. *Environmental Education Research*, *9*(3), 283–303. https://doi.org/10.1080/13504620303459

Marchant, E., Todd, C., Cooksey, R., Dredge, S., Jones, H., Reynolds, D., … Brophy, S. (2019). Curriculum-based outdoor learning for children aged 9-11: A qualitative analysis of pupils’ and teachers’ views. *BioRxiv*, 536441. https://doi.org/10.1101/536441

O’Brien, L. (2009). Learning outdoors: the Forest School approach. *Education 3-13*, *37*(1), 45–60. https://doi.org/10.1080/03004270802291798

Petrovan, S. O., & Schmidt, B. R. (2016). Volunteer conservation action data reveals large-scale and long-term negative population trends of a widespread amphibian, the Common Toad (Bufo bufo). *Plos One*, *11*(10), e0161943. https://doi.org/10.1371/journal.pone.0161943

Potvin, P., & Hasni, A. (2014). Analysis of the decline in interest towards school science and technology from Grades 5 through 11. *Journal of Science Education and Technology*, *23*(6), 784–802. https://doi.org/10.1007/s10956-014-9512-x

Prokop, P., Tuncer, G., & Kvasničák, R. (2007). Short-term effects of field programme on students’ knowledge and attitude toward biology: a Slovak experience. *Journal of Science Education and Technology*, *16*(3), 247–255. https://doi.org/10.1007/s10956-007-9044-8

Pyle, R. (1992). Intimate relations and the extinction of experience. *Left Bank*, *2*, 61–69.

Pyle, R. (1993). *The Thunder Tree: Lessons from an Urban Wildland*. Bostin: Houghton Mifflin.

Qualifications and Curriculum Authority. (2002). *Designing and timetabling the primary curriculum*. London.

Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2004). *A review of the research on outdoor learning*. London.

Schmeller, D. S., Julliard, R., Bellingham, P. J., Böhm, M., Brummitt, N., Chiarucci, A., … Belnap, J. (2015). Towards a global terrestrial species monitoring program. *Journal for Nature Conservation*, *25*, 51–57. https://doi.org/10.1016/j.jnc.2015.03.003

Schultz, P. W. (2011). Conservation means behavior. *Conservation Biology*, *25*(6), 1080–1083. https://doi.org/10.1111/j.1523-1739.2011.01766.x

Scott, G. W., & Boyd, M. (2012). A potential value of familiarity and experience: can informal fieldwork have a lasting impact upon literacy? *Education 3-13*, *42*(5), 517–527. https://doi.org/10.1080/03004279.2012.731418

Scott, G. W., & Boyd, M. (2014). Getting more from getting out: increasing achievement in literacy and science through ecological fieldwork. *Education 3-13*, 1–10. https://doi.org/10.1080/03004279.2014.996242

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. https://doi.org/10.1002/fee.1225

Sullivan, M. J. P., Newson, S. E., & Pearce-Higgins, J. W. (2015). Using habitat-specific population trends to evaluate the consistency of the effect of species traits on bird population change. *Biological Conservation*, *192*, 343–352. https://doi.org/10.1016/J.BIOCON.2015.10.009

Titman, W. (1994). *Special places; special people: The hidden curriculum of School Grounds*.

UK Government. School Standards and Framework Act Section 77, School Standards and Framework Act § (1998). Statute Law Database.

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

Wells, N. M., Myers, B. M., & Henderson, C. R. (2014). School gardens and physical activity: a randomized controlled trial of low-income elementary schools. *Preventive Medicine*, *69 Suppl 1*, S27-33. https://doi.org/10.1016/j.ypmed.2014.10.012

West, A., Edge, A., & Stokes, E. (1999). *Secondary education across Europe: Curricula and school examination systems*. London.

Wheeler, B. W., Cooper, A. R., Page, A. S., & Jago, R. (2010). Greenspace and children’s physical activity: A GPS/GIS analysis of the PEACH project. *Preventive Medicine*, *51*(2), 148–152. https://doi.org/10.1016/J.YPMED.2010.06.001

Wilson, E., & Wembridge, D. (2018). *The State of Britain’s Hedgehogs 2018*. London . https://doi.org/10.1371/journal.pone.0185809

Wood, A., Stedman-Edwards, P., & Mang, J. (2000). *The Root Causes of Biodiversity Loss*. London: Earthscan Publications Ltd.

**Figure legends**

Figure 1. Distribution map of responding schools across Britain.

Figure 2. Nature habitat areas reported in grounds of surveyed schools

**Tables**

Table 1. Respondent characteristics

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Academy | Private | State | Vol.-aided | Comb. | Total |
| Early years/primary | England | 108 | 84 | 563 | 23 | 0 | 778 |
| Wales | 0 | 0 | 13 | 0 | 0 | 13 |
| Scotland | 0 | 0 | 64 | 0 | 0 | 64 |
| Total | 108 | 84 | 640 | 23 | 0 | 855 |
| Secondary | England | 97 | 59 | 57 | 3 | 0 | 216 |
| Wales | 0 | 0 | 7 | 0 | 0 | 7 |
| Scotland | 1 | 4 | 26 | 0 | 0 | 31 |
| Total | 98 | 63 | 90 | 3 | 0 | 254 |
| Sixth form/FE college | England | 1 | 5 | 37 | 3 | 9 | 55 |
| Wales | 0 | 0 | 0 | 0 | 0 | 0 |
| Scotland | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1 | 5 | 37 | 3 | 9 | 55 |
| Through (all years) | England | 6 | 80 | 4 | 1 | 0 | 91 |
| Wales | 0 | 0 | 0 | 0 | 0 | 0 |
| Scotland | 0 | 1 | 2 | 0 | 0 | 3 |
| Total | 6 | 81 | 6 | 1 | 0 | 94 |
| Special school | England | 1 | 19 | 7 | 4 | 1 | 32 |
| Wales | 0 | 0 | 1 | 1 | 0 | 2 |
| Scotland | 0 | 0 | 2 | 3 | 0 | 5 |
| Total | 1 | 19 | 10 | 8 | 1 | 39 |
| Total |  | 214 | 252 | 783 | 38 | 10 | 1297 |