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ORIGINAL PAPER

# Urban domestic gardens (XI): variation in urban wildlife gardening in the United Kingdom

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**Abstract** Two consequences of the continued urbanisation of the human population are that a growing proportion of the landscape is less hospitable to, and that a growing proportion of people are disconnected from, native biodiversity. One response of the UK government has been to establish a goal, and an associated baseline indicator, of increasing the extent and range of public participation in gardening for wildlife. The formulation of policy to attain this end requires, however, insight into the factors that are associated with the level of participation. Here we examine the relationships, across 15 areas in five UK cities, between the proportion of households providing various garden features for wildlife or participating in various wildlife gardening activities, and housing densities and characteristics of the garden resource. We show that significant numbers of households participate in some form of wildlife gardening, but that the predominant form this participation takes is feeding wild birds. Key variables associated with spatial variation in wildlife gardening activities are the proportion of households with access to a garden and, more importantly, average garden size and the proportion of land cover by gardens. There was no evidence for strong effects of household density or the socio-economic status of householders on the prevalence of wildlife friendly features in gardens or on the participation by householders in activities to encourage wildlife. Our results suggest important considerations in attempts to increase awareness and participation in wildlife gardening.

**Keywords** Biodiversity · Domestic gardens · Housing · Urbanisation

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## Introduction

By 2007 more than half of the global human population is predicted to live in urban areas (United Nations 2004). In some nations that proportion is already much higher; c. 90% of the present population of the United Kingdom is suburban/urban (ODPM 2001). The quality of urban environments, and particularly of urban green spaces, is thus increasingly seen as an important issue. This quality can have significant impacts on (a) the physical and mental well-being of the people living and working in these areas (e.g. Ulrich 1984; Dunnett and Quasim 2000; Takano et al. 2002; CABE Space 2004; Galea et al. 2005); (b) urban economies, through a diverse array of impacts, including on house prices, the costs of heating and cooling buildings, and the ease of attracting businesses and employees (e.g. Luttik 2000; Morancho 2003; CABE Space 2004); and (c) the provision both of ecosystem services (e.g. clean air and water) and of biodiversity (e.g. Blair 1996; Bolund and Hunhammar 1999; Alberti 2005; Er et al. 2005; Gaston et al. 2005a; White et al. 2005; Zanette et al. 2005; Kühn and Klotz 2006).

In the United Kingdom, the government has set out five aims with regard specifically to biodiversity in urban areas: (a) to ensure that cities, towns and other settlements contribute fully to the goals of biodiversity conservation; (b) to ensure that construction, planning, development and regeneration have minimal adverse impacts on biodiversity and enhance it where possible; (c) to ensure that biodiversity conservation is integral to sustainable urban communities, both in the built environment, and in parks and green spaces; (d) to ensure that biodiversity conservation is integral to measures to improve the quality of people's lives, delivered through other initiatives; and (e) to value, further and enhance people's own contributions to improving biodiversity in towns and cities and to increase their access to it (DEFRA 2002). To this end, five urban biodiversity indicators have been established. One of these is the 'Proportion of households undertaking wildlife gardening in England' (Indicator T5 in DEFRA 2002; Indicator T3 in DEFRA 2003), 'to increase the extent and range of public participation in gardening for wildlife' (DEFRA 2002, 2003).

The use of the wildlife gardening indicator reflects the high proportion of urban green space that comprises domestic (private) gardens (Gaston et al. 2005a; Loram et al., in press), and therefore the potentially marked benefits that might be gained if these were managed in a fashion sympathetic to native biodiversity (Gaston et al. 2004, 2005b). It also recognises the potential benefits of widespread public awareness of biodiversity issues.

The baseline assessment of this wildlife gardening indicator was derived from the results of two surveys (DEFRA 2003). The first showed the percentage of households undertaking various approaches to encourage wildlife in their gardens [feed the birds/provide bird feeders, bird tables or bird bath; avoid using chemical sprays or treatments; plant varieties attractive to wildlife; make and use own compost; leave dead wood and/or leaves around; put up nest boxes; feed wild animals (e.g. foxes, hedgehogs); use peat substitutes; have a pond aiming to attract wildlife; have a special wild area aiming to encourage wildlife]. It revealed a high percentage of households undertaking wildlife gardening, but that the majority limit this to feeding the birds. The second survey showed the proportion of respondents that have 'done something to encourage wildlife in gardens' broken down by settlement size. It revealed that the likelihood of participation in wildlife gardening declined as the population size of settlements increased.

A variety of ways have been suggested in which the wildlife gardening indicator could usefully be improved (Wray et al. 2005). Interpretation of the results and the formulation of policy responses require, however, additional insight into the factors that are associated

with the level of participation in wildlife gardening. Two potentially important correlates are the size of individual private/domestic gardens and the regional coverage of such gardens, both of which are known to influence the occurrence patterns of individual species and the species richness of particular taxa (e.g. Smith et al. 2006a, 2006b). These factors may be particularly important given that social changes mean that more people are living on their own and for longer, such that around 3.8 million additional dwellings may be required in England alone before 2021 (DETR 2000). Moreover, in order to protect greenfield sites, the government target is that 60% of new houses must be built on brownfield sites or in place of existing buildings (DETR 2000), and housing planning guidelines therefore recommend an increase in the current density of new houses from 2,000–2,500 to 3,000–5,000 houses $km^{-2}$ (ODPM 2002). This will continue a recent historical trend for declines in average garden size (Kellett 1982) that has been exacerbated by backland development and the loss of many front gardens to hard standing for cars (Royal Horticultural Society 2006).

In this paper we examine the relationships, across 15 areas in five UK cities, between the proportion of households providing various garden features for wildlife or participating in various wildlife gardening activities, and housing densities and characteristics of the garden resource. This work forms part of a much broader consortium project to assess multiple dimensions of the sustainability of a variety of urban forms using these study areas (Jones 2002; http://www.city-form.com), and builds on work conducted in the Biodiversity in Urban Gardens in Sheffield (BUGS I; Thompson et al. 2003, 2004, 2005; Gaston et al. 2004, 2005a, b; Smith et al. 2005, 2006a, 2006b) and in the Biodiversity in Urban Gardens (BUGS II; Loram et al., in press) projects.

## Methods

The analysis was carried out across five cities in the United Kingdom, Edinburgh, Glasgow, Leicester, Oxford and Sheffield. In these, three study areas (each containing c. 2,000 households) were selected to capture a variety of urban forms, such that each city should contain a city centre area (Inner), an outer suburban area (Outer), and an area situated between the centre and suburbs (Middle). The boundaries of each area were delineated using those of output areas from the UK 2001 census (see Boyle and Dorling 2004). The number of households in each study area was determined directly from these census data, as was the proportion of households in socio-economic group AB (occupants engaged in professional, business and administrative employment).

All residential addresses in the study areas were extracted from the address layer within the Ordnance Survey MasterMap digital cartographic dataset (Murray and Shiell 2003) and sorted by postcode, street, and building number or name (where applicable). Every third address was then selected to produce a mailing list containing 700–1,000 addresses for each study area, to which a questionnaire was posted together with a prepaid return envelope. To enhance response rates, reminder letters were sent to households from which a response had not been received two weeks after the initial mailing, and then again a week later. The questionnaire contained 50 questions relating to the aims of the wider consortium project (understanding social and environmental urban sustainability; see Jones 2002) and thus the four questions on wildlife and gardening used in this study formed only a small part, a structure that minimised potential biases caused by the level of interest of people in wildlife and/or gardening influencing the likelihood of returning the form. Of the 11,893

questionnaires sent, 37% were returned and although the response rates for the individual areas varied from 19% to 61% (Table 1), overall they were very similar in Middle and Outer areas collectively (40.9 and 40.2% respectively), but lower in the Inner areas (29.5%).

Respondents were asked to indicate whether they had access to a private garden, shared/communal garden, patio or yard, roof terrace or large balcony, or none of these. Respondents were then asked to indicate which, if any, of a list of features (bird feeder/table, bird bath, nest box, pond, compost heap) were present in their garden. They were then asked how frequently food was provided by household members for (a) birds and (b) other wild animals (e.g. foxes, hedgehogs), choosing from daily, weekly, monthly, less than monthly and never. Note, the baseline assessment of the DEFRA wildlife gardening indicator aggregates a number of the above features, and does not distinguish between provision of features and feeding activities (DEFRA 2003), whilst their separation has been advocated in a recent review of the indicator (Wray et al. 2005). Lastly, respondents were asked to estimate the average number of hours spent gardening (e.g. cutting the lawn, trimming hedges, weeding) in a typical week in the summer months. Although respondents were asked to leave blank the response to any question that they felt unhappy answering, the relatively few blanks for the questions on access to gardens, garden features and wildlife feeding were interpreted as negative because it was deemed relatively easy for respondents to scan down the list of possibilities, not see any that applied and omit to tick the 'none of the above' boxes (this assumption makes little difference to the results reported here). However, with respect to the amount of time spent gardening, blanks were treated as missing data because it seemed plausible that some people would be unsure about making a specific estimate of the number of hours they spend gardening in a week.

Land cover characteristics of each study area were determined in a Geographic Information System, based on the classification of surface cover polygons by Ordnance Survey in the MasterMap topographic layer. The Ordnance Survey classifications were used to calculate the proportion of each study area with a land cover type of garden and non-garden vegetated surface. A small number of polygons (c. 2%), described by Ordnance Survey as 'Unknown' or 'Unclassified' were classified by eye using aerial photographs. To estimate average garden size in each study area, total garden area was divided by the estimated number of households with access to a private or shared garden or yard/patio, as determined by responses to the questionnaire. Garden size was not measured directly using the MasterMap data because the gardens of some houses comprised more than one polygon (e.g. in the case of the front and back garden being separated by the house itself), thus necessitating the prohibitively time-consuming manual assignment of garden polygons to the dwelling of each respondent.

## Results

### Access to outside space

Access to outside space varied widely across our sample, showing distinct patterns across the Inner, Middle and Outer areas (Fig. 1). The proportion of households with access to a private garden was much higher in the Middle and Outer areas than in Inner areas, where access to shared gardens, yards/patios and terraces tended to be as frequent as access to a private garden. Over 27% of respondents in Inner areas had no access to any type of outside space, while the corresponding figures for Middle and Outer areas were 4.5 and 3.1%, respectively (Table 1).

**Table 1** Questionnaire responses across the 15 study areas

| | Inner | | | | | | Middle | | | | | | Outer | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Edin | Glas | Leic | Oxf | Shef | Inner | Edin | Glas | Leic | Oxf | Shef | Middle | Edin | Glas | Leic | Oxf | Shef | Outer | |
| Mailing list size | 947 | 881 | 781 | 609 | 785 | 4003 | 740 | 773 | 694 | 772 | 927 | 3906 | 906 | 879 | 597 | 893 | 709 | 1603 | 11893 |
| Response rate (%) | 31.68 | 28.15 | 18.69 | 39.08 | 32.74 | 29.50 | 41.22 | 36.35 | 36.17 | 40.67 | 48.98 | 40.89 | 51.77 | 25.03 | 41.54 | 26.88 | 61.07 | 40.24 | 37.03 |
| Access to | | | | | | | | | | | | | | | | | | | |
| Private garden | 13.00 | 6.88 | 9.93 | 49.58 | 23.53 | 21.00 | 60.00 | 37.05 | 74.49 | 67.52 | 76.82 | 64.5 | 90.62 | 86.11 | 97.55 | 82.08 | 83.83 | 87.96 | 61.36 |
| Shared garden | 71.33 | 28.74 | 24.11 | 22.27 | 21.96 | 36.24 | 42.62 | 64.75 | 6.88 | 19.75 | 12.80 | 27.99 | 10.87 | 5.09 | 0.82 | 10.42 | 10.85 | 8.48 | 23.08 |
| Yard | 4.00 | 20.24 | 11.35 | 18.49 | 17.65 | 14.14 | 7.21 | 8.63 | 27.53 | 21.34 | 27.81 | 19.22 | 16.20 | 16.67 | 21.63 | 17.50 | 26.79 | 20.15 | 18.19 |
| Terrace | 4.33 | 14.57 | 4.26 | 9.66 | 14.90 | 9.82 | 0.98 | 1.80 | 3.24 | 5.41 | 0.00 | 2.07 | 1.28 | 0.46 | 0.41 | 0.83 | 2.77 | 1.37 | 3.90 |
| No outside space | 13.33 | 36.03 | 53.19 | 14.71 | 32.16 | 27.18 | 4.92 | 6.12 | 2.43 | 5.41 | 3.53 | 4.45 | 0.21 | 8.80 | 0.41 | 7.08 | 2.54 | 3.06 | 10.07 |
| Garden features | | | | | | | | | | | | | | | | | | | |
| Bird feeder/table | 9.00 | 5.67 | 8.51 | 26.05 | 12.16 | 12.36 | 26.23 | 29.14 | 27.13 | 28.03 | 28.04 | 27.74 | 47.33 | 23.61 | 59.59 | 37.08 | 47.58 | 44.54 | 29.74 |
| Bird bath | 3.33 | 1.21 | 4.96 | 10.92 | 4.71 | 4.91 | 9.51 | 9.35 | 13.36 | 13.06 | 13.91 | 12.02 | 24.09 | 8.33 | 47.76 | 20.42 | 32.56 | 27.32 | 15.17 |
| Pond | 1.00 | 2.83 | 2.13 | 5.88 | 1.57 | 2.62 | 1.31 | 3.24 | 9.31 | 9.87 | 11.48 | 7.45 | 10.45 | 3.70 | 22.86 | 8.33 | 17.32 | 12.98 | 8.17 |
| Nest box | 2.33 | 1.21 | 4.96 | 9.24 | 3.92 | 4.15 | 9.51 | 10.79 | 10.93 | 9.55 | 14.35 | 11.33 | 24.73 | 6.02 | 37.55 | 13.75 | 25.17 | 22.65 | 13.54 |
| Compost heap | 7.33 | 0.40 | 0.71 | 17.23 | 4.31 | 6.44 | 13.11 | 21.94 | 18.62 | 32.80 | 26.49 | 23.17 | 34.33 | 5.09 | 39.59 | 12.92 | 41.57 | 29.94 | 21.14 |
| None of these | 85.00 | 86.23 | 84.40 | 60.08 | 82.35 | 79.59 | 65.25 | 56.83 | 55.06 | 47.13 | 53.64 | 55.35 | 34.75 | 69.91 | 24.49 | 49.17 | 28.87 | 38.49 | 55.72 |
| Feed birds | | | | | | | | | | | | | | | | | | | |
| Daily | 6.00 | 3.24 | 3.55 | 16.39 | 7.84 | 7.62 | 14.43 | 11.15 | 15.79 | 13.38 | 15.45 | 14.15 | 29.21 | 21.76 | 39.18 | 26.67 | 25.87 | 28.45 | 17.62 |
| Weekly | 3.33 | 3.24 | 4.96 | 11.34 | 7.45 | 6.01 | 11.80 | 14.39 | 8.10 | 11.46 | 13.02 | 11.96 | 15.78 | 19.91 | 18.37 | 17.92 | 17.09 | 17.40 | 12.35 |
| Monthly | 2.67 | 1.21 | 2.13 | 4.20 | 3.14 | 2.71 | 6.23 | 3.24 | 5.67 | 8.28 | 5.52 | 5.82 | 6.61 | 4.17 | 7.35 | 2.92 | 5.54 | 5.55 | 4.88 |
| Less than monthly | 8.00 | 2.43 | 2.84 | 9.66 | 3.14 | 5.50 | 9.18 | 10.79 | 11.34 | 17.83 | 17.00 | 13.71 | 13.86 | 14.35 | 15.10 | 12.92 | 18.48 | 15.22 | 12.05 |
| Feed mammals | | | | | | | | | | | | | | | | | | | |
| Daily | 7.33 | 0.81 | 0.71 | 2.52 | 0.39 | 2.71 | 3.28 | 2.88 | 3.24 | 1.27 | 2.43 | 2.57 | 0.00 | 3.24 | 6.94 | 3.75 | 3.23 | 2.93 | 2.74 |
| Weekly | 0.33 | 0.40 | 2.84 | 0.84 | 0.78 | 0.85 | 3.61 | 2.88 | 2.43 | 1.27 | 1.99 | 2.38 | 3.20 | 4.63 | 6.94 | 2.08 | 4.85 | 4.24 | 2.65 |
| Monthly | 0.67 | 0.40 | 0.00 | 0.84 | 0.39 | 0.51 | 1.31 | 0.72 | 0.40 | 0.96 | 1.99 | 1.19 | 1.71 | 1.85 | 1.63 | 0.42 | 0.69 | 1.25 | 1.03 |
| Less than monthly | 0.33 | 2.02 | 0.71 | 1.26 | 0.78 | 1.02 | 4.92 | 4.68 | 4.45 | 5.41 | 7.06 | 5.51 | 5.76 | 5.09 | 10.61 | 2.92 | 4.16 | 5.55 | 4.31 |
| Time spent gardening | 1.28 | 0.84 | 0.89 | 2.17 | 2.94 | 1.33 | 3.23 | 4.18 | 3.21 | 2.69 | 2.94 | 3.19 | 4.92 | 3.65 | 5.55 | 4.32 | 4.43 | 4.63 | 3.27 |

Responses are expressed as percentages, and time spent gardening is expressed as mean hours per week

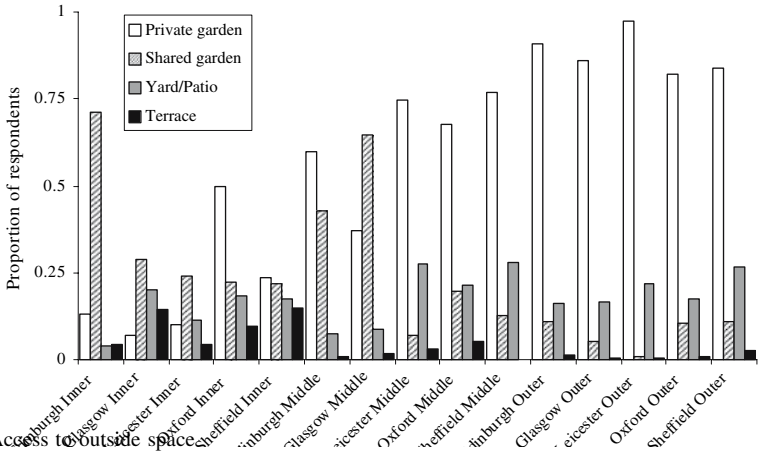


**Fig. 1** Access to outside space

The proportion of households with access to a private garden was uncorrelated with household density ($r_s$ = -0.26, $n$ = 15, $p$ = 0.35) and the proportion of households in social group AB ($r_s$ = 0.16, $n$ = 15, $p$ = 0.58). However, there was a negative relationship between address density and the proportion of households with access to a private garden ($r_s$ = -0.6, $n$ = 15, $p$ = 0.018), reflecting the high ratio of business addresses to residential addresses in the Inner areas.

## Garden features

Of all respondents, 44.3% had one or more of the five garden features (bird feeder/table, bird bath, nest box, pond, compost heap). This figure increased to 56.1% when including only those respondents who reported access to a garden or yard (i.e. those households with a piece of outside space associated with their dwelling). Less than 0.5% of respondents reporting no access to a garden or yard provided any of the features listed in the questionnaire (note that it is possible to attach a bird feeder to a window of a high rise flat, in order to attract avian visitors). Because we are interested in exploring the distribution of wildlife friendly garden features across space, we report results here using proportions of all households, rather than considering only those who reported access to an outside space. In any case, the two measures are very highly correlated (all $r_s > 0.9$), differing markedly only in Inner areas, and all conclusions presented here are qualitatively identical using both measures.

The prevalence of the garden features showed striking differences among the study areas, generally increasing from inner to outer areas (Fig. 2). Across all areas, frequency of garden features in descending rank order was bird feeder/table (27.9%), compost heap (21.1%), bird bath (15.7%), nest box (13.5%) and pond (8.2%; Table 1). The proportions of households with each of the different types of garden features were all intercorrelated (all $r_s > 0.8$), indicating strong spatial covariation in the occurrence of garden features; areas with a high proportion of households containing one garden feature were likely to be rich in all of them.

The occurrence of each garden feature was strongly positively related to proportion cover by gardens and average garden size, but independent of household density, proportion of social group AB, and proportion cover by non-garden greenspace (Fig. 3;

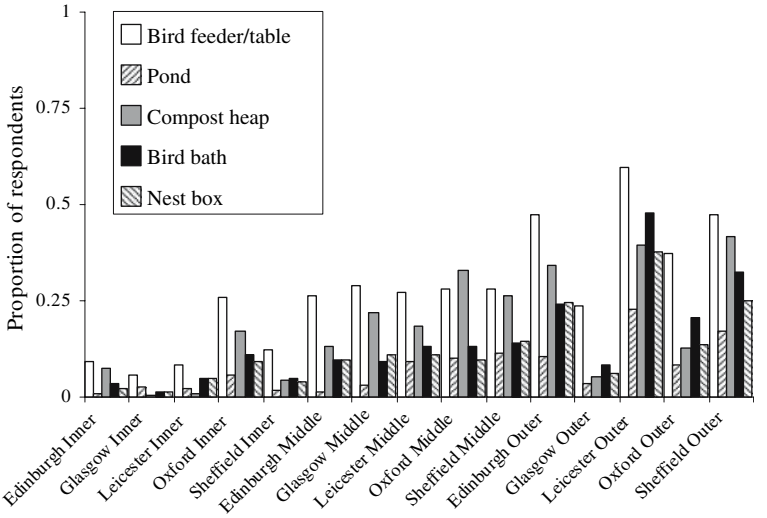


**Fig. 2** Prevalence of garden features

Table 2). One consequence of the absence of a significant negative effect of household density on the prevalence of garden features is that the overall density of these garden features per unit area will necessarily increase with household density. Whilst the proportion of households with one or more garden features was positively and apparently nonlinearly related to the proportion of households with access to a garden (Fig. 3; Table 2), all other relationships remained strong using only data from respondents reporting access to a garden and the conclusions were qualitatively unchanged.

## Activities to encourage wildlife

We considered households where food was provided for birds and mammals on a daily or weekly basis to be those where significant levels of supplementary food provision were occurring (see Table 1 for a full breakdown of levels of wildlife feeding activities). Frequent food provision for birds varied systematically across the 15 areas, generally increasing from the Inner areas through the Middle areas to the Outer areas (Fig. 4). The proportion of households frequently providing food varied from 6 to 58% for birds (mean across all areas 30%), and from 1.2 to 13.9% for mammals (mean across all areas 5.4%). A large proportion of wildlife feeding activity was infrequent; 36.1% of all bird feeding activity and 49.8% of all mammal feeding activity was carried out on a monthly or less than monthly basis.

The prevalences of bird and mammal feeding, and time spent gardening were positively related to proportion of cover by gardens and average garden size, but independent of household density, proportion of social group AB, and proportion of cover by non-garden greenspace (Fig. 5; Table 2). Again, one consequence of the absence of a significant negative effect of household density on the prevalence of activities to encourage wildlife is that the density of households providing food for birds and mammals will necessarily increase with household density. The proportion of households feeding birds and

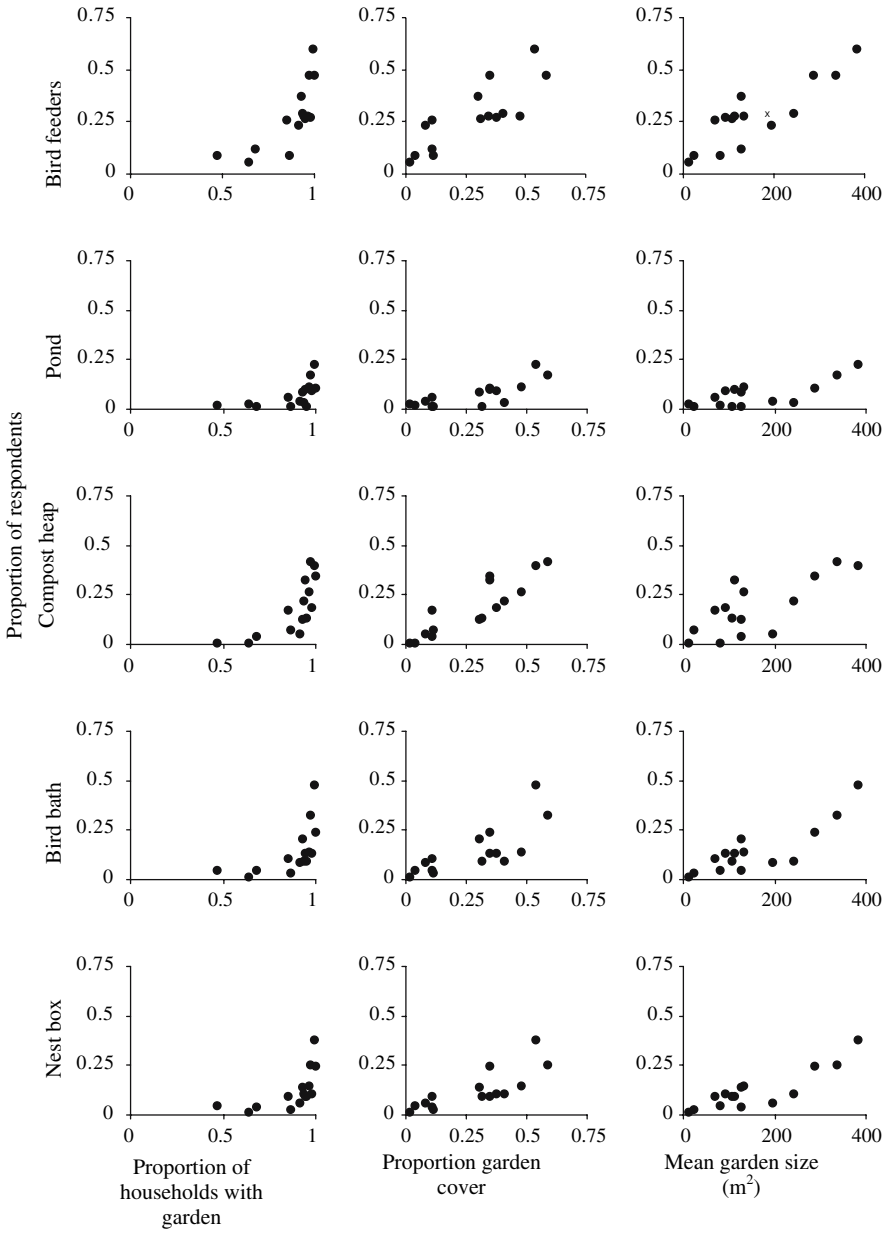


**Fig. 3** Correlates of garden features

mammals, and the time spent gardening were positively and nonlinearly related to the proportion of households with access to a garden (Fig. 5; Table 2), but the remaining relationships were strong using only data from respondents reporting access to a garden and did not affect the conclusions.

**Table 2** Spearman rank correlation coefficients between the proportion of households with a garden, household density (households $ha^{-1}$), proportion of social group AB, the proportion of green space cover, the proportion of garden cover and garden size ($m^2$), and the proportion of households in study areas with different garden features, frequent feeding of birds and mammals, and the mean hours spent gardening

| | Proportion of households with garden | Household density | Proportion of social group AB | Proportion of green space cover | Proportion garden cover | Mean garden size |
|---|---|---|---|---|---|---|
| Bird feeder | 0.75** | -0.08 | 0.36 | 0.14 | 0.87*** | 0.81*** |
| Bird bath | 0.58* | -0.06 | 0.37 | 0.08 | 0.78** | 0.68** |
| Nest box | 0.60* | -0.07 | 0.36 | 0.01 | 0.87*** | 0.77** |
| Pond | 0.55* | -0.11 | 0.52* | -0.03 | 0.70** | 0.65** |
| Compost heap | 0.72** | -0.06 | 0.66** | -0.08 | 0.90*** | 0.69** |
| Feed birds | 0.72** | -0.31 | 0.10 | 0.44 | 0.57* | 0.78** |
| Feed mammals | 0.56* | -0.05 | -0.17 | -0.08 | 0.44 | 0.41 |
| Hours gardening | 0.74** | -0.34 | 0.06 | 0.40 | 0.67** | 0.88*** |

Figures for bird and mammal feeding are the proportion of respondents indicating that feeding occurred daily or weekly

* $p < 0.05$,** $p < 0.01$,*** $p < 0.001$

## Discussion

The results of our surveys confirm two central findings from the baseline assessment of the wildlife gardening indicator, one of the five indicators of urban biodiversity used by the UK government (DEFRA 2003). The first is the significant numbers of households participating in some form of wildlife gardening, and the second is that the predominant

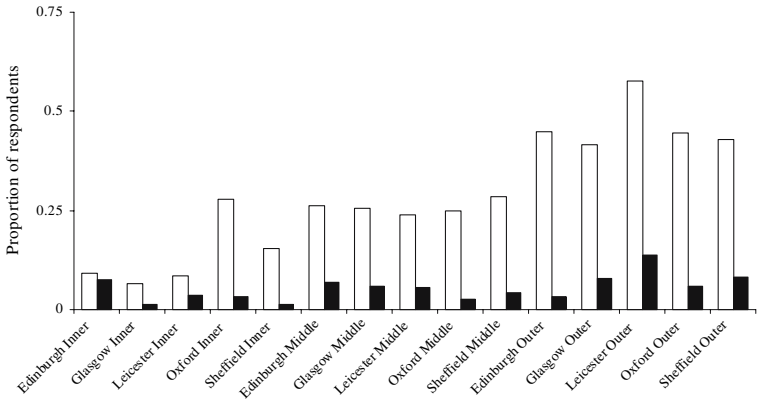


**Fig. 4** Prevalence of bird and mammal feeding. Proportion of households where food was frequently (daily or weekly) put out to encourage birds (*open bars*) and mammals (*filled bars*)

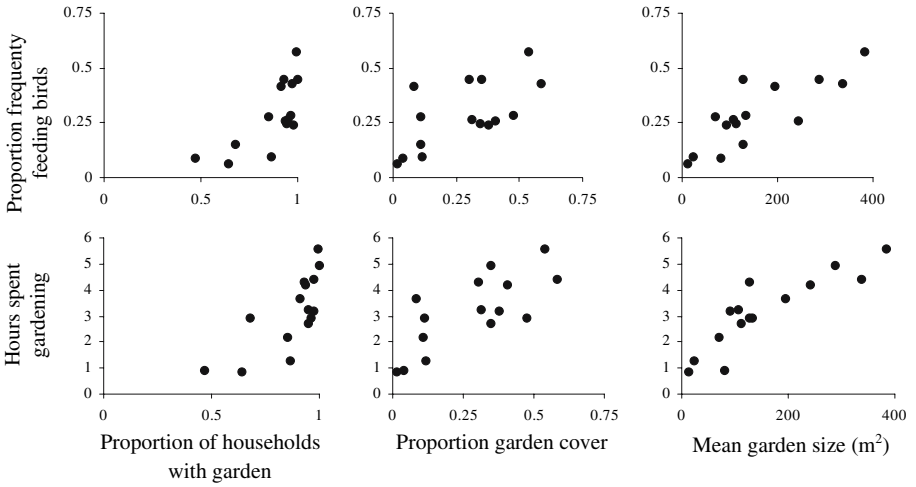


**Fig. 5** Correlates of feeding activity and time spent gardening

form this participation takes is feeding wild birds (Table 1). These are thus both true at a broad country-level scale (baseline survey), and within individual urban areas (this study). Because of the nature of our surveys (see Sect. 'Methods'), it is difficult sensibly to extrapolate the results to provide additional estimates of levels of national participation in wildlife gardening activities (although the levels recorded for the different kinds of study area provide some indications). As intended, the results nonetheless provide a rich source of information on the spatial and temporal patterns of variation in these levels.

Both within and between cities, there is substantial variation in participation in wildlife gardening activities. Key variables associated with the spatial variation in wildlife gardening activities are, unsurprisingly, the proportion of households with access to a garden and, more importantly, average garden size and the proportion of land cover by gardens (Figs. 3, 5; Table 2). Where individual gardens are large and garden cover is broad, there is disproportionately high participation in wildlife gardening. As we move to areas with smaller gardens and sparser garden cover, the provision of wildlife-friendly garden features and involvement in activities aimed at encouraging wildlife decline strongly (this is potentially related to the documented decline in the likelihood of participation in wildlife gardening as the population size of settlements increases; DEFRA 2003). These results complement those from a narrower study of the role of garden size in determining garden composition (Smith et al. 2005). For 61 gardens distributed across the city of Sheffield, this showed that large gardens supported more landcover types, contained greater extents of three-quarters of these types, and were more likely to contain trees taller than 2 m, vegetable patches and composting sites.

Given that much of the variation in the frequency of most of the features and activities can be explained simply in terms of garden size and the proportion of cover by gardens, this suggests that remote data (maps, aerial photographs, etc.) could be used to identify areas in which campaigns to raise awareness of the potential benefits of wildlife gardening activities could usefully be targeted. This could be either (a) because those areas have low proportions of households undertaking such activities and are thus areas where they may potentially make a particularly significant impact—it remains an open question to what extent the biodiversity potential of inner city areas, with low coverage by gardens, could

usefully be improved through provision of appropriate resources; or (b) because those areas have high proportions of households undertaking such activities and are thus where additional engagement or alternative approaches may be more readily achieved (given that even in areas of high participation the majority of households still do not undertake wildlife gardening activities).

We found no evidence for strong effects of household density or the socio-economic status of householders on the prevalence of wildlife friendly features in gardens or on the participation by householders in activities to encourage wildlife (Table 2). The former result is presumably because across cities the density of housing and the density of buildings is weakly linked, through the occurrence in inner city areas of large numbers of other kinds of buildings. The absence of a simple relationship between housing density and wildlife gardening does, however, suggest that future increases in housing density per se may not reduce engagement in wildlife gardening.

Moreover, the *density* of bird feeders, compost heaps, frequent bird feeding and frequent mammal feeding all increase significantly with household density, because the statistically non-significant decreases in the proportions of households with these features as housing density increases (Table 2) are more than offset by the increases in numbers of houses. If all else were equal, and particularly if new developments behaved like present ones and there were no threshold effects, this would mean that the per unit area supply of these features would all increase with future increases in housing density. This might arguably to some extent help offset some of the negative effects of increased housing density on bird and mammal populations. However, the loss of habitat is likely to be a stronger driver than provision of individual resource elements. Moreover, other wildlife gardening features (ponds, birdbaths, nestboxes) do not show an increase in density with household density.

Our results suggest two further important considerations in attempts to increase awareness and participation in wildlife gardening. First, the level and kinds of access to spaces in which such activities can be conducted varies systematically across cities, with limited access to private gardens and greater access to terraces, yards and shared gardens in inner city areas, and widespread access to private gardens in outer city areas (Table 1). In order to increase take up of wildlife gardening activities it would thus seem helpful to tailor advice and opportunities carefully to the kinds of spaces that are available in different areas. Second, data on wildlife gardening activities that do not address the temporal frequency with which those activities are being carried out may markedly overestimate their likely impact. Whilst, for example, the proportions of households that feed birds are quite high, the majority do so on a rather infrequent basis, greatly reducing (although not eliminating) the potential value of those activities.

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