Results of a 15-year systematic survey of two common commensal rodents in England

Lambert, M., Vial, F., Pietravalle, S., Cowan, D.

Supplementary Method: Description of variables used in the analyses - adapted from the English Housing Survey Surveyor Briefing Manual; Completing the Survey Form (March 2009).

Litter;

The level of litter and rubbish around the dwelling was assessed by surveyors in order to provide an indication of household attitudes to home and its maintenance, as well providing an indication of the levels of harbourage for rats and mice and other health hazards. The assessment was applied to private gardens and plots and did not include well managed compost heaps. More recently, a simple (3-category) scoring system has been used to assess the level of litter or rubbish, but this information was not available for the majority of surveys, instead presence or absence of litter and rubbish was used.

Plot width;

Plot width in metres was measured (to the nearest metre) from left hand to right hand edge.

Pets/livestock kept outside

Recorded presence or absence of rabbit hutches, chicken runs, aviaries, dog kennels, etc. outside (including in garages, sheds and stables) which might attract vermin.

Situation of block;

Concerns the nature of the road on which the dwelling is located. This is an indication of the amount of through traffic and its consequence for noise. If a block was set back from a main road, either by grass planting or small slip roads or both, the situation was described as that of the main road.

- Major trunk road – a dual carriageway or very busy ‘A’ road.
- Main road – A road linking different parts or suburbs or a town or city, or linking villages.
- Side road – typically a road off a main road which is not a cul-de-sac or crescent.
- Cul-de-sac/crescent – road with no through traffic
- Private road – un-adopted road with access only for residents or approved persons
• Unmade/no road – typically a track to a farmhouse or remote cottage.

_Drainage system faults;_

Survey data for presence or absence of faults in underground drainage including blockages or other faults relevant to Health and Safety risks were aggregated into a single yes/no response.

_Tenure type;_

Tenures relates to the ownership of the dwelling.

• Owner occupied dwellings includes properties owned outright or under a mortgage agreement, and those in shared ownership and part ownership with a local authority or housing association, and dwellings bought from a local authority.

• Private rented includes dwellings rented from a private landlord, private company, other organisation, relative or friend and includes properties owned by Defence Estates (MOD) but not managed by Housing Associations.

• Local authority includes properties rented from the local authority or any new town or development Corporation.

• Housing association includes properties rented from a housing association, including co-operatives and housing charitable trusts and includes properties owned by Defence Estates (MOD) but managed by Housing Associations.

_Dwelling type;_

• End terrace – the end of a row of more than 2 attached properties

• Mid terrace – a dwelling attached on both sides

• Semi-detached – code only if dwelling is one of a pair.

• Detached – including link-detached dwellings.

• Temporary – e.g. caravan or houseboat.

• Purpose-built flats – building was originally built containing flats. Residential accommodation over shops and other non-residential included if the flats have their own separate access.
- Other - converted flats (buildings converted into individual flats which have been defined as separate dwellings and non-residential plus flat where residents must pass through non-residential accommodation to gain access to their living accommodation.

*Date of construction;*

Date of original construction. If a property had a large later extension or had been partially rebuilt, age of the oldest part was recorded even if it accounted for less than half of the area of dwelling.

*Region;*

Location of dwelling by Government Office Region (GOR).

Variables relating to the LOCAL AREA.

Surveyors were asked to define the ‘area around the dwelling of which the dwelling seems to be a part’ and estimate the number of dwellings in that area. This Local Area was likely to be, but was not necessarily, defined by physical boundaries such as roads, railway lines, canals, etc. The survey dwelling was not necessary at the centre of the area; surveyors were asked to define an area of manageable size so that they could clearly define the boundaries of the local area and visually inspect the whole area on foot before proceeding to complete the following questions:

*Number of dwellings in area;*

- 500+
- 300-499
- 100-299
- 50-99
- 25-49
- Less than 25

*Nature of area;*

- Commercial City/Town Centre – this is the area that would constitute part/all of the centre of a city or town. Areas do not have to be run down to be coded as city or town centre. It is likely that these areas will have a high percentage of commercial properties such as shops and businesses.
• Urban – this is the area around the core of towns and cities, and also older urban areas which have been swallowed up by a metropolis. Areas would be largely but not exclusively residential.

• Suburban residential – this is the outer area of towns or cities, and would include large, planned housing estates on the outskirts of towns or larger areas of older residential stock.

• Rural residential – these can be free standing residential areas or suburban areas of villages, often meeting the housing needs of people who work in nearby towns and cities.

• Village centre – these are traditional English villages or the old heart of villages which have been suburbanised.

• Rural – these areas are predominantly rural e.g. agricultural with isolated dwellings or small hamlets.

Problems in area;

Depending on the year of the survey, up to 16 categories of problems in the local area, such as litter, neglected buildings, scruffy gardens, vacant buildings and vandalism, were scored by the surveyors on a scale of 1 (no problems) to 5 (major problems). The mean score from 14 of these categories (\( \bar{x} \)) was used to allocate dwellings to one of four categories; no problems (\( \bar{x} = 1 \)), slight problems (\( 1 < \bar{x} < 1.5 \)), moderate problems (\( 1.5 < \bar{x} < 2.0 \)) or substantial problems (\( \bar{x} > 2.0 \)). This variable was treated as a factor in the models; the 14 categories (selected because they were recorded for all survey years) were vacant sites, intrusive industry, non-conforming uses, vacant boarded-up buildings, ambient air quality, heavy traffic, intrusion from motorways and arterial roads, noise from railways or aircraft, nuisance from on-street parking, litter and rubbish, scruffy gardens, vandalism, graffiti, and scruffy or neglected buildings.

Rodent control;

Where the householder reported a current problem the surveyor asked to see evidence and asked two additional questions;

• Has anyone treated the rats/mice problem?

• Is anything currently being done to stop or control the rats/mice problem?

If the answer to the first question was yes, further details were recorded on how the problem was treated and by whom.
Supplementary Table S1: Number (n) and percentage of occupied dwellings with mice present.

| Year       | Sample | n  | Weighted %       | Un-weighted %     |
|------------|--------|----|------------------|-------------------|
| 2009 - 2010| 16047  | 373| 2.24 (1.98 - 2.50)| 2.32 (2.09-2.56) |
| 2008 - 2009| 15512  | 411| 2.46 (2.20 - 2.73)| 2.65 (2.40-2.90) |
| 2007 - 2008| 15523  | 409| 2.46 (2.19 - 2.73)| 2.63 (2.38-2.89) |
| 2006 - 2007| 15604  | 358| 2.07 (1.82 - 2.32)| 2.29 (2.06-2.53) |
| 2005 - 2006| 15648  | 339| 1.94 (1.70 - 2.17)| 2.17 (1.94-2.39) |
| 2004 - 2005| 16059  | 345| 2.04 (1.80 - 2.28)| 2.15 (1.92-2.37) |
| 2003 - 2004| 15874  | 344| 2.02 (1.79 - 2.26)| 2.17 (1.94-2.39) |
| 2002 - 2003| 15950  | 381| 2.14 (1.90 - 2.38)| 2.39 (2.15-2.63) |
| 2001       | 16721  | 285| 1.44 (1.21 - 1.61)| 1.70 (1.51-1.90) |
| 1996       | 11691  | 240| 1.84 (1.53 – 2.15)| 2.05 (1.80-2.31) |
Supplementary Table S2: Number (n) and percentage of occupied dwellings with rats present.

| Year    | Sample | Rats inside | Rats outside |
|---------|--------|-------------|--------------|
|         | n  | Weighted %  | Un-weighted % | n  | Weighted %  | Un-weighted % |
| 2009-2010 | 16047 | 53 0.29 (0.20 - 0.39) | 0.33 (0.24-0.42) | 13375 | 444 3.11 (2.80 - 3.42) | 3.32 (3.02-3.62) |
| 2008-2009 | 15512 | 59 0.34 (0.24 - 0.44) | 0.38 (0.28-0.48) | 12860 | 505 3.64 (3.29 - 3.99) | 3.92 (3.59-4.26) |
| 2007-2008 | 15523 | 71 0.42 (0.31 - 0.54) | 0.46 (0.35-0.56) | 12786 | 494 3.46 (3.12 - 3.80) | 3.86 (3.53-4.26) |
| 2006-2007 | 15604 | 57 0.37 (0.26 - 0.48) | 0.37 (0.27-0.46) | 12976 | 455 3.04 (2.72 - 3.36) | 3.51 (3.19-3.82) |
| 2005-2006 | 15648 | 60 0.36 (0.25 - 0.46) | 0.38 (0.29-0.48) | 13062 | 444 3.10 (2.78 - 3.42) | 3.40 (3.09-3.71) |
| 2004-2005 | 16059 | 56 0.30 (0.21 - 0.39) | 0.35 (0.26-0.44) | 13387 | 444 3.10 (2.79 - 3.42) | 3.32 (3.01-3.62) |
| 2003-2004 | 15874 | 46 0.24 (0.16 - 0.32) | 0.29 (0.21-0.37) | 13202 | 450 3.04 (2.73 - 3.34) | 3.41 (3.10-3.72) |
| 2002-2003 | 15950 | 58 0.31 (0.22 - 0.40) | 0.36 (0.27-0.46) | 13090 | 494 3.24 (2.92 - 3.56) | 3.77 (3.45-4.10) |
| 2001     | 16721 | 47 0.27 (0.18 - 0.36) | 0.28 (0.20-0.36) | 13805 | 432 2.94 (2.60 - 3.29) | 3.13 (2.84-3.42) |
| 1996     | 11691 | 36 0.35 (0.19 - 0.51) | 0.31 (0.21-0.41) | 9491  | 198 1.72 (1.33 - 2.12) | 2.09 (1.80-2.37) |
Supplementary Table S3: Number and percentage of occupied dwelling with rodents present by factor type. Percentages were weighted using the survey dwelling weights to derive nationally-representative estimates of occurrence (1996 – 2010).

| Sample | Mice inside | Rats inside | Rats outside |
|--------|-------------|-------------|--------------|
|        | n           | Weighted %  | n            | Weighted %  | Sample | n        | Weighted %  |
| a) Tabulated by litter |             |             |              |              |        |          |             |
| No     | 74697       | 1246        | 190          | 0.25 (0.21 - 0.30) | 63161  | 1602     | 2.30 (2.16 - 2.44) |
| Yes    | 23171       | 927         | 153          | 0.64 (0.52 - 0.75) | 17808  | 1106     | 5.85 (5.45 - 6.25) |
| b) Tabulated by number of dwellings in area |             |             |              |              |        |          |             |
| 500+   | 10208       | 279         | 32           | 0.30 (0.17 - 0.44) | 7709   | 262      | 3.14 (2.69 - 3.58) |
| 300-499| 10669       | 213         | 34           | 0.33 (0.20 - 0.46) | 8346   | 273      | 2.77 (2.39 - 3.16) |
| 100-299| 31854       | 606         | 81           | 0.21 (0.16 - 0.26) | 25649  | 612      | 2.04 (1.85 - 2.23) |
| 50-99  | 21994       | 381         | 69           | 0.29 (0.20 - 0.37) | 18467  | 498      | 2.40 (2.12 - 2.67) |
| 25-49  | 14184       | 250         | 43           | 0.31 (0.20 - 0.42) | 12325  | 405      | 2.98 (2.64 - 3.31) |
| Less than 25 | 10623 | 467         | 86           | 0.72 (0.54 - 0.91) | 9770   | 670      | 5.85 (5.35 - 5.35) |
| c) Tabulated by width of plot |             |             |              |              |        |          |             |
| Same as dwelling | 31827       | 842         | 141          | 0.44 (0.35 - 0.53) | 29669  | 878      | 2.64 (2.44 - 2.85) |
| Less than 10m | 23126       | 396         | 56           | 0.21 (0.14 - 0.27) | 23126  | 691      | 2.40 (2.19 - 2.62) |
| Less than 20m | 22809       | 382         | 56           | 0.24 (0.16 - 0.31) | 22809  | 702      | 2.68 (2.44 - 2.93) |
| 20m or more | 5639        | 300         | 52           | 0.83 (0.58 - 1.08) | 5637   | 407      | 6.77 (6.04 - 7.51) |
| d) Tabulated by keeping pets outside |             |             |              |              |        |          |             |
| No     | 93505       | 1934        | 290          | 0.29 (0.25 - 0.34) | 76407  | 2094     | 2.44 (2.31 - 2.57) |
| Yes    | 5578        | 244         | 53           | 0.90 (0.59 - 1.21) | 5466   | 588      | 10.04 (9.1 - 10.98) |
| e) Tabulated by road type |             |             |              |              |        |          |             |
| Major trunk road or main road | 13460       | 358         | 68           | 0.51 (0.36 - 0.66) | 10099  | 489      | 4.61 (4.15 - 5.06) |
| Side road | 43954       | 1130        | 157          | 0.33 (0.27 - 0.39) | 37019  | 1160     | 2.73 (2.55 - 2.91) |
Cul de sac/crescent  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 37727          | 521     | 1.23    | 0.18      | 31776     | 852     | 2.24      |
| 3091           | 110     | 3.30    | 0.90      | 2209      | 117     | 4.55      |
| 1398           | 79      | 5.62    | 1.15      | 1241      | 104     | 9.01      |

f) Tabulated by nature of area  
City centre  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 3205           | 84      | 2.27    | 0.41      | 1455      | 55      | 2.95      |

Urban  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 21314          | 689     | 3.00    | 0.48      | 15161     | 506     | 2.92      |

Suburban  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 57436          | 868     | 1.29    | 0.19      | 49087     | 1201    | 2.07      |

Rural residential  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 11296          | 241     | 2.13    | 0.34      | 10609     | 417     | 3.59      |

Village centre  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 3652           | 103     | 2.70    | 0.50      | 3364      | 182     | 5.41      |

Rural  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 2715           | 243     | 8.58    | 1.84      | 2654      | 361     | 12.35     |

No faults  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 95500          | 2019    | 1.95    | 0.31      | 78882     | 2508    | 2.82      |

Faults  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 2489           | 138     | 5.68    | 0.92      | 2099      | 158     | 7.28      |

No problems  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 18223          | 283     | 1.49    | 0.27      | 16263     | 402     | 2.14      |

Slight problems  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 51422          | 987     | 1.82    | 0.27      | 43675     | 1311    | 2.77      |

Moderate problems  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 20024          | 561     | 2.69    | 0.41      | 15318     | 603     | 3.55      |

Substantial problems  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 9811           | 364     | 3.32    | 0.69      | 6954      | 404     | 5.27      |

i) Tabulated by tenure type  
Owner occupied  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 51670          | 958     | 1.76    | 0.29      | 49212     | 1424    | 2.68      |

Private rented  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 12260          | 410     | 3.09    | 0.63      | 9119      | 388     | 4.00      |

Local authority  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 22227          | 574     | 2.57    | 0.27      | 15248     | 594     | 3.63      |

Housing  
|                | Value 1 | Value 2 | Value 3   | Value 4   | Value 5 | Value 6   |
|----------------|---------|---------|-----------|-----------|---------|-----------|
| 13555          | 257     | 2.12    | 0.38      | 8830      | 320     | 3.48      |
| Association (RSL) | j) Tabulated by dwelling type |
|------------------|------------------------------|
|                  | End terrace                  |
|                  | 11347 283 2.29 (1.97 - 2.61) |
|                  | 45 0.37 (0.24 - 0.50) 11131 345 2.73 (2.39 - 3.08) |
|                  | Mid terrace                  |
|                  | 21168 618 2.72 (2.45 - 2.98) |
|                  | 97 0.45 (0.34 - 0.56) 20805 637 2.65 (2.40 - 2.89) |
|                  | Semi detached                |
|                  | 28986 471 1.41 (1.26 - 1.57) |
|                  | 70 0.21 (0.15 - 0.26) 28815 949 2.69 (2.49 - 2.90) |
|                  | Detached                     |
|                  | 16072 421 2.25 (2.02 - 2.49) |
|                  | 73 0.39 (0.29 - 0.49) 16032 669 3.71 (3.38 - 4.04) |
|                  | Purpose built flat           |
|                  | 18645 281 1.54 (1.29 - 1.80) |
|                  | 43 0.24 (0.13 - 0.35) 4049 107 2.24 (1.73 - 2.75) |
|                  | Other                        |
|                  | 3442 125 3.28 (2.53 - 4.02) |
|                  | 17 0.51 (0.16 - 0.86) 1557 48 2.72 (1.71 - 3.73) |
| k) Tabulated by date of construction |
| Pre 1850         | 3099 221 7.29 (6.20 - 8.38) |
|                  | 48 1.39 (0.91 - 1.87) 2758 258 8.78 (7.61 - 9.95) |
| 1850-1899        | 8834 349 3.46 (3.03 - 3.89) |
|                  | 67 0.68 (0.49 - 0.88) 7542 305 3.64 (3.18 - 4.11) |
| 1900-1918        | 8221 293 3.37 (2.92 - 3.82) |
|                  | 47 0.56 (0.38 - 0.75) 7446 310 3.95 (3.45 - 4.45) |
| 1919-1944        | 17834 454 2.29 (2.04 - 2.54) |
|                  | 69 0.38 (0.28 - 0.49) 16701 616 3.28 (2.98 - 3.58) |
| 1945-1964        | 23309 402 1.50 (1.32 - 1.69) |
|                  | 49 0.18 (0.12 - 0.24) 19778 561 2.42 (2.18 - 2.67) |
| 1965-1980        | 22305 303 1.24 (1.07 - 1.42) |
|                  | 38 0.12 (0.07 - 0.16) 16124 388 2.06 (1.81 - 2.31) |
| Post 1980        | 16093 177 0.97 (0.79 - 1.16) |
|                  | 29 0.21 (0.11 - 0.31) 12047 288 2.03 (1.71 - 2.35) |
| l) Tabulated by region |
| East Midlands    | 9147 185 1.91 (1.58 - 2.24) |
|                  | 21 0.28 (0.14 - 0.43) 8162 289 3.28 (2.85 - 3.71) |
| Eastern          | 10161 164 1.64 (1.34 - 1.95) |
|                  | 32 0.35 (0.21 - 0.49) 8656 302 3.10 (2.71 - 3.49) |
| London           | 13968 621 3.99 (3.60 - 4.38) |
|                  | 71 0.47 (0.33 - 0.60) 8759 228 2.19 (1.87 - 2.52) |
| North East       | 7340 116 1.48 (1.14 - 1.83) |
|                  | 21 0.23 (0.12 - 0.34) 6515 167 2.31 (1.89 - 2.73) |
| North West & Merseyside |
| South East       | 13852 225 1.62 (1.37 - 1.86) |
|                  | 38 0.26 (0.17 - 0.35) 11591 353 2.83 (2.44 - 3.22) |
| South West       | 10355 167 1.49 (1.23 - 1.75) |
|                  | 38 0.35 (0.23 - 0.48) 8937 291 2.94 (2.56 - 3.32) |
| West Midlands    | 9961 199 1.92 (1.60 - 2.24) |
|                  | 49 0.48 (0.30 - 0.66) 8499 463 4.73 (4.23 - 5.22) |
| Yorkshire &      | 11200 282 2.10 (1.80 - 2.40) |
|                  | 33 0.22 (0.14 - 0.31) 9439 319 2.98 (2.58 - 3.38) |
|          |       |   |     |  |  |  |
|----------|-------|---|-----|---|---|---|
| Humberside |      |   |     |  |   |   |
| m) Tabulated by month of survey |       |   |     |  |   |   |
| January  | 6272  | 167| 2.48 (2.06-2.89) | 29 | 0.42 (0.26-0.59) | 5207 | 223 | 3.86 (3.30-4.42) |
| February | 9024  | 220| 2.35 (1.97-2.74)  | 30 | 0.33 (0.20-0.47)  | 7482 | 229 | 2.76 (2.36-3.16)  |
| March    | 3230  | 88 | 2.76 (2.03-3.47)  | 11 | 0.25 (0.09-0.41)  | 2659 | 95  | 3.13 (2.43-3.82)  |
| April    | 4171  | 102| 2.31 (1.79-2.83)  | 18 | 0.36 (0.18-0.54)  | 3446 | 142 | 3.67 (2.99-4.35)  |
| May      | 10087 | 212| 1.83 (1.53-2.12)  | 36 | 0.30 (0.19-0.42)  | 8340 | 283 | 2.87 (2.48-3.26)  |
| June     | 6735  | 139| 1.95 (1.57-2.33)  | 25 | 0.43 (0.23-0.64)  | 5676 | 208 | 3.38 (2.84-3.92)  |
| July     | 12286 | 259| 1.87 (1.61-2.14)  | 49 | 0.37 (0.25-0.48)  | 10211| 343 | 3.00 (2.64-3.36)  |
| August   | 10312 | 196| 1.70 (1.42-1.98)  | 30 | 0.28 (0.156-0.41) | 8527 | 289 | 3.12 (2.68-3.55)  |
| September| 4151  | 72 | 1.71 (1.21-2.20)  | 8  | 0.16 (0.04-0.28)  | 3419 | 113 | 3.01 (2.37-3.66)  |
| October  | 7785  | 162| 1.82 (1.50-2.14)  | 34 | 0.41 (0.26-0.56)  | 6471 | 223 | 3.01 (2.62-3.52)  |
| November | 11739 | 284| 2.33 (2.00-2.66)  | 36 | 0.29 (0.17-0.41)  | 9651 | 323 | 3.13 (2.74-3.52)  |
| December | 1810  | 47 | 2.22 (1.50-2.93)  | 4  | 0.19 (0.00-0.39)  | 1490 | 48  | 2.72 (1.87-3.56)  |
Supplementary Table S4: Exploration of temporal patterns in the prevalence of mice inside dwellings. The best model (highlighted in purple) was the model with the lowest AIC and a significant reduction in model deviance (Chi-square test for analysis of deviance) compared to the null model.

| Model                                      | AIC      | Analysis of deviance (p-value) |
|--------------------------------------------|----------|---------------------------------|
| S(Year)+S(Month)                          | 18647.14 | <0.001                          |
| Year (factor)+S(Month)                     | 18651.56 | <0.001                          |
| S(Year)                                   | 18651.92 | <0.001                          |
| Year only (factor)                         | 18655.64 | <0.001                          |
| S(Year)+Month (factor)                    | 18657.55 | <0.001                          |
| Year+S(Month)                              | 18658.51 | <0.001                          |
| Year (factor) + Month (factor)             | 18661.99 | <0.001                          |
| S(Month)                                   | 18664.8  | <0.001                          |
| Year only                                  | 18668.32 | <0.001                          |
| Year + Month (factor)                      | 18668.8  | <0.001                          |
| Month only (factor)                        | 18675.34 | 0.004                           |
| Null model                                 | 18681.1  |                                  |
Supplementary Table S5: Exploration of temporal patterns in the prevalence of rats inside dwellings. The best model (highlighted in purple) was the most parsimonious model with the lowest AIC. ΔAIC < 2 are not deemed significant. Models with the grey diagonal shading are thus not deemed more valid than the null model. For each model, the change in model deviance (Chi-square test for analysis of deviance) compared to the null model is also presented.

| Model                           | AIC     | Analysis of deviance (p-value) |
|---------------------------------|---------|--------------------------------|
| Year only                       | 4108.48 | 0.14                           |
| S(Year)                         | 4108.49 | 0.14                           |
| **Null model**                  | 4108.66 |                                 |
| S(Month)                        | 4108.74 | 0.17                           |
| Year (factor)+S(Month)          | 4108.91 | 0.07                           |
| Year+S(Month)                   | 4108.93 | 0.15                           |
| S(Year)+S(Month)                | 4108.94 | 0.15                           |
| Year only (factor)              | 4110.62 | 0.07                           |
| Year + Month (factor)           | 4117.86 | 0.25                           |
| S(Year)+Month (factor)          | 4117.87 | 0.25                           |
| Month only (factor)             | 4119.48 | 0.43                           |
| Year (factor) + Month (factor)  | 4121.65 | 0.14                           |
Supplementary Table S6: Exploration of temporal patterns in the prevalence of rats outside dwellings. The best model (highlighted in purple) was the most parsimonious model with the lowest AIC. ΔAIC < 2 are not deemed significant. Models with the grey diagonal shading are thus not deemed more valid than the model with only a smoother for year. For each model, the change in model deviance (Chi-square test for analysis of deviance) compared to the null model is also presented.

| Model                               | AIC        | Analysis of deviance (p-value) |
|-------------------------------------|------------|-------------------------------|
| S(Year)                             | 21868.39   | <0.001                        |
| S(Year)+S(Month)                    | 21868.9    | <0.001                        |
| S(Year)+Month (factor)              | 21869.14   | <0.001                        |
| Year only (factor)                  | 21873.51   | 0.002                         |
| Year (factor)+S(Month)              | 21874.14   | 0.003                         |
| Year (factor) + Month (factor)      | 21874.22   | <0.001                        |
| S(Month)                            | 21880.37   | 0.1                           |
| Null model                          | 21881.13   |                               |
| Year+S(Month)                       | 21882.04   | 0.21                          |
| Year only                           | 21882.63   | 0.47                          |
| Month only (factor)                 | 21883.14   | 0.05                          |
| Year + Month (factor)               | 21884.67   | 0.06                          |
Supplementary Table S7: Variance inflation factor (VIF) values were used to detect collinearity between the candidate explanatory variables. All VIF values were below 3, indicating there is no collinearity between variables, and hence no variables were excluded from the analysis. VIF was calculated using the AED package in R version 3.2.4.

| Candidate Variable                  | GVIF |
|-------------------------------------|------|
| Litter                             | 1.07 |
| Number of dwellings in area         | 1.16 |
| Width of plot                       | 1.17 |
| Animals outside                     | 1.05 |
| Road type                           | 1.08 |
| Nature of area                      | 1.15 |
| Drainage system faults              | 1.01 |
| Problems in area                    | 1.00 |
| Tenure type                         | 1.10 |
| Dwelling type                       | 1.06 |
| Date of construction                | 1.17 |
| Region                              | 1.01 |
| Month                               | 1.02 |
| Year                                | 1.02 |
Supplementary Figure S1: receiver operating characteristic (ROC) curves for the three models

a) Mice inside dwellings

b) Rats inside dwellings
Supplementary Figure S2: Statistical significant (p<0.05) interactions between the variable region and other model variables on the prevalence of mice inside dwellings.

a) Dwelling type
b) Tenure type

![Pie chart showing percentage of dwellings with mice inside by tenure type in different regions.]

Legend:
- Owner occupied
- Housing association (RSL)
- Local authority
- Private rented

c) Problems in area

![Bar chart showing percentage of dwellings with mice inside by severity and region.]

Legend:
- No problems
- Slight problems
- Moderate problems
- Substantial problems
Supplementary Figure S3: Statistical significant (p<0.05) interactions between the variable region and other model variables on the prevalence of rats inside dwellings

a) Litter

b) Plot width
Supplementary Figure S4: Statistical significant (p<0.05) interactions between the variable region and other model variables on the prevalence of rats outside dwellings

a) Drainage system faults

b) Number of dwellings in area
c) Nature of area

![Graph showing the percentage of dwellings with rats outside in different areas.](image)

- City centre
- Rural residential
- Urban
- Rural
- Suburban residential
- Village centre

d) Problems in area

![Graph showing the percentage of dwellings with rat problems in different areas.](image)

- No problems
- Slight problems
- Moderate problems
- Substantial problems
Supplementary Figure S5: Temporal variations in the percentage of dwellings surveyed tabulated across 12 variables

a) Litter

b) Number of dwellings in area
c) Pets/livestock kept outside

![Graph showing % of dwellings for pets/livestock kept outside.]

Legend: No, Yes

d) Plot width

![Graph showing % of dwellings for plot width.]

Legend: Same as dwelling, less than 10m, less than 20m, 20m or more
e) Road type

f) Nature of area
g) Drainage system faults

h) Problems in area
i) Tenure type

j) Dwelling type
k) Date of construction

l) Region
Supplementary Figure S6: Temporal variation in the percentage of dwellings with a current rodent problem (and where information on rodent control arrangements was recorded) having a) done something about the problem and b) taking action at the time of the survey according to their tenure type.
Supplementary Figure S7: Estimated smoothed function, using thin plate regression splines, for year of survey on the percentage of dwellings with a current rodent problem (and where information on rodent control arrangements was recorded) having a) done something about the problem and b) taking action at the time of the survey. The solid line is the smoother and the dotted lines are the 95% confidence bands. The y-axis represents the value taken by the centered smoother. It is the contribution (at a value of the covariate) made to the fitted value for that smooth function.

The model selection process suggested the use of generalized additive models (GAM) fitted with binomial errors and logit link function to model the effects of year of survey as a smoothed function on the percentage of dwellings with a current rodent problem (and where information on rodent control arrangements was recorded) having a) done something about the problem (df = 8.34, deviance, 30.58, p<0.001) and b) taking action at the time of the survey (df = 8.49, deviance, 79.42, p<0.001), with the estimated smoothers showing pronounced non-linear effects.

References
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