# Location of badger catches over time

The locations of badgers caught relative to the treatment area boundary might be expected to change over time with relatively more badgers being caught nearer to the boundary in later culls due to immigration of badgers from the area surrounding the treatment area. To investigate this, the treatment area was divided into 500m rings and the density of badgers trapped within each ring was calculated using the area of land accessible for culling as the denominator. Badger capture rates per $km^2$ were calculated for all culls. Trap locations were not available for all culls therefore rates of badger capture per trapping opportunity were only calculated for culls occurring in 2002 or later. If immigration is detectable by this method of analysis, the density of badgers should be higher near to the treatment boundary than further from the boundary with successive culls.

The number of badgers trapped per $km^2$ decreased with each cull (Figure 1A) but the badgers caught per trap opportunity was similar for each cull (Figure 1B). The latter is not surprising as trapping methods dictated that traps were to be deployed in proportion to the signs of activity observed. There was some evidence that the rate of badger capture (per $km^2$ or per trapping opportunity) near to the treatment area boundary was higher relative to the rate further from the boundary across all culls (Figure 1). It was not apparent whether the relationship between density and distance differed by cull.

To investigate the relationship between density and cull, two analyses were undertaken. First, the ratio of the density of badgers in the 'outer' treatment areas (defined as within 1000m of the treatment area boundary) and the density in the 'inner' treatment areas (alternative definitions of >1000m, >2000m or >3000m from the treatment area boundary) was calculated for each triplet and cull and analysed using linear regression. The ratio generally increased with successive culls, regardless of the definition of 'inner' treatment area (Figure 2A) and similar patterns were observed in many of the triplets (Figure 2B). Regression analyses confirmed that the ratio differed by cull (cull considered to be a categorical variable) with culls after the initial cull having higher ratios (Table 1). If the effect of cull was considered to be linear, there was a significant interaction between triplet and the effect of cull: effects ranged from negligible to positive between the triplets (Table 1). Similar effects were observed regardless of which definition of the 'inner' treatment area was used.

Second, the counts of badgers in the 'outer' and 'inner' treatment areas were analysed with Poisson regression using the area of land accessible for culling as an offset variable. Accounting for triplet the presence of an interaction between cull and location (binary 'outer' vs. 'inner' variable) effects was tested. Whether cull was considered to be a categorical variable or to have a linear effect, numbers of badgers were lower in successive culls. There were significant interactions between cull and location in both model types (regardless of which

definition of 'inner' area was used: Table 2). In all models, the effect of location (that there were more badgers in the 'outer' area) was modified by the effect of cull so that the disparity between 'outer' and 'inner' areas increased with culls subsequent to the initial cull (Table 2).

There is some evidence that badger densities near to the treatment area boundary increased relative to densities further from the boundary with successive culls. This was not observed universally among triplets. There is stronger evidence for a general decrease in the density of badgers across all triplets with sustained culling.

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Table 1 – Parameter estimates from two models of the ratio density of badgers in the outer 1000m against the density of badgers >1000m from the treatment area boundaries. Ratios were $\log_e$ transformed before analysis.

| | | | | |
|---|---|---|---|---|
| Categorical Cull effect | Cull number | Parameter estimate† | SE | p-value for effect |
| | 2 | $-5.34 \times 10^{-4}$ | 0.13 | Cull |
| | 3 | 0.27 | 0.13 | 0.008 |
| | 4 | 0.37 | 0.13 | |
| | 5 | 0.46 | 0.14 | |
| | 6 | 0.22 | 0.20 | |
| | 7 | -0.16 | 0.32 | |
| | 1 (reference) | 0.00 | 0.00 | |
| | | | | |
| Linear Cull effect + Interaction with Triplet | Triplet | Cull effect parameter estimate‡ | SE | p-value for effect |
| | A | 0.13 | 0.18 | Cull |
| | B | -0.03 | 0.16 | $3.02 \times 10^{-6}$ |
| | C | 0.06 | 0.17 | |
| | D | 0.38 | 0.19 | Triplet*Cull |
| | E | -0.03 | 0.17 | 0.005 |
| | F | 0.05 | 0.18 | |
| | G | 0.27 | 0.18 | |
| | H | 0.24 | 0.18 | |
| | I | 0.05 | 0.19 | |
| | J | 0.26 | 0.11 | |

† Estimates represent the change in $\log_e$('outer' density/'inner' density) between each cull and the initial cull. Positive numbers indicate a higher ratio and therefore higher densities in the 'outer' part of the trial area

‡ Estimates represent the change in $\log_e$('outer' density/'inner' density) with each cull within each triplet. Positive numbers indicate an increasing trend in density in the 'outer' part of the treatment area relative to the 'inner' part.

Table 2 – Parameter estimates from two models of the number of badgers in either the outer 1000m or >1000m from the treatment area boundaries. Interactions between the cull and locations effects included in both models. Parameter estimates have been calculated including the interaction with the cull effect. The estimated cull effects have not been included in the calculation of the parameters and 95% CI.

| | Categorical Cull effect model† | | | | Linear Cull effect model‡ | | |
|---|---|---|---|---|---|---|---|
| Cull | Parameter estimate | 95% CI | | | Parameter estimate | 95% CI | |
| 1 | 30.18% | 20.68% | 40.42% | | 10.84% | 0.32% | 22.46% |
| 2 | 17.36% | 0.96% | 36.41% | | 8.67% | -1.64% | 20.07% |
| 3 | 59.63% | 37.44% | 85.40% | | 6.55% | -3.57% | 17.72% |
| 4 | 84.95% | 52.39% | 124.46% | | 4.46% | -5.45% | 15.42% |
| 5 | 91.82% | 53.08% | 140.36% | | 2.42% | -7.30% | 13.16% |
| 6 | 70.19% | 30.12% | 122.59% | | 0.42% | -9.11% | 10.95% |
| 7 | -34.95% | -64.19% | 18.16% | | -1.55% | -10.89% | 8.78% |

† p-value of cull*location interaction (6 df): $5.16 \times 10^{-12}$: Estimates represent the relative density of badgers in the 'outer' area compared to the 'inner' area for each cull.

‡ p-value of cull*location interaction (1 df): $3.25 \times 10^{-10}$: Estimates represent the relative density of badgers in the 'outer' area compared to the 'inner' area for each cull.