Department
for Environment
Food & Rural Affairs

Setting the minimum and maximum numbers in badger cull areas in 2017

Advice to Natural England

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Overview

1. Natural England is the competent authority for badger control licensing for the purpose of preventing the spread of bovine TB. It is a requirement of the Guidance and the licences to set a minimum number in advance of each year's cull in an authorisation letter that is issued to each cull company once the licensing authority is satisfied that the cull company's preparations, planning and funding are sufficient to deliver a successful cull. The purpose of setting a minimum number under the current licence is to ensure that the cull company delivers the required level of population reduction in order to achieve the expected benefits in controlling bovine TB.

2. This advice to Natural England sets out the approach for estimating the badger population in the cull areas in 2017 and the minimum number of badgers to be removed.

3. The minimum number is intended to achieve a 70% reduction of the population relative to the initial starting population. The culling objective is for no more than 30% of the starting population to remain on conclusion of the cull. The 70% target is derived from the Randomised Badger Control Trial (RBCT) where it was estimated that the culls achieved a mean of 70% control of the starting populations across the 10 areas[1], which resulted in disease reduction benefits for the cattle herds in those areas.

4. Culling also needs to "*not be detrimental to the survival of the population concerned*" within the meaning of Article 9 of the Bern Convention on the Conservation of European Wildlife and Natural Habitats. For that purpose Natural England set a maximum number of badgers to be removed from the licensed area.

5. The approach to setting the minimum and maximum numbers was published by Defra in August 2014, August 2015 and August 2016 in advice to Natural England.[2] [3] [4] [5]

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[1] Woodroffe, R., Gilks, P., Johnston, W. T., Le Fevre, A. M., Cox, D. R., Donnelly, C. A., Bourne, F. J., Cheeseman, C. L., Gettinby, G., McInerney, J. P. and Morrison, W. I. (2008), Effects of culling on badger abundance: implications for tuberculosis control. Journal of Zoology, 274: 28–37. doi:10.1111/j.1469-7998.2007.00353.x

[2] Setting the minimum and maximum numbers for Year 2 of the badger culls. Advice to Natural England. August 2014

[3] Setting the minimum and maximum numbers for Year 3 of the badger culls. Advice to Natural England. August 2015.

[4] Setting the minimum and maximum numbers in Dorset for Year 1 of the badger cull. Advice to Natural England. August 2015.

[5] Setting the minimum and maximum numbers in licensed badger control areas. Advice to Natural England. August 2016

6. The estimate of population size must relate to the whole culling area, including any land within that area on which no culling is planned to take place. Any population estimate will have some degree of uncertainty which leads to an interval around the population estimate within which the true population is likely to lie. However, operating with uncertainty does not prevent an effective cull from being carried out, as shown during the RBCT culls, where no minimum numbers or targets were set.

7. This advice is divided into four sections.

    - Section A covers the areas in Somerset and Gloucestershire where culling began in 2013.
    - Section B covers the eight areas where culling began in 2015 or 2016.
    - Section C covers the new areas that will begin culling in 2017.
    - Section D covers concluding remarks affecting all of the areas.

8. New cull areas will be named using a combination of a number and county. Areas will be ordered for numbering firstly by starting year, secondly by alphabetical order of the county[6] and thirdly by decreasing area size.

[6] Where an area spans county borders, the county comprising the highest proportion of an area will be used to name the area.

Section A: Area 1-Gloucestershire, Area 2-Somerset

9. In 2017 Area 1-Gloucestershire and Area 2-Somerset will begin supplementary badger control having successfully completed four years of licensed badger control. Unlike previous years sett surveys are no longer required. However both minimum and maximum numbers of badgers to be removed are required in order to sustain the benefits of licensed badger control while avoiding local extinction. The minimum and maximum numbers will be set by considering historic patterns of cull numbers in both the RBCT and over the last four years in the current culls. In general the number of badgers culled in second and subsequent culls was approximately 40% of the number culled in the first year. Therefore 40% of the year one cull total is set as the baseline and the minimum and maximum numbers are set equidistant above and below the baseline so that the difference between them is equivalent to 25% percent of the pre-cull population. **For Area 1-Gloucestershire the minimum is 160 and the maximum is 580, for Area 2-Somerset the minimum is 140 and the maximum is 610**. This approach produces similar minimum and maximum ranges to the sett survey based approach used in previous years and both areas achieved the minimum number and did not exceed the maximum number in those years.

10. There was considerable variation in historic cull patterns particularly in year two of the RBCT areas. Furthermore if contiguous areas are culled the levels of immigration and badger movement may be reduced which could reduce the comparability of population estimates over time. Therefore the amount of effort deployed by the cull companies and its spatial distribution will continue to be monitored given the uncertainty in the size of the remaining badger population.

Section B: Areas 3 to 10

11. As several hundred badgers have been removed from these areas methods based on an un-culled population are no longer appropriate. Instead, as in previous years, surveys of the number of active setts were used to estimate the current population.

12. In order to ensure that accurate assessments of sett activity were available to provide robust evidence to inform an estimate of the population and minimum numbers, all eight cull companies were instructed to carry out a thorough sett survey programme. APHA surveyors then carried out a Quality Assurance check in sample parcels across the whole of the cull areas. The density of active setts following this process is listed in Table 1 in Annex 1.

13. As described in detail in the 2015 advice to Natural England, the population can be estimated by multiplying the number of active setts by the number of badgers per active sett.

$$P_n = A.S_n.B_0.\alpha$$

14. Where P_n is the current population; A is the area in km^2. S_n is the current active sett density; B_0 is the average number of badgers per active sett before culling began and α is a factor to account for reductions in the numbers of badgers per active sett after culling.

15. The estimates for number of badgers per active sett before culling began are estimated from the National Sett Survey data within 20km of each cull area. (See section C for more details).

16. A discussion of the evidence and rationale for the α factor is set out in the 2015 Advice to Natural England[3]. Putting a quantifiable value on α is difficult, as each active sett in the culling area will be affected differently depending on numbers of badgers removed and how the population has recovered in different areas through net reproduction and net migration and how this affects sett use.

17. Taking into account the available evidence, and following a similar rationale to previous years, we use sett activity surveys as the basis for estimating the current population.

18. The starting population is estimated by reducing the estimate of the current population by one-sixth, to account for 20% population growth in the intervening period, and adding the number culled in year one. The population size is defined at the lower end of the range. Given the overall uncertainty associated with the methods and the range (lower to upper limits), we consider that it is still more prudent to manage the uncertainty by defining a realistic minimum number that aims to achieve the desired level of population reduction to secure the anticipated disease control benefits than to define it too high, with a risk of removing too many badgers. The minimum and maximum numbers are then calculated as in previous years see Table 1 in Annex 1.

19. The licence also requires Natural England to define a maximum number, for the purposes of avoiding the removal of too many badgers. In the first year of the cull, NE defined the maximum reduction level at 95% of the initial starting population (as opposed to the 70% minimum number) to avoid local extinction in the area. Therefore all of the calculations for the minimum can be repeated for this purpose, simply altering the goal to leave 5% of the initial population rather than 30%. The calculations are shown in Table 1 in Annex 1.

Section C: New areas for 2017

20. In 2015 and 2016 the population for new areas was estimated using data from the National Sett Survey. The National Sett Survey[7], which estimated the number of main setts across different land class groups, was combined with the Social Group Size study[8], which used hair–trapping and subsequent DNA analysis to estimate the range of social group sizes across different landscape types, to provide an estimate of the population. In both the sett survey and the social group size estimation project, data were analysed according to landscape type. The landscape types were grouped into seven broad categories, known as Land Class Groups (LCG) for analysis.

21. The National Sett Survey and the Social Group Size projects produced estimates of the mean number of social groups and numbers of badgers per social group respectively per LCG in England and Wales.

22. In 2016 this approach underestimated the variation of population across the different cull areas, even those in the same LCG. Therefore the National Sett Survey data was re-analysed and, rather than looking across an entire LCG, only National Sett Survey data collected within the cull area in question or within 20km of it was used to estimate the population. This approach produces a better estimate of the range of the number of badgers culled in the new areas in 2016 than the original National Sett Survey approach.

23. In order to allow for the potential that the number of main setts and individuals in a social group may vary to a greater extent than that when using the averages estimated by the two national surveys, a Monte Carlo resampling procedure, using the raw data from the Badger Sett Survey and Social Groups Size projects, was carried out to produce the estimates of population size. Ten thousand iterations of random selections of one kilometre squares and social group sizes were performed to produce the mean population size along with the 95% confidence intervals for each area.

24. Taking into account the available evidence and following a similar rationale to setting the minimum and maximum numbers last year, **we use the National Sett Survey (20km) method for estimating the population and define the population size at the lower end of the range.** This is a precautionary approach and assumes that this method is the most reliable one available.

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[7] Judge, J., Wilson, G.J., Macarthur, R., Delahay, R.J. & McDonald R. A. (2014) Density and abundance of badger social groups in England and Wales in 2011–2013. Sci. Rep. **4**, 809; DOI:10.1038/srep03809

[8] Judge, J., Wilson, G.J., Macarthur, R. & Delahay, R.J. (2017) . Estimates of badger social group sizes in England and Wales. Scientific Reports 7: 276 DOI:10.1038/s41598-017-00378-3

25. Given the overall uncertainty associated with the methods and the range (lower to upper limits), we consider that it is still more prudent to manage the uncertainty this year by defining a realistic minimum number that can be revised in the light of new data, than to define it too high, with a risk of removing too many badgers.

26. The licence also requires Natural England to define a maximum number, for the purposes of avoiding the removal of too many badgers. In the first year of the cull, NE defined the maximum reduction level at 95% of the initial starting population (as opposed to the 70% minimum number) to avoid local extinction in the area. Therefore all of the calculations for the minimum can be repeated for this purpose, simply altering the goal to leave 5% of the initial population rather than 30%. The calculations are shown in Table 2 in Annex 1.

Section D: Conclusions

27. A summary of the minimum and maximum numbers for all areas is in Table 3 in Annex 1.

28. As badger culling continues we have learnt that we were often dealing with more uncertainty than we anticipated, and therefore in defining minimum numbers in subsequent years we needed to avoid false levels of confidence. As with previous years, we need to consider two realistic scenarios:

    a) that during the cull, there is accumulating evidence that the number of badgers in the cull area is low, and that the number of badgers removed, despite a high level of contractor effort sustained across the whole cull area, is towards the lower end of our estimates. In this scenario, if the minimum and maximum numbers were set too high, Natural England would need to consider adjusting the numbers down to bring them in line with the actual circumstances being observed in the cull, so as to manage the risk of too many badgers being removed; OR

    b) that during the cull, there is accumulating evidence that the number of badgers is higher than the minimum and maximum numbers suggest, either because the cull company quickly exceeds the minimum number, or because feedback from observations suggests there is a higher level of activity observed than expected. In these circumstances, Natural England would need to consider the need to compel the cull company to continue the cull by revising the minimum and maximum numbers upwards to ensure that the optimum disease benefits can be secured.

29. Daily data collected through the course of the cull about the level of effort being applied across the cull area, and locations of badgers removed, will enable Natural England to build an assessment of progress towards the cull total. This will allow

Natural England to assess whether the estimated population was a reasonable reflection of the true population.

30. If the evidence suggests that there are more badgers than the estimates indicated (e.g. because the number of badgers killed per unit effort is relatively high), Natural England will have the ability to revise the number upwards at an appropriate point, to ensure that the cull company is required to carry on the cull in order to achieve effective disease control.

31. Conversely, if the estimates are too high there will be a risk of removing too many badgers. In these circumstances, Natural England could, on the basis of careful consideration of the evidence and provided that the level of effort applied by the cull company has been sufficient, adjust the maximum number downwards at an appropriate point.

Annex 1

Table 1: Area 3 to Area 10 sett survey results and calculations of minimum and maximum numbers								
	Area 3-Dorset	Area 4-Cornwall	Area 5-Cornwall	Area 6-Devon	Area 7-Devon	Area 8-Dorset	Area 9-Gloucestershire	Area 10-Herefordshire
Setts per km	1.04	0.43	0.89	1.7	0.51	2.53	2.05	0.79
Badgers per sett	1.93	2.024	1.92	1.84	2.216	2.096	1.568	2.4
Area	223	393	272	567	431	416	649	285
Population in spring 2017	448	342	465	1774	487	2206	2086	540
Pop immediately after first cull	N/A	285	387	1478	406	1838	1738	450
Number culled in year 1	N/A	711	851	2038	833	3000	1858	624
Pre-Cull population	879	996	1,238	3,516	1,239	4,838	3,596	1,074
30% level	264	299	371	1055	372	1451	1079	322
5% level	44	50	62	176	62	242	180	54
Minimum Number	184	43	93	719	115	754	1,007	218
Maximum Number	404	292	403	1,598	425	1,964	1,906	487

Note for Area 3-Dorset the pre-cull population and badgers per sett are taken from the 2016 advice to NE paper.

Table 2: The estimates of the population and the minimum and maximum numbers for the new areas in 2017

	Area (km^2)	Population estimates		Based on lower level of estimates	
		Lower level	Upper level	Minimum number	Maximum number
Area 11-Cheshire	292	804	1347	563	764
Area 12-Devon	563	3264	4058	2285	3101
Area 13-Devon	433	1909	2557	1336	1814
Area 14-Devon	249	1126	1606	788	1070
Area 15-Devon	206	1212	1725	848	1151
Area 16-Dorset	1030	7393	9969	5175	7023
Area 17-Somerset	280	1851	2396	1296	1758
Area 18-Somerset	198	1258	1874	881	1195
Area 19-Wiltshire	623	3922	5087	2745	3726
Area 20-Wiltshire	546	2278	3426	1595	2164
Area 21-Wiltshire	332	1480	2235	1036	1406

Where an area spans county borders the county with the highest proportion of an area is used to designate the area.

Table 3: Summary of minimum and maximum numbers for all cull areas in 2017

Area	Minimum number	Maximum number
Area 1-Gloucestershire	160	580
Area 2-Somerset	140	610
Area 3-Dorset	184	404
Area 4-Cornwall	43	292
Area 5-Cornwall	93	403
Area 6-Devon	719	1598
Area 7-Devon	115	425
Area 8-Dorset	754	1964
Area 9-Gloucestershire	1007	1906
Area 10-Herefordshire	218	487
Area 11-Cheshire	563	764
Area 12-Devon	2285	3101
Area 13-Devon	1336	1814
Area 14-Devon	788	1070
Area 15-Devon	848	1151
Area 16-Dorset	5175	7023
Area 17-Somerset	1296	1758
Area 18-Somerset	881	1195

Area 19-Wiltshire	2745	3726
Area 20-Wiltshire	1595	2164
Area 21-Wiltshire	1036	1406