Estimates of badger population sizes in the West Gloucestershire and West Somerset pilot areas

Methods

1. The methodologies used to estimate badger population numbers in order to set minimum and maximum targets in the licences are described in a report to Natural England dated 22 February 2013.

2. Before the pilot culls started, hair trapping was carried out in both areas in order to gather data with which to assess the efficacy of the cull. This methodology is described in detail in a protocol agreed by the Independent Expert Panel. **Essentially the same protocol was followed in August 2013 as for October 2012.**

Hair Trapping Methodology

3. Hair trapping was carried out for 18 days in August up until the start of each cull, in order to secure an up-to-date estimate of the population in each area for the period immediately before the cull starting. The hair trapping is also a possible basis for assessing the efficacy of the culling when the pilots are finished. This component of the hair trapping methodology is not covered in this paper, which only focuses on the use of hair trapping to estimate the population of badgers in the cull area.

4. Sampling was carried out within 50 randomly selected 1km squares in each pilot area. Hair traps were placed at all active setts and along badger runs associated with setts in the accessible land within each cull area, and adjacent to land that was inaccessible for culling. Sampling was completed and hair traps were removed from sites 2-3 days before culling started. A number of improvements to the 2012 hair trap sampling methodology were made with the approval of the Independent Expert Panel with the aim of improving the robustness of the data. These were:

   • A larger number of hair traps were deployed than 2012 (several hundred more) giving the potential for a more precise population estimate;

   • A 3 day optimisation period was used at the start in order to ensure hair traps were deployed correctly, and to allow for adjustments before hair was sampled for the following 15 days;

   • Locations of hair traps and associations with setts were recorded.

5. The hair trapping strategy was based on the principle that the cull needed to reduce the badger population in the entire cull area (including both accessible and inaccessible land) by at least 70%. Some hair traps were removed by protestors in the course of the 3 week period, but analysis confirmed that this would have little impact on the integrity of the population estimates.

6. Hair samples were removed daily for 15 days, and traps were decontaminated and reset. DNA from each hair sample was amplified (to generate multiple copies to

enable more effective detection) and then sequenced to provide a unique genetic profile for each badger. In order to estimate the population for the whole cull area, it was assumed that there was no difference in the population density of badgers in the areas not participating in the cull ("inaccessible areas") within the cull area compared to the areas that are participating ("accessible areas"). The hair trapping allowed the estimation of the number of badgers per sett within the samples 1 km squares. This density was then averaged out over the whole area to derive the overall population estimate. The method allowed the confidence intervals around the estimate to be defined, assuming that all uncertainties had been included.

Results – Revised Estimates

7. The 2013 estimate of the badger population in Somerset was from 997[1] to 1908[†] with a central estimate of 1450[†] badgers. This translates to an objective of 1183[†] badgers killed to achieve an 80% chance of culling at least 70% of the population.

8. The 2013 estimate of the badger population in Gloucestershire was from 1522[†] to 3464[†] with a central estimate of 2347[†] badgers. This translates to an objective of 1919[†] badgers killed to achieve an 80% chance of culling at least 70% of the population.

Table: showing the number of badgers estimated for the pilot cull areas in Somerset and Gloucestershire. All numbers are rounded to the nearest 10 badgers.

	Somerset		Gloucestershire	
	2012	**2013**	**2012**	**2013**
Central population estimate	2400	1450	3400	2350
Probable range (95% confidence intervals)	1500-3910	1000-1910	2000-5420	1520-3460
Minimum number to be culled	2080	1180	2860	1920
80% range	1970-2970	1192-1690	2660-4080	1925-2740

9. The survey conducted in 2013 found that there was about a 99% chance that there were fewer badgers per sett in Somerset in 2013 than in 2012. There was also a 92% chance that there were fewer badgers per sett in Gloucestershire in 2013 than in 2012. When these measurements are expressed in terms of total populations, there is high confidence[2] that the populations in both areas have declined between 2012 and 2013.

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[1] The audits carried out on this work by internal and external auditors confirm that the processes and methodology for collecting and analysing hair trapping data were correctly followed by AHVLA. The analysis depends on reasonable assumptions that are listed in the report. The final report was signed off by AHVLA on 3 October 2013.

[2] This terminology uses the definitions developed by the Intergovernmental Panel on Climate Change http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch1s1-6.html. High confidence suggests about an 8 out of 10 chance.

Audit Process

10. A number of steps were taken to audit the process to ensure that the resulting population estimates are robust:

a. **Data checks** - the hair trap database has been checked for errors by AHVLA staff to ensure all data are included and no mistakes are contained. All corrections have been documented. **Complete.**

b. **Database audit** - the hair trap database has been audited to ensure data used in the analysis are consistent with the original data sheets and any changes are justified and documented. Assessed by M. Wahl (external auditor). Subsequent changes to database documented and delivered. **Complete - see attached auditors report in Annex A.**

c. **Data summary** - Hair trap data were filtered to remove hair traps and setts that did not meet the inclusion conditions detailed in the report. The hair sample barcode data were then matched to the hair DNA barcode data received from Fera to produce a list of individual badger identities and the dates and locations at which they were trapped. From these data the number of setts that were trapped, and the number of setts producing DNA profiles were counted. **Complete.**

d. **Data summary audit** - Checks are made to ensure the data summaries were drawn from the correct data, and that any corrections were justified and documented. Assessed by M. Wahl (auditor). **Complete – see attached auditors report in Annex A**.

e. **Data analysis** - from the consolidated hair trap/DNA data, a frequency distribution was drawn of badger identities. That involved producing a list of the number of badgers caught once, twice, etc. This distribution was analysed using a capture-mark-recapture model to estimate the number of badgers across the area sampled. This number is divided by the number of setts sampled to derive the average number of badgers per sett. Uncertainty is estimated by repeatedly resampling the database to produce estimates, which are then averaged and from which the level of variation is also. The use of this model has previously been reviewed by the IEP. The average number of badgers per sett was then multiplied by the estimated total number of active setts in the pilot area to derive the population estimate. **Complete**.

f. **Statistical audit** - the process of deriving the frequency distribution was audited to ensure the correct data were used to derive it, with any changes justified and documented. Assessed by M. Wahl (auditor). The CMR analysis and subsequent calculations were then audited internally. The same calculations were then audited externally. Delivered by T. Coulson (Oxford University). Subsequent corrections were made. These were checked and approved by the internal and external statistical auditors. **External audit (T. Coulson) of consistency of calculations complete, based on a earlier data summary, although he confirmed the reproducibility of the results.**

g. **Report writing** - Background, methods, summary results, analytical results and brief interpretation of the results presented in a report.

h. **Report audit** - The report has been audited to ensure correspondence of the methods and results sections with the methods followed and results documented. Assessed by M. Wahl, external auditor. Subsequent corrections delivered by AHVLA authors. **Complete.**

i. **Report approval (internal)** - The report has been submitted to AHVLA senior managers for approval. **Complete**

j. **Delivery of Report** - The report has been delivered to Ian Boyd, Chief Scientific Advisor, Defra.

Auditor's report: Estimation of the population size in the Gloucestershire and Somerset pilot areas by hair trapping and sett survey.

Data Quality Assurance (QA) was applied at all stages of the process from the source data collection up to the data being handed over to the statistician.

The details of the QA applied were as follows:

- Hair sampling - source data: Both the theoretical training and the collection of the hair samples in the field were followed to the auditor's satisfaction.
- The hair sample analysis in the laboratory had been followed for the reserve area and the auditor was satisfied with the processes and that the recommendations she had made had been implemented. She did not follow the process again for either Gloucester or Somerset (these both took place a few weeks after the reserve area)
- Hard copies of hair trapping forms were compared with the data entered in the spreadsheets. Very few errors were noted for either Gloucester or Somerset and mainly consisted of date errors (the year recorded as 2014 instead of 2013). In addition, a few forms with data had not been entered. All the above errors and omissions were corrected
- The data was reviewed by data management and subsequently "cleaned".
- The auditor reviewed the "clean database" and was satisfied with the corrections made, as well as with the documentation justifying the corrections
- The database was then handed over for "transformation" to create the format required for the analysis. The auditor was taken through the process and there too was satisfied with the method applied
- Finally the auditor reviewed the summary figures but not the population estimate in the final report concentrating on the actual figures. She (in conjunction with data management) was able to replicate the figures that were quoted.

Having reviewed the data, the processes and the changes made to it I would recommend that the database be locked to prevent further changes and this dataset be used for all subsequent analysis.

In conclusion, from a quality assurance point of view the auditor is satisfied with the completeness and accuracy of the data collected as well as with the "transformations" made. She also would like to point out that all teams in the field as well as in the office did a very good job. The few errors noted were minimal in view of the huge amount of data collected.

Martine Wahl M.D. Independent Certified Auditor

October 3rd 2013