



Animal &
Plant Health
Agency

Badger Vaccine Deployment Project

Final Lessons Learned Report

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About the Authors

Clare Benton took over project management of the BVDP from Fiona Rogers in September 2014. Dr Gavin Wilson was Project Manager of the BVDP in 2010 and Senior Reporting Officer throughout the rest of the project.

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The Woodchester Park unit is now part of the Animal & Plant Health Agency (APHA). Prior to April 2013, this agency was known as AHVLA (Animal Health & Veterinary Laboratories Agency). The Woodchester Park unit moved from Fera (Food & Environment Research Agency) to APHA in October 2014. For the purposes of this report, the unit will be referred to as APHA throughout.

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1. Executive Summary

- The Badger Vaccine Deployment Project (BVDP) was initiated in 2009 and field operations began in 2010. The BVDP was not set up as a scientific trial to investigate the effect of BadgerBCG deployment on TB in badgers or cattle. Rather, it aimed to provide the first use of a vaccine for bovine tuberculosis in badgers outside of research trials, to develop practical knowledge on the processes involved in vaccinating badgers and to facilitate training of lay vaccinators. This lessons learned report¹ describes the vaccine deployment and lay-vaccinator training, and stakeholder attitudes to vaccination.
- The injectable BadgerBCG vaccine was deployed in a 100km² study area near Stroud in Gloucestershire between 2010 and 2014. During this time, 3802 doses of BadgerBCG were delivered over up to 115 premises.
- The number of badgers vaccinated in each year ranged from 541 to 998, delivered by a team of between 5 and 7 field ecologists across an area of up to 90km². Vaccine operations took place within scheduled trapping rounds between June and October each year. **This provided an indication of the level of vaccine coverage that is achievable when deployment is carried out by an experienced team and this report provides guidance on the labour and time required to carry out badger vaccination at a large scale.**
- A Lantra approved training course was developed in consultation with the Royal College of Veterinary Surgeons in order to accredit non-veterinary personnel to deliver the BadgerBCG vaccine. This course was run 22 times over the five years of the project, with additional bespoke training courses held for government staff. A maximum of 10 lay vaccinators were trained on each course, with courses scheduled according to the vaccine deployment timetable within the BVDP.
- A dedicated phone line, webpage and e-mail address were established through which all enquiries relating to badger vaccination could be directed and responded to, providing a centralised communications hub for lay vaccinators, landowners, members of the public and all other stakeholders. A database of all lay vaccinators was established, including an online register of trained persons which facilitated communications between lay vaccinators and also provided a point to which enquires could be directed from landowners and members of the public interested in badger vaccination in their area. The provision of advice by APHA staff to lay vaccinators starting their own badger vaccination schemes continued throughout the project; this ranged from giving advice on ordering vaccine and equipment to providing practical field advice.
- The standard of field activities and data management of organisations and individuals carrying out badger vaccination was monitored. To this end, all data on the number and locations of badgers vaccinated by lay-vaccinators were returned to APHA and a database developed to capture UK wide data on badger vaccination.

¹ The lessons learned are emboldened within the text of the report to provide context, rather than listed separately.

- All data on the number and locations of badgers vaccinated in England and Wales since 2010, both government-led and wider vaccine deployment, were returned, quality checked and collated on the APHA database. This process is ongoing. **The database is a valuable resource, providing accurate information on the pattern of vaccine deployment effort across the country, allowing rapid reporting of progress on vaccine deployment, and collating data for use in analysing the effects of vaccination on cattle bTB in future².**
- An understanding of effort and cost of the activities involved in a vaccination program was developed over the course of the project. **Cost was relatively greater in the first year reflecting additional activities such as land sign-up and initial survey, which are significantly less laborious in subsequent years. This was further enhanced due to efficiencies gained through field staff becoming familiar with the project area, including the distribution of badger activity, in years two to five³.** The average cost of vaccine deployment using government staff was £2448 per km².
- Our license permitted vaccination from May to November inclusive. The number of badgers trapped per unit of effort reduced towards the end of the trapping season, throughout October and November. This indicates that in order to maximise trapping success **a) fieldwork is carried out earlier in the vaccination season, and b) land parcels vaccinated very late in the season are scheduled earlier in the following year.**
- The number of premises on which vaccination took place varied between years (82-95). This was primarily a result of natural fluctuations in the levels and location of badger activity, identified during the annual pre-vaccination sett check process.
- The area of vaccination coverage is not straightforward to quantify. One measure is the area of land within the premises on which badgers were vaccinated, which provides a general guide to the size of the vaccine area. However, this can be disproportionately influenced by inclusion or exclusion of large premises, resulting from changes in badger activity or access permission.
- 194 individuals attended the training courses throughout the project (excluding government staff attending bespoke courses). Feedback on the training courses was consistently positive. The most consistent critical feedback was that **trainees would have valued more training on the preparatory work required prior to trap setting and vaccination, including surveying for and identifying badger activity, trap siting and pre-baiting⁴.** Some newly accredited lay vaccinators reported difficulties and low trap success in their initial efforts after training. Trapping badgers requires a range of skills and experience which were outside the scope of the course. The provision of training is currently being revised to provide greater learning opportunities about the full process of badger trapping and vaccination.

² See page 14

³ See page 18

⁴ See page 20

2. Aims of the BVDP

Management of bovine tuberculosis in livestock in the UK is confounded by the presence of persistent infection in badger populations. Badger vaccines, if used effectively, have the potential to contribute to control of the disease in badgers through long term use in combination with other controls in cattle and badgers.

Defra has spent over £11 million on research into injectable badger vaccines and the injectable BadgerBCG is the first licenced product from the bTB Vaccines Research Programme. A Marketing Authorisation for BadgerBCG was granted by the Veterinary Medicines Directorate (VMD) in 2010. Under the Veterinary Surgery (Vaccination of Badgers Against Tuberculosis) Order 2010, trained lay persons were permitted to vaccinate badgers by injection, under the direction of a veterinary surgeon. In order to ensure effective deployment of this vaccine, building of practical knowledge in the processes involved, and confidence in the farming industry was required.

The stated aims⁵ of the Badger Vaccine Deployment Project (BVDP) were:

- To build confidence in the principle and practicalities of vaccination
- To develop practical know-how for vaccinating badgers
- To provide the capacity to train lay badger vaccinators

The BVDP aimed to develop an understanding of the practicalities, cost and effort of deploying BadgerBCG, in order to better understand how this approach could be best utilised. It was also anticipated that lessons learned about injectable vaccine deployment would be relevant in the event of the licensing of an oral bait vaccine.

In the original scope of the project, the aim was to enroll six 100km² areas, and vaccination was to be carried out by companies or organisations subcontracted to APHA. Landowner sign up and surveys for badger activity took place in all six areas. Prior to the start of trapping and vaccination, the project scope was reduced to the single vaccination area, the Stroud area in Gloucestershire. Hence, badger vaccination in the BVDP took place in the Stroud area only.

⁵ EFRA Report on Vaccination, see <http://www.publications.parliament.uk/pa/cm201314/cmselect/cmenvfru/258/258we03.htm>

3. Methods

3.1) Fieldwork

3.1.1) Landowner sign up

Sign up of landowners for the project was carried out in autumn 2009, over the six 100km² areas in the original BVDP scope, as described above. Cattle herd owners within the proposed areas were targeted with a mailshot inviting registration to the project, along with an invitation to a local meeting. Landowners had multiple sign-up options. They could register to participate at a meeting, by returning a completed registration form, online on the project webpage, or by calling the dedicated project phone line. In addition, we conducted some face to face visits to landowners within the Stroud area in order to increase sign up in that area. Sufficient landowners were signed up in time for the start of vaccine deployment in Stroud in 2010. Across the original six project areas, 696 landowners granted access permission, prior to the reduction in project scope. Table 1 show the breakdown of methods by which landowners signed up to the project.

Table 1. The routes by which landowners signed up to the BVDP project. A total of 696 landowners signed up across the six 100km² areas within the original project scope.

Sign up method	Percentage of landowners signed up
Responding to mailshot	62%
Signed up at farmers meeting	8%
Signed up over the dedicated phone line	19%
Registered to participate on the project webpage	5%
Called or visited by APHA staff	6%

Mailshots sent out to landowners within the proposed BVDP areas were the principal method of signing up project land. Within the mailshot, landowners received information about the project as well as a project registration form and a pre-paid return envelope. **This method to sign up landowners proved successful although involved significant back-office organisation and staff time. Although sign up at farmers meetings contributed to less than 10% of the sign up, these meetings had additional value in terms of building confidence amongst stakeholders by Defra and APHA officials going to in the project areas to discuss the project direct with farmers. The meetings provided a forum to share information with farmers in the project areas and to discuss the evidence around TB in badgers more generally.**

3.1.2) Fieldwork Programme

Project area

The BVDP project area in Stroud was subdivided up into zones of approximately 20km² each. Vaccine was deployed across these zones on a rolling schedule over the field season (July – November), annually from 2010 to 2014 inclusive. The timing of the start of fieldwork each year was determined in part by other commitments of the team. Fieldwork was carried out by 5 ‘lead vaccinator’ APHA field staff, with occasional support from other APHA staff when necessary. Trapping and vaccination was carried out in each zone sequentially throughout the season, and training of lay vaccinators built into this timetable.

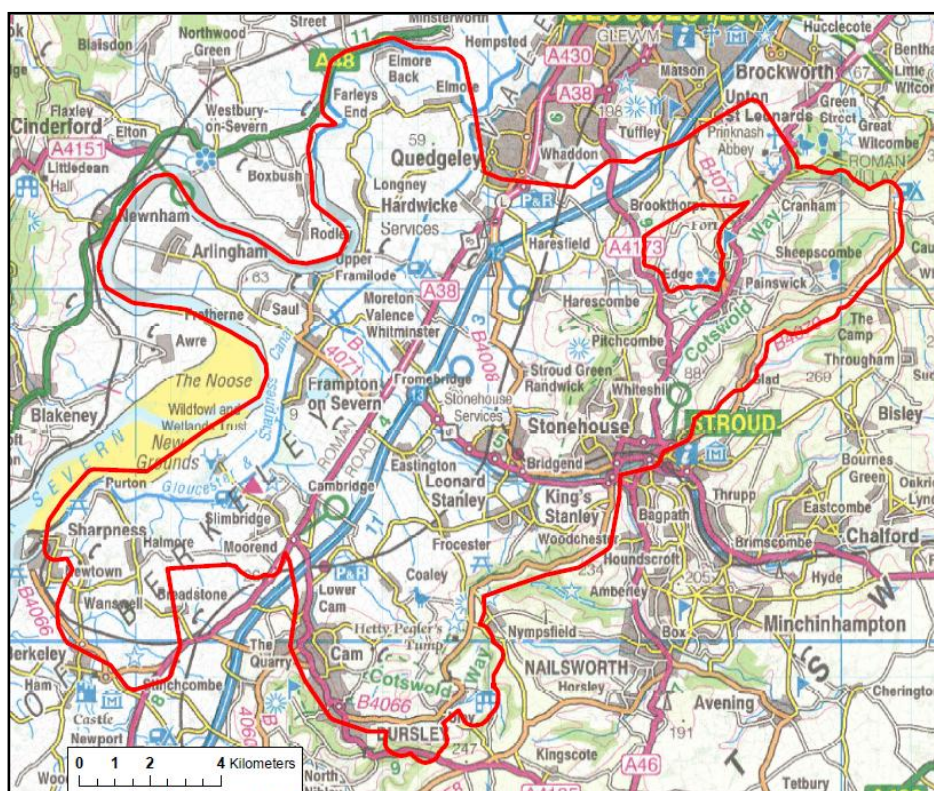


Fig 1: Outline of the BVDP project area near Stroud. Land access was not available to all premises within this outline.

Initial Sett Survey:

The aim of the initial survey was to identify the location of setts and locations of badger activity, in order to plan the trapping and vaccination schedule. This was carried out during the winter of 2009/2010 by APHA field staff. Setts identified during sett surveys were entered onto the vaccination database and were digitised on a GIS mapping project. From this information, maps were produced of badger setts on each premises, which were primarily used to guide field staff when checking badger activity levels prior to deploying traps during each round of vaccination.

Guidance on the manpower effort and time requirements of sett surveying, based on experience gained during the BVDP, is presented in the General Advice & Guidance section at the end of this report.

Sett Checking

Immediately prior to trap deployment on a zone, sett checking was carried out, using the sett maps generated from the initial sett survey. This became easier over time as field staff became more familiar with the project land. Current badger activity levels were recorded, informing the trap deployment patterns. Any new setts found during this process were added to the database and digitised on the GIS mapping project. Levels of badger activity on any particular premises varied between years e.g. inactive setts becoming active or vice versa, or new setts appearing. Where no active setts or signs of badgers were noted on a given premises during the sett check, no traps were deployed there in that year, and activity rechecked during the following season's sett checking.

Trap Deployment

Following sett checks, peanut bait was deployed at points around the setts and associated areas of activity in order to get the badgers used to encountering and eating peanuts and to help inform suitable positions for trap placement. Cage traps were then deployed gradually around the sett and at other areas of activity e.g. latrines. **Rather than place all traps at once, gradual trap deployment reduced the likelihood of disturbing the resident badgers to the extent that they might leave the area, and helped to maximise trapping success.** Each of the 5 lead vaccinators could set up a round consisting of up to around 50 cage traps, often covering a number of premises.

Prebaiting

Once cage traps were in place, they were locked open and pre-baited with peanuts for 7-10 days, in order to encourage badgers to become habituated to entering traps. Initially, bait was placed at the front of the traps and was then moved towards the back of the trap towards the end of the pre-baiting period.

Vaccine Deployment

Traps were set to catch for two consecutive nights. Traps were checked early the following morning, in accordance with the times set out in the Standard Operating Procedure (SOP), as follows:

- May – up to 9am
- June – Aug – up to 8am or within 3 hours of first light, whichever is the later
- Sept – up to 9am or within 3 hours of first light, whichever is the later
- Oct-Nov – up to 10am or within 3 hours of first light, whichever is the later

At each location within a trapping round, the traps were checked to establish the number of trapped badgers. Then the required number of BadgerBCG vaccine doses, stored in the appropriate cold chain, were prepared at the vehicle. Prior to vaccination, a health and welfare assessment was conducted in order to assess whether a trapped badger was fit to vaccinate. The vaccine was then injected into the rear hind leg muscle of the trapped badger through the bars of the trap. Vaccinated badgers were then marked with a fur clip and stock marker spray in order to identify them if they were caught on the following morning. Where necessary, wickets were used to restrain animals in order to allow vaccination (see Figure 2).



Fig 2: Badger being vaccinated with BadgerBCG within the BVDP project area, photo credit J.Judge.

In some cases the number of nights on which traps were set was reduced to one due to inclement weather, or very occasionally extended to three or four if no badgers were trapped. Following the trap placement and pre-baiting, each vaccinator's trap round was divided into two halves. The activities involved in the trapping week are as follows:

- Day 1 afternoon: First half of round traps set to catch, second half pre-baited
- Day 2 morning: Badgers from first half of round vaccinated and released, empty traps closed down
- Day 2 afternoon: First half of round traps are reset, second half pre-baited
- Day 3 morning: New badgers trapped are vaccinated, recaptures from previous day released without re-vaccinating, all traps closed.
- Day 3 afternoon: Second half of round traps set to catch
- Day 4 morning: Badgers from second half of round vaccinated and released, empty traps closed down
- Day 4 afternoon: Second half of round traps reset.
- Day 5: New badgers trapped are vaccinated, recaptures from previous day released without re-vaccinating, all traps removed and disinfected prior to deployment elsewhere.

Guidance on labour required for pre-baiting and vaccination and consumables required is given in the General Advice & Guidance section at the end of the report.

Cleaning and Disinfecting

Following vaccine deployment at a sett, cage traps were returned to an APHA facility and steam cleaned prior to redeployment at another vaccination site. All other equipment, including vehicles and footwear, was disinfected with FAM 30, with close attention being paid to biosecurity at all times, including when moving between premises.

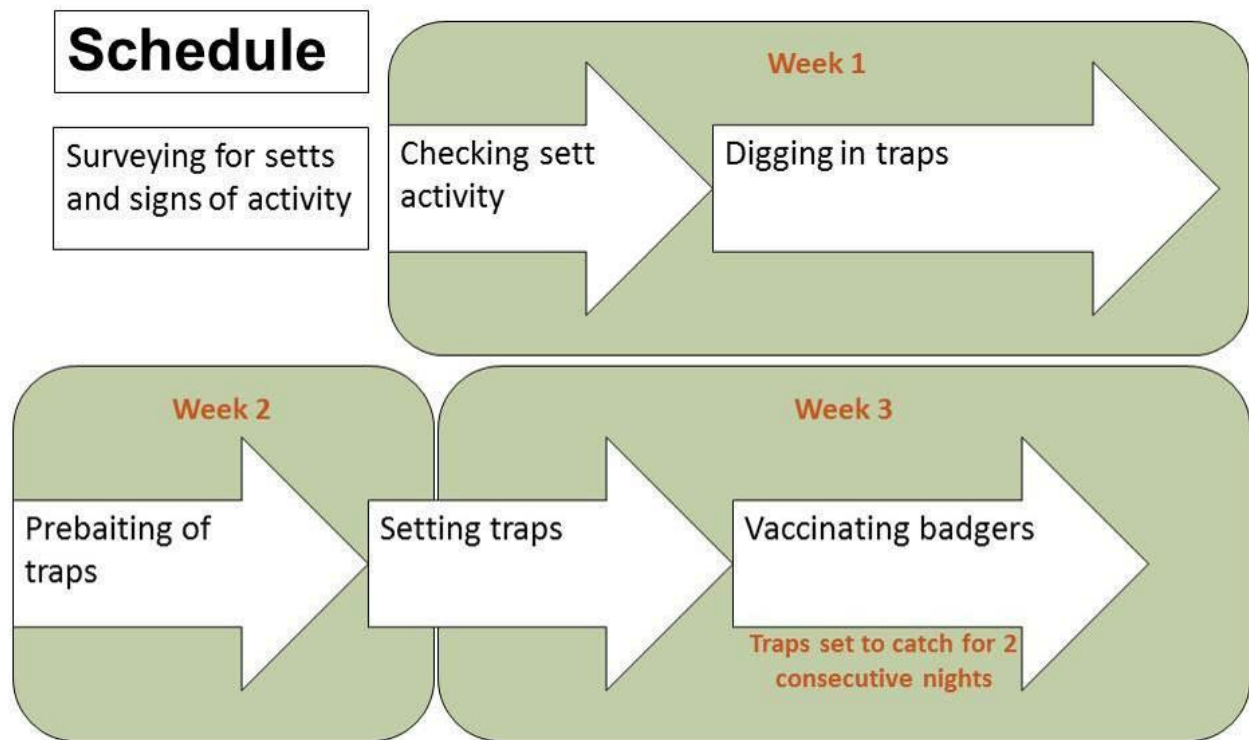


Fig 3: Schematic describing the cycle of activities in a vaccination round.

3.2) Training

3.2.1) Development of the Cage Trapping & Vaccination of Badgers Training Course

The Cage Trapping and Vaccination of Badgers Course was set up in 2010 to train lay vaccinators to carry out BadgerBCG deployment. The format and content of the course was agreed by the Royal College of Veterinary Surgeons, and the course was accredited through a customised provision arrangement with Lantra. Courses were run in each year of the BVDP. The aim of the course was to train lay vaccinators in cage trapping and vaccination of badgers with BadgerBCG, and accredit them such that they could apply for a Natural England license to trap badgers for the purpose of vaccination.

The training was run within the field schedule of the Badger Vaccine Deployment Project, to allow trainees hands-on experience of trapping and vaccinating badgers. This provided a maximum capacity for 50 trainees over 5 training courses annually. The course was carried out over four days and comprised of classroom and practical field sessions. The training course was run 22 times over the course of the project. Trainee's learned about legislation, requirements of lay vaccinators, theory of cage trapping and vaccination and gained hands on experience in cage trapping and vaccinating badgers in the wild. The competence of trainees was assessed through observation during practical field sessions and a written assessment. Trainees were given the opportunity to complete feedback forms, the results of which are summarised in the Results section. Demand for places on the courses increased each year.

3.2.2) Lay Vaccinator Support

Throughout the course of the BVDP, APHA responded via our dedicated phone line and e-mail to a wide variety of requests and enquiries from a range of parties including lay vaccinators, potential course trainees, landowners, wildlife groups and members of the public. In addition, individual APHA field trainers provided field guidance to lay vaccinators over the phone. The badger vaccine e-mail account received around 2000 enquiries throughout the project, ranging from requests for information about training courses, requests for Certificates of Competence, advice on ordering BadgerBCG, clarifications on published research relating to badger vaccination, and more. In addition, APHA staff occasionally attended meetings when invited, with local vets and landowners in order to help facilitate lay-vaccinator led BadgerBCG vaccination initiatives.

3.2.3) Certificate of Competence Scheme

On successful completion of the course, trainees became accredited lay vaccinators and were issued a Lantra Certificate of Training. In order to then proceed to cage trap and vaccinate, lay vaccinators then applied to APHA for a Certificate of Competence, which was valid for 12 months, and a licence to cage trap and vaccinate from the statutory licensing authority (Natural England/Natural Resources Wales). The Certificate of Competence scheme provided the processes by which APHA audited lay vaccinators.

The training course cost was £750 per trainee and the Certificate of Competence registration scheme cost was £700 per annum for a sole operator and £350 per certified lay vaccinators if were 2 or more individuals on the same certificate; each individual being responsible for meeting the conditions of the certification. From 2012 onwards, for members of voluntary and community sector (VCS) organisations, Defra provided funded

50% of the course fee and 50% of the fee for their Certificate of Competence. The Certificate of Competence fee covered the cost of administering the scheme and auditing.

The purpose of the Certificate of Competence Scheme was to satisfy the RCVS that the conditions to allow lay vaccination of badgers under the Veterinary Surgeons Act were being met. In order to apply for a Certificate of Competence, applicants had to meet the following conditions:

1. Successfully complete the Cage Trapping and Vaccination of Badgers course
2. Agree to comply with Standard Operating Procedures (SOPs) relating to trapping, welfare and vaccination.
3. Records of number of badgers trapped and vaccinated must be kept and submitted annually to APHA by 31st December by submitting copies of all BVDP3 Trapping and Welfare Forms (this form included details on the number of badgers vaccinated and spatial location data indicating where vaccination was carried out).
4. Agree to auditing and monitoring of all related paperwork and field operations by APHA.
5. Details of intended prescribing vet must be provided.
6. Evidence of suitable premises for storing of vaccine, either on your own premises or through a local vet/wholesaler, must be provided.
7. Agreement that pharmacovigilance will be complied with (requirement for lay vaccinators to report any suspected adverse reactions to the vaccine to the Marketing Authorisation Holder).

3.2.4) Auditing

Auditing was carried out in order to ensure compliance with Standard Operating Procedures and to satisfy the RCVS that the conditions to allow lay vaccination of badgers under the Veterinary Surgeons Act were being met. Within the terms of the Certificate of Competence scheme, we requested that lay vaccinators contacted us at least one month prior to proposed vaccination operations, in order to allow us to organise an audit visit if necessary. During the first years of the scheme, few organisations held Certificates of Competence hence it was feasible to visit all vaccinators throughout the season. As the numbers of lay vaccinators increased, auditing all individuals at this frequency was no longer possible. The decision was then taken to audit at the organisational level. APHA aimed to audit every lay vaccinator group within their first year of operation. Audits involved scrutiny of data returns and field visits. In addition to picking up occasional deviations from trapping and vaccination SOPs, the visits also effectively functioned as support visits for the lay vaccinators, with opportunity for advice and constructive feedback.

3.3) Databases

To manage the data generated from the BVDP project in the Stroud area, and data on wider deployment of BadgerBCG vaccine in England and Wales by lay vaccinators, a database and associated GIS projects were established (See Table 2.), which linked several key data sources. Databases were set up and maintained by the Knowledge and Information Management and Systems Team (KIMS), Fera. Existing data on land ownership and cattle herds were obtained through the Customer & Land Database (CLAD) and the Cattle Tracing Scheme (CTS) via the former Veterinary Laboratories Agency (VLA) and uploaded to Fera servers. Data generated during fieldwork (e.g. sett surveys, trapping, vaccinating) were checked and entered by APHA staff via a secure web interface, which updated the database. Data from vaccination of all badgers by licensed lay vaccinators were also returned and collated under the Certificate of Competence scheme, meaning that details of all badger vaccination in England and Wales was maintained in one database. The databases were viewed using a GIS project, which queries databases to produce a 'query view', e.g. all cattle farmers in an area that have registered to participate. The databases could also be queried via the web interface or directly via the SQL server.

Table 2. The main databases used within the BVDP:

Database type	Aims	Outputs
Landowners	<ul style="list-style-type: none"> • Identify landowners. • Identify cattle farmers in catchment area. • Register of farmers participating/ not participating in project. • Identify farm types and practices. 	<ul style="list-style-type: none"> • Export landowner mailing list, by area and participation and survey status. • No. of landowners participating and method of registering participation. • No. of landowners declined to participate. • What is the area of land signed up – (Hectares using CLAD table). • What is the area of land where permission has been declined – (Hectares using CLAD table). • What is the number of farm types in the area signed up.
Sett Survey	<ul style="list-style-type: none"> • Record location and activity of badger setts. • Select farms for trapping and vaccinating. • Estimate sett density. 	<ul style="list-style-type: none"> • What is the area of land surveyed - (m² using CLAD). • What is the number of surveyed farms with /without badger setts present. • Area of land surveyed. • Location of badger setts.

Trapping and Vaccination	<ul style="list-style-type: none"> • Record sett activity prior to trapping. • Record of trapping. • Record of vaccination. 	<ul style="list-style-type: none"> • Numbers and spatial locations of vaccinated badgers within BVDP. • Wider deployment of BadgerBCG by lay vaccinators. • Paper component of lay vaccinator auditing procedures. • Area vaccinated.

Outputs from the vaccination database

The database linked GIS projects enabled the rapid production of survey maps and sett checking maps, facilitating the work of the field teams. Summaries of information ranging from the current numbers of lay vaccinators to the number of vaccine doses delivered at any point in time were regularly produced for Defra on request.

The database allowed progress in wider vaccine deployment to be monitored, maintaining spatially accurate data on all badger vaccine deployment effort across the country. This can continue to be used as injectable vaccination continues in the future, and provides a means to produce data subsets to enable future analyses of the effect of badger vaccination on cattle TB.

The collation of vaccination data received annually from lay vaccinators also formed part of the auditing process, within the framework of the Certificate of Competence scheme, by allowing checks on trapping and welfare information reported from vaccination groups, and on compliance with the Standard Operating Procedures that are a condition of the Natural England license.

From 2015, the database will be used to assist Natural England to monitor actions taken under each vaccination licence issued.

4. Results

4.1) Fieldwork

4.1.1) Vaccine Deployment

Deployment of BadgerBCG within the BVDP project area commenced on 5th July 2010 with the final vaccinations carried out on 24th October 2014. A breakdown of deployment by project year is given in Table 3.

Table 3. Numbers of badgers vaccinated in each year of the project, by age class.

Year	Adults vaccinated	Cubs vaccinated	Age unknown vaccinated	Total vaccinated
2010	382	132	27	541
2011	452	150	26	628
2012	705	257	36	998
2013	693	127	14	834
2014	583	214	4	801

The number of badgers trapped increased after the first year of operations. **Anecdotal evidence suggests that badgers in areas where trapping has not previously occurred may become used to the presence of traps and associated activities, resulting in improved capture rates in subsequent years.** However, other factors can affect how many badgers are trapped including the number of badgers in an area, and local weather conditions.

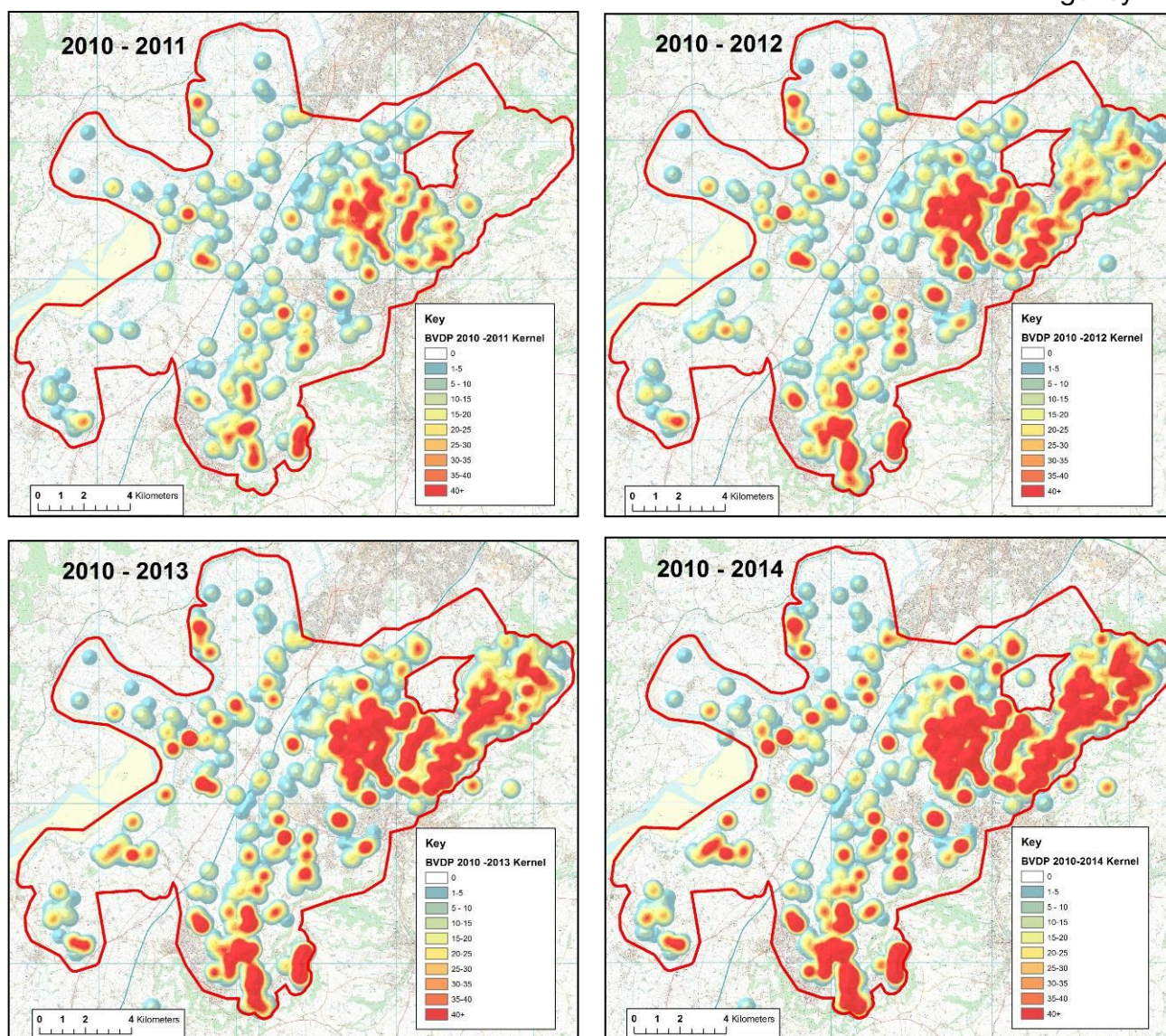


Fig 4: Heatmaps of BadgerBCG deployment across the BVDP area, produced using ArcGIS 10.2 (ESRI 2013, ArcGIS Desktop, Release 10.2, Redlands, CA: Environmental Systems Research Institute). The 'kernel density' tool in the Spatial Analyst toolbox was used to produce maps of where BadgerBCG was deployed within the BVDP project area. Points are weighted according to the number of vaccine doses deployed, with warmer colours indicating more doses deployed.

BadgerBCG was not deployed uniformly across the BVDP area (see Figure 4). This mainly reflects variations in badger presence and density, relating to suitability of habitat. Some parts of the project area had a low badger density e.g. the floodplains near the River Severn whereas other areas had high badger densities, particularly in the north east and south. In addition to the underlying heterogeneity in badger density, some land within the project boundaries did not have land access granted. In such cases remote trapping was carried out at the boundary of non-signed up land, in order to catch badgers moving across the boundary.

Seasonal variation in trapping success

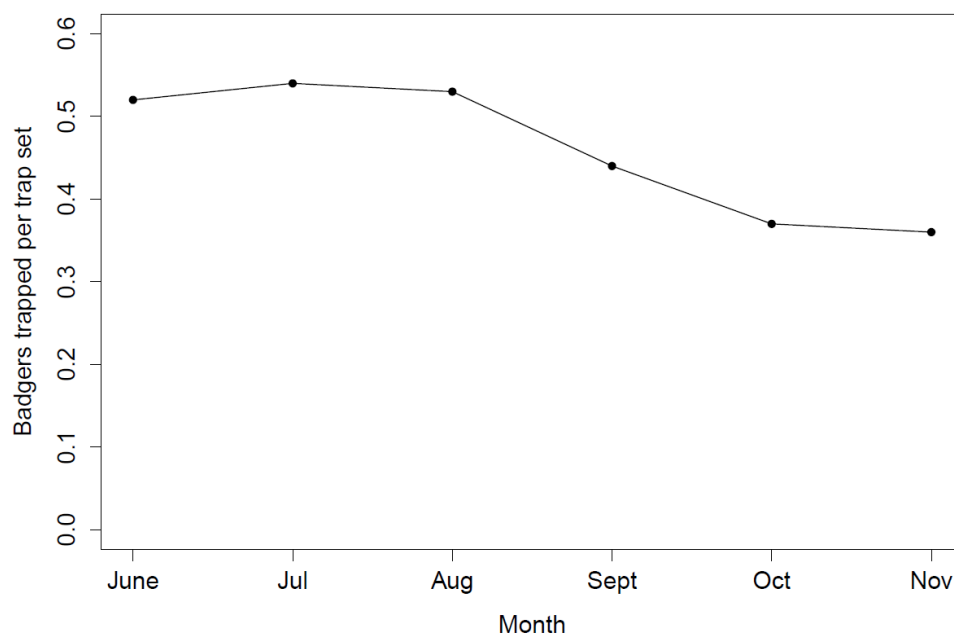


Fig 5: Seasonal variation in the average number of badgers trapped per trap set. Data from 2010 – 2014 included.

Trapping efficiency, as measured by the number of badgers trapped divided by the number of traps set varied slightly across the vaccination season. Trapping efficiency was consistently above 0.5 between June and August (i.e an average of more than 0.5 badgers caught per trap set, or more than 1 out of every 2 traps set catching a badger), however this declined gradually towards the later part of the trapping season, with lower trapping success in October and November (Figure 5). **This suggests that the earlier part of the vaccination season is likely to yield higher trapping success.**

4.1.2) Area Vaccinated

The total number of premises on which vaccination took place, and the total area of land of those premises vaccinated within all years of the BVDP is shown in Table 4.

Table 4. Number and area of premises vaccinated during all years of the BVDP

Year	Number of premises vaccinated	'Area' of premises vaccinated (km ²)
2014	95	82
2013	107	88
2012	115	95
2011	86	84
2010	93	90

Traps were only deployed on premises where badger activity was noted during sett checks in a given year. For this reason the number and area of premises fluctuated between years of the project, despite little change in landowner participation overall (see Section 5.1 for full details). **It is important to note that using the area of the premises vaccinated in isolation to reflect the area influenced by vaccination may be**

useful as a general guide to the extent of the vaccination program, but may not provide a straightforward indication of the vaccine coverage because:

- Landowners may have signed up to the project but have no badger activity on their land
- Landowners may have not participated in the BVDP for the full period so may have had their land vaccinated for 1,2,3,4 or 5 years
- Premises where badger setts have only been active in certain years of the study so may have had their land vaccinated for 1,2,3,4 or 5 years
- Landowners where badgers are active but trapping efforts were unsuccessful

Additionally, premises where access is not permitted may still be affected by vaccination, if there is vaccination on neighbouring premises, which contains badgers which use the non-signed up land. A proportion of the badgers that use land where access was not granted will still be vaccinated. Hence, determining a scientifically robust definition of 'area vaccinated' is likely to require further considerations including estimates of the proportion of badgers vaccinated and typical ranging behavior of badgers.

4.1.3) Costs of Vaccine Deployment

The BVDP fulfilled a range of functions in support of Defra's policy on badger vaccination from 2010-2014. However, it was possible to extract the costs of the field component of vaccine deployment for each year, shown in Table 5.

Table 5. Costs of vaccine deployment within the corresponding financial years

Activity	2010/11	2011/12	2012/13	2013/14	2014/15	Average
Vaccine deployment	£246,380	£226,682	£242,763	£172,185	£188,209	£215,244

Costs of vaccine deployment were highest during the first year of the project, and generally reduced in subsequent years. This is consistent with other multi-year badger trapping-based projects carried out by the APHA team. **Staff time required to deliver a trapping program in a newly established project area is greater than in subsequent years, mainly as a result of increasing staff familiarity with both the project land and the landowners. This is particularly the case if the same staff carry out trapping rounds at the same location each year, where time spent liaising with landowners, locating trap positions and working around farming activities is much streamlined.**

The slight increase in cost in 2012/13 was due to the requirement to survey some extra land parcels in order to maintain the size of the project area after removal of access permissions. Changes in staff costs are reflected in the increase between the final two years of the project. **These costs translate into an average cost of £2448 per km², for government staff to deliver vaccine deployment.**

4.2) Training

4.2.1) Numbers of lay vaccinators trained

In addition to the 22 times that the Cage Trapping & Vaccination of Badgers training course was run, two bespoke training courses were run in Wales for the Welsh Government in 2012, resulting in the accreditation of 20 lay vaccinators. APHA also ran bespoke courses for the Welsh Government in 2013 and 2014. These courses were in support of the Welsh Government vaccination initiative in the Intensive Action Area in Pembrokeshire.

Table 6: Uptake of available training course places between 2010-2014. Only one external course was available in 2010, in all other years, five course dates were publicised.

Year	Number of courses	External Trainees	Internal Trainees	Total Trainees
2010	3	8	20	28
2011	4	31	2	33
2012	5	41	4	45
2013	5	39	1	40
2014	5	47	1	48

4.2.2) Conversion rate of successful course trainees to active lay vaccinators

The proportions of trained individuals each year who were from groups that are still actively vaccinating badgers are shown in Table 7. Data from the final two courses of 2014 are excluded from these figures as this course was in late September 2014 and so successful trainees would have been unlikely to commence vaccination so late in that season.

Table 7. Percentage of trainees from groups that are still actively involved in badger vaccination

Year	Percentage of trainees from groups that are still actively vaccinating
2010	25 % (2 out of 8)
2011	57% (17 out of 30)
2012	53% (21 out of 40)
2013	84% (32 out of 38)
2014	83% (24 out of 29)

Only one external training course was held in 2010 and 25% of those trained on that course were from groups that are still actively involved in badger vaccination. The proportion of trainees from organisations actively delivering badger vaccination programs increased throughout the project. This likely reflects the cumulative increase in awareness of badger vaccination, with fewer trainees being sent by their organisations merely to ‘fact-find’. **As groups have grown in experience they have taken on larger vaccination projects and as such have sent more staff members / volunteers for training. The availability of the Defra grant for members of Voluntary & Community Sector (VCS) organisations, between 2012-2014, also encouraged non-commercial operators such as Wildlife Trusts and regional badger groups to train staff / volunteers.**

4.2.3) Training Course Feedback

At the end of each training course, following the practical and theory assessment, trainees were given the opportunity to complete a feedback form, inviting comments on their training experience. Trainees were asked to score aspects of the course (Presentations, Handouts, Tutors, Field Sessions, Ease of booking, Facilities, Food) on a scale (Poor, Average, Good, Very Good, Excellent) as well as giving the course an overall evaluation score, the results of which are presented in Figure 6. Feedback for all years of the course was consistently positive. A selection of the comments is shown below. The most consistent critical feedback was that **trainees would have liked more teaching and instruction on surveying, pre-baiting and trap placement**. A number of newly accredited lay vaccinators reported difficulties and low trap success in their initial efforts after training. **Trapping badgers requires a range of skills and experience which the current course was not designed to provide**. For this reason, the provision of training has now been revised to address this knowledge gap with APHA offering separate courses in ‘Field Surveying to support Badger Vaccination’, ‘Pre-baiting and Trap-Siting for Badger Vaccination’ and ‘Cage Trapping & Vaccination of Badgers’. Splitting the training into separate courses provides the opportunity for vaccination groups to address specific knowledge gaps and develop the supporting skills essential to a successful vaccination campaign.

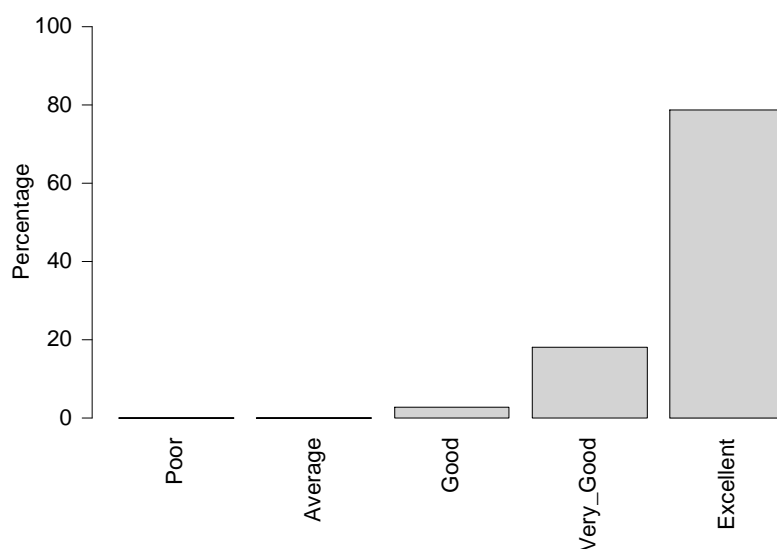


Fig 6: Summary of overall evaluation scores from trainees attending the Cage Trapping & Vaccination of Badgers training courses delivered by APHA between 2010 and 2014.

Trainees were asked to comment on their overall evaluation of the course, what they liked best and what else they would have liked the course to cover, some examples are given below:

Overall Evaluation

'Brilliant course, very knowledgeable instructors. Good balance of theory and practical'

'Brilliant course, great content and well laid out. Well organised. Vaccination training was excellent very clear and hand on training in the field was first class'

'Exceeded expectations. However another day in field solely on survey and prebaiting would have been good - no use being able to vaccinate if you can't catch any!'

What else would you have liked the course to cover?

43 trainees commented that they would have liked the course to cover more detail on some aspect of the following; field surveying (including the use of GPS units and grid references), pre-baiting and trap placement. Some examples are given below.

'More on pre baiting and getting the badger to the trap. More on trap placement (remote trapping)'

'Pre baiting, more on badger ecology and survey skills i.e going out to setts, using maps and identifying runs, latrines etc & where best to site bait/traps.'

'In the time frame available it's not possible to fit more in, but would like to survey a sett, pre baiting and deployment of traps'

4.2.4) Findings from Audit Visits conducted within the Certificate of Competence scheme.

Between 2011-2014, 27 audit visits were carried out by APHA staff to 15 different organisations holding Certificates of Competence (Table 8). Repeated audit visits were made to 7 groups over this period. No major non-compliances were noted at any of the field audit visits and 44% of audit reports found no non-compliances in observed lay vaccinator operations.

Table 8: Summary of non-compliances noted from audit reports by APHA 2011-2014

Category	No. of reports	% of reports
No recommendations resulting from audit report	12	44%
< 3 minor non-compliances noted in report	7	26%
3-5 minor non-compliances noted in report	8	30%

Seven organisations have been the subject of repeated field audit visits. These were organisations who applied for Certificates of Competence during the early stages of the scheme, hence auditing resource was available to audit more frequently. As uptake of the scheme increased, resources were no longer available to audit at this frequency. The decision was then taken to audit at the organisational level. APHA aimed to audit every lay vaccinator group within their first year of operation, which in most cases has been achievable. For organisations that were audited more than once, the number of non-compliances generally dropped after the

first audit visit, indicating that recommendations made were taken on board by lay vaccinators and adherence to Standard Operating Procedures improved. Additionally, the audit visits offered an opportunity for feedback and advice from experienced APHA staff to the new lay vaccinators.

From 2015 onwards, monitoring of badger vaccination licenses will be carried out by Natural England in England and the Department for Natural Resources, Welsh Government in Wales, with technical support and advice from APHA.

4.2.5) Wider Deployment of BadgerBCG

The extent of wider deployment of BadgerBCG in England and Wales increased over the 5 years of the project. In 2010, only APHA were vaccinating badgers, primarily within the BVDP area but also as part of a small commercial contract in Somerset. In 2011 the first non-APHA led BadgerBCG deployment commenced, with the Badger Trust, Gloucestershire Wildlife Trust and a private vet deploying vaccine at modest scales. Growth continued in 2012 with 2 more Wildlife Trusts commencing vaccination as well as 2 commercial operators and another Badger Group starting vaccination. Additionally, the Welsh Government commenced badger vaccination in the IAA (Intensive Action Area) in Pembrokeshire, an area of 288km². A total of 1424 badgers were vaccinated in this area in 2012 (IAA Badger Vaccination Project, Welsh Government, 2012). Between the 2012 and 2013 field seasons there was a substantial rise in the number of lay vaccinators, with 16 non-governmental organisations carrying out badger vaccination, primarily within the TB High Risk area but also within the Edge area of England. These included 7 Wildlife Trusts, 5 Badger Groups, an ecological consultancy and 4 commercial operators. The spatial extent of BadgerBCG deployment by lay vaccinators increased further in 2014, with vaccination commencing in Sussex and increasing in Dorset and Derbyshire. Maps showing the growth of wider deployment of BadgerBCG between 2011 and 2014 are shown in Figure 7a & b.

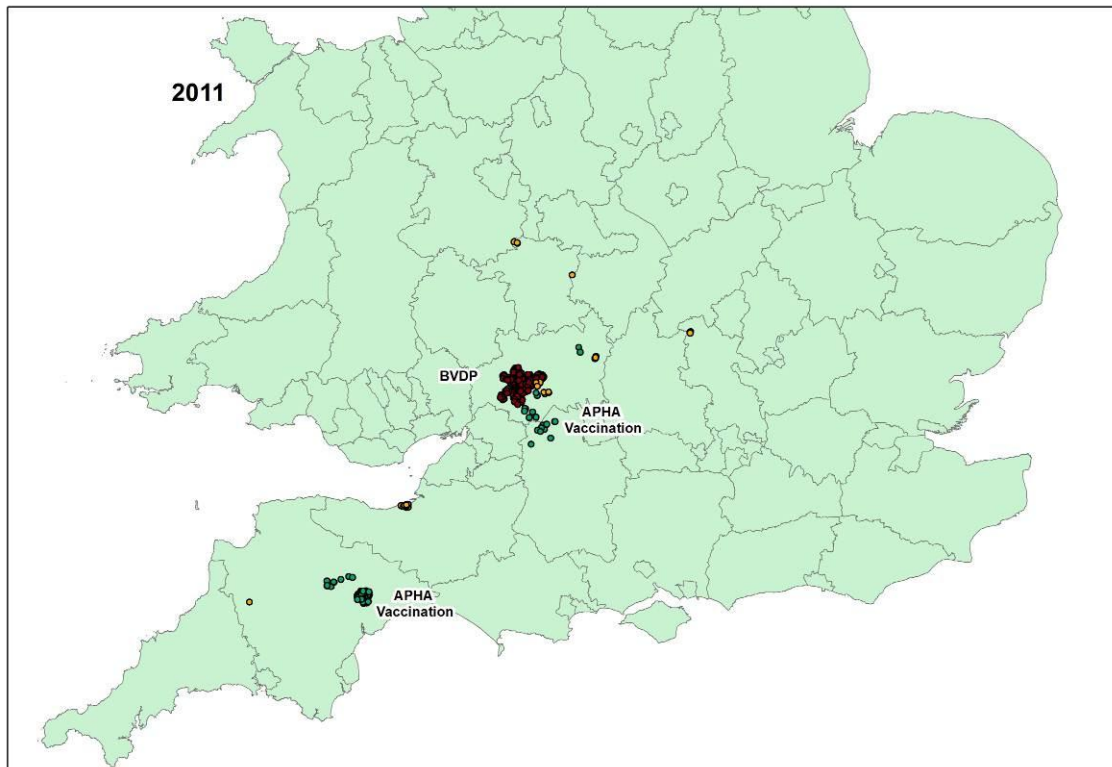


Fig 7a: Wider Deployment of BadgerBCG in 2011. Yellow points indicate vaccination by lay vaccinators. Green points are APHA vaccination for the National Trust, Killerton Estate and for the Defra funded Oral Bait research study.

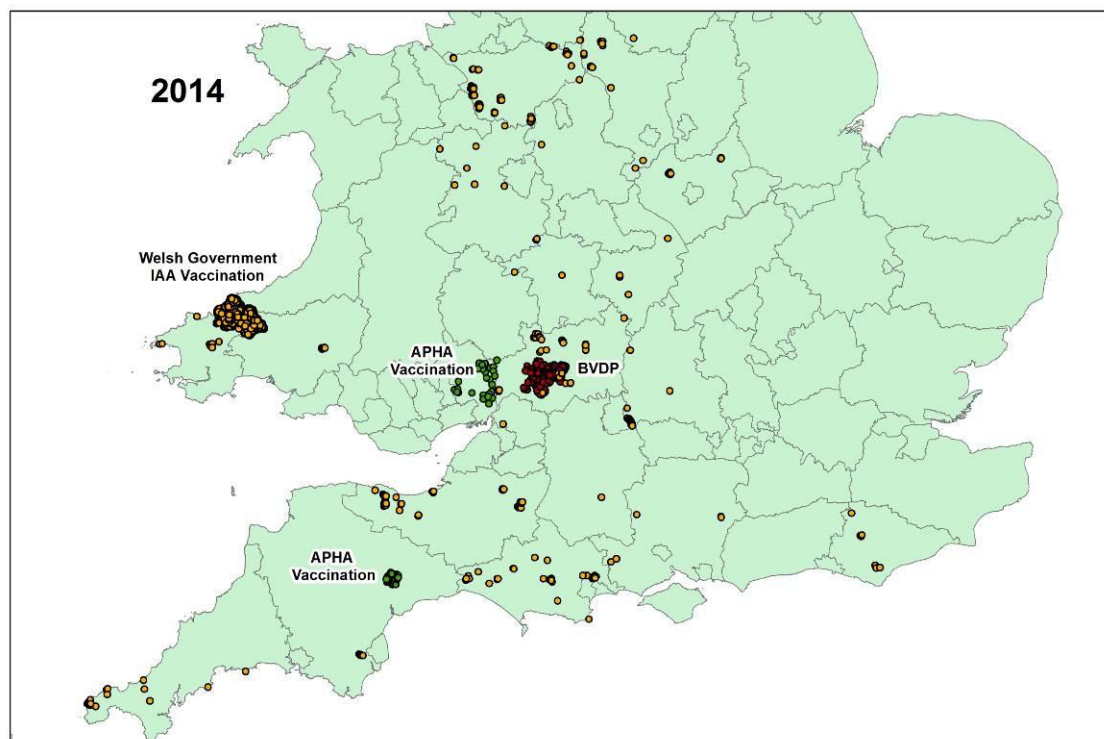


Fig 7b: Wider Deployment of BadgerBCG in 2014. Yellow points indicate vaccination by lay vaccinators. Green points are APHA vaccination for the National Trust, Killerton Estate and in the course of the Defra funded Oral Bait research study.

5. Attitudes to Vaccination

5.1) Landowner Participation

Following signup, the majority of contact with participating landowners was face to face with APHA field staff during vaccination operations. Efforts were made to ensure that the same APHA field individuals trapped on the same land parcels each year, in order to build familiarity and trust with the landowners. At the end of the project, each landowner was provided a letter which summarised the number of badgers trapped on their land in each year of the project and thanked them for their participation in the project.

Of 154 landowners signed up for the BVDP in the Stroud area, 13 (8%) landowners withdrew access permission during the project (8%). The reasons for this were generally not made clear. Three landowners initially gave access permission but then withdrew this permission shortly afterwards, prior to the commencement of vaccination in 2010. In one of these cases no specific reason was given, only that the landowner had had a 'change of heart'. In the second case, the landowner changed his mind prior to the commencement of fieldwork and stated that he only wished to be part of a study involving badger culling. In the third case access permission had been granted by the tenant farmer but was subsequently withdrawn by the landowner prior to the commencement of vaccination. Six landowners withdrew access permission during the study, after 1, 2, or 3 years of vaccination. In four of these cases, no specific reason was given for withdrawal. One landowner withdrew following the presence of a reactor within his herd and another due to an unrelated dispute with Defra over a non-specified issue. The remaining four withdrawals from the project were all due to changes in land ownership; in two cases land was sold to other landowners already participating in the BVDP and in the remaining two cases, access was not given by the new landowner.

Despite the lack of published research on the effect of badger vaccination on TB incidence in cattle herds, which remains a key knowledge gap, **92% of landowners who signed up to the BVDP continued to grant access permission to their land for the five years of the project.** Following the completion of the project fieldwork in 2014, a number of landowners expressed an interest in the availability of badger vaccination in the future.

5.2) Social Science Research

One of the stated aims of the BVDP was to 'increase farmer confidence in TB vaccines'. In order to assess this, a social science study was run by the Countryside & Community Research Institute (CCRI) involving landowners both within and outside the BVDP project area. This work has resulted in two publications to date:

Enticott, G. *et al.* Farmers confidence in vaccinating badgers against bovine tuberculosis. 2012. *Veterinary Record* 170 (8): 204.

Maye, D *et al.* Assessing farmer confidence in badger vaccination: some findings from a survey of cattle farmers in England. 2013. *Journal of Rural and Community Development*, 8(3), 49-64.

The social science study was primarily concerned with capturing farmer confidence and trust in government and its ability to control bovine TB. Views were collected via telephone interviews of participating farmers. Study areas, apart from the BVDP area were selected based on high bTB incidence, suggesting that badger vaccination could be deployed there in the future. The initial telephone survey was held in autumn 2010; this had an 80% response rate and generated 339 useable responses. The results of this initial survey suggested mixed support for badger vaccination, with around half of respondents agreeing that badger vaccination was a good thing to do and around 40% of respondents suggesting that vaccination would increase their confidence about avoiding TB restrictions in the future. A repeat telephone survey was conducted in 2014. The final results of the social science study by the CCRI will be published in due course on the Defra website, and will include details on attitudes to vaccination for farmers within the BVDP as compared to those outside the project area.

6. General Advice and Guidance

The experience of initiating and delivering the management, field delivery and lay vaccinator training has resulted in a range of lessons learned. The following are some generic guidelines aimed at providing basic information on the requirements of starting and running a vaccination campaign, to help understand the logistic challenges involved.

6.1) Effort required for surveying:

A detailed survey of a proposed vaccine area is required prior to trapping and vaccination. Many factors will affect how long this process takes:

- This is best carried out in the winter preceding the first vaccine season. Surveying between November and April inclusive will increase the likelihood of finding setts and field signs, when vegetation is low.
- Whether surveyors will be allowed to work alone or whether working in pairs is mandatory. If lone working is not permitted, the time taken to survey an area will double.
- Our very experienced surveyors could survey approximately 1 km² per day. For less experienced surveyors 0.5 km² - 0.7 km² per day is a more reasonable expectation. This will depend on experience and fitness of surveyors, and terrain.
- Terrain: OS Explorer maps (Scale 1:25,000 min) can indicate the likely level of difficulty of the terrain, such as large areas of woodland, or steeply sloping land. We produced survey maps at a scale of 1:10000 for surveyors to take with them in the field.
- Presence of woodland; in order to effectively survey a woodland area, the most efficient approach to 'sweep' with multiple surveyors walking through an area of woodland at staggered spatial intervals.
- Habitat suitability: it may be that some proportion of a proposed area may be unsuitable for badger trapping e.g. densely urbanised areas, treatment works etc. Within the outline of a proposed area, it is valuable to try to estimate how much of it will actually require surveying when estimating total surveying effort.

6.2) Estimating badger numbers per km²

In order to estimate how many badgers might be expected to be trapped per km², we reviewed trapping data from the Badger Vaccine Deployment Project, Gloucestershire, vaccination at the National Trust Estate in Killerton, Devon and data released by the Welsh Government from the Intensive Action Area (IAA) in Pembrokeshire.

Based on data from these badger vaccination projects, the average number of badgers vaccinated was **6.5 badgers per km²**.

It is important to note that these projects were carried out in areas of known high badger density so this estimate may be relatively high. Badger distribution tends to be patchy in line with variations in habitat suitability. For example, within both the BVDP (approx. 100km²) and Killerton (approx. 23km²) project areas there was a mix of suitable badger habitat where large numbers of badgers were trapped and vaccinated (mixture of woodland and farmland) and poorer badger habitat (e.g. the floodplain associated with the River Severn in Gloucestershire). If resources are available, initial surveys within a proposed area may be valuable in order to provide an indication of the likely badger density.

6.3) Estimating equipment requirements

An average of 6.5 badgers per km², indicates approximately 10 cages placed per km². However, given variation in badger abundance over relatively small scales, this could vary markedly, from around 2 cages per km² up to 30 cages per km² in high density patches. Traps are set for 2 nights so 10 cages should be sufficient to capture 6.5 badgers. Efficient trap deployment, yielding a consistently high capture rate only comes with experience and knowledge of the area.

Peanuts are used for bait points and pre-baiting for an average of 14 days.

On average, we estimate the following requirements:

300g per cage per day (double handful)

10 cages x 14 days x 300 = 42,000 = 1.7 25kg bags / km²

Other consumables that will be required are string and wire, Defra approved disinfectant (e.g. FAM30 or Safe4), clinical waste disposal – we have not attempted to calculate these costs per trap. Other costs to take into account include vaccine doses, portable fridges etc. For further guidance on these costs and availability of these please contact APHA (badgervaccine@apha.gsi.gov.uk).

6.4) Estimating manpower effort

Pre-baiting:

An experienced APHA field ecologist could site and pre-bait a trap round of up to 50 cages, split into two halves as described above. **It is important at the outset not to embark on a trap round that is too large and hence presents a risk to either the vaccinator or a welfare risk to the trapped animals. Hence for less experienced vaccinators, a reasonable rule of thumb is that one person can site and pre-bait a 20 cage trap round covering typically 2 km².** As with surveying this is likely to greatly vary according to operator experience, fitness and terrain. Individuals soon learn what they are capable of as they gain experience. The landscape can strongly influence how easy or otherwise it is to dig in traps and consequently how long this process takes. Physical access to the trapping site can also have a large bearing on how long a round may take i.e. whether it is possible to drive close to the sett, or whether is necessary to walk long distances carrying heavy traps.

Vaccinating:

Our experienced field staff operate trapping rounds involving 25-30 cages in a single morning. For less experienced persons, a starting estimate would be that one person (or a team of two if lone working is not permitted) can vaccinate 10 cages covering approximately 1km² in a single vaccination morning. Factors

influencing this include how far apart the cages are placed, i.e. are the traps close together or deployed at setts far apart from each other, or are one or more of the trap locations at sites requiring a long walk. In all vaccine operations, and particularly when being carried out by inexperienced individuals, **it is very important to carefully consider the size of the trapping round and number of traps deployed. This is critical to ensure that all trapped badgers are vaccinated and released from the traps within the timescale specified in license conditions.**