**Bovine Tuberculosis Disease Control**

Tuesday 20th May 2013, 2.00 - 4.00pm, Jubilee Room, Westminster Hall

**Seminar Summary**

Badgers are a significant source of bovine tuberculosis (BTB), a bacterial disease of cattle. Between 1998 and 2005, the *Randomised Badger Culling Trial* (RBCT) was undertaken in England to quantify the impact of two forms of culling cage-trapped badgers on the incidence of TB in cattle. It was designed, overseen and analysed by the *Independent Scientific Group* on Cattle TB (ISG). The trial was conducted at 30 100km² sites within the high risk area for bovine TB in England, split into 10 sets of 3 areas. Within each set, one area was culled proactively (once a year for 4-7 years), one reactively (culled only when/where a cattle TB outbreak is confirmed) and one not at all (control site). Reactive culling was suspended early in 2003. The impact of proactive culling was measured at two sites: the culling zone and in the surrounding 2km zone. Over the period of the trial, proactive culling was linked with a 23.2% decrease in TB herd incidence in the culling zone compared to the control zone. However, it is also linked with a 24.5% increase in confirmed TB among herds up to 2km outside the culling zone compared to herds up to 2km outside the control zone. ISG suggested that both forms of culling disrupt the badgers, causing them to range more widely (perturbation).

The ISG concluded that it was not practically or economically feasible to carry out culling on the scale necessary to gain beneficial effects. However, a further review by Sir David King concluded that, “removal of badgers from areas of the country where there is high and persistent incidence of TB in cattle was the best option available.” Follow up studies at the sites showed that the positive impact of proactive culling in the culling zone diminishes slowly after culling is stopped, while the perturbation effects in the 2km zone disappeared relatively quickly. Overall, it is estimated that the average net reduction of new confirmed cattle herd TB incidents would be around 16% over 9 years (5 years culling, 4 years post-cull) using the same methods as in the RBCT over a 150km² area. In December 2011, after a public consultation exercise, the government announced its intention to proceed with two pilot badger culls in Somerset and Gloucestershire, which were subsequently postponed to 2013. The aim of these two pilots is to test on the ground the practicality of badger culling conducted by farmers as an additional BTB management tool, using shooting of free-ranging badgers and applying strict licensing conditions to minimise the potential adverse impacts of badger culling.

POST held this private briefing session to give Members, Peers and parliamentary staff the opportunity to debate the relevant issues with key experts. The event was chaired by Lord Oxburgh and attendees heard brief opening remarks from four speakers:

**Professor Ian Boyd**, the Defra Chief Scientific Adviser,
**Mr Nigel Gibbens**, the Defra Chief Veterinary Officer
**Professor Christl Donnelly**, Imperial College, London
**Professor Rosie Woodroffe**, Zoological Society London.

Professors Donnelly and Woodroffe were members of the Independent Scientific Group on Cattle TB. Short summaries of the opening remarks and the following discussion are given below

**Professor Ian Boyd (IB)**
Bovine TB is increasing at around 3% per annum, resulting in the slaughter of around 28,000 cattle per year in England alone. It has doubled in prevalence over the last 10 years, with 25% of herds affected in endemic areas. Since the 1980s the rate and geographic spread of TB infection in GB has been steadily increasing, although large areas of the North and East of England remain virtually free of BTB. Many cattle controls are in place to control the spread of BTB, although these are not enough in the presence of a wildlife reservoir of infection. Under the worst case scenario of the rate of infection continuing to increase, there is a risk the cattle industry could be lost in large areas of the country. The Government cannot afford continuing to support farmers by providing compensation for cattle lost to BTB. There is also the possibility that barriers currently in place to prevent the spread of BTB to humans could fail under the pressure of increased disease incidence in cattle and other species. Possible alternative controls have been trialled, including control of BTB by badger culling, and comparative studies undertaken, to look at the data from other countries that have given over control to the industry, which have culled the ‘wildlife reservoir’ species. It is not enough to just control TB in either cattle or wildlife reservoirs, a more holistic control strategy is required, which involves the testing of cattle, controlling cattle movement and intelligent bio control (to include limitation of contact between badgers and cattle, and the removal of affected cattle) in addition to wildlife controls, whilst continuing efforts to develop licensed cattle and oral badger TB vaccines.

**Mr Nigel Gibbens (NG)**

TB is caused by a mycobacterium that can be transmitted from animal to animal, either directly or via the environment. The disease develops slowly, with early transmission possible, even from animals not displaying symptoms. It can spread by uncontrolled movements of undetected infected cattle and it is a difficult disease to eradicate, with infected individuals needing to be identified and removed to avoid geographic spread. Unlike human TB, treatment of affected animals is not a practical option, although vaccination is a possibility in the future. Traditionally, efforts to control TB in cattle have been focused on the early identification of disease in a herd and the removal of infected cattle. Effective barriers are in place to mitigate the risk of human infection, namely milk pasteurisation, regular testing of cattle herds and meat inspection. All cattle in the UK are regularly tested and if TB is found affected animals are removed, trade is restricted from affected herds and that herd is then tested again more frequently until the whole herd tests as TB free. Farmers are also encouraged to buy livestock with care to prevent the geographical spread of TB and cattle over 42 days of age moved from herds in the endemic (high risk) BTB regions of England and Wales must undergo statutory pre-movement testing for TB, unless going for slaughter. Parts of the country at high risk have annual testing and unaffected areas are tested for TB every 4 years. TB has not been found in badger populations in some low risk areas, but if TB is found in a cattle in those areas herd testing is increased in both the index herd and any surrounding herds, with a view to protecting both cattle and the badger population. Biosecurity also plays a role in disease control, which includes physical barriers such as fencing reduce badger and cattle contact. However, disease control requires reducing the number of infected animals to reduce frequency of transmission either by vaccination of cattle and badgers or by reducing the size of the badger population. TB tests are imperfect; detecting on average around 80% of all infected animals, which is why the whole herd must be tested, tests must be repeated at regular intervals, or combinations of tests be used to maximise detection of infected cattle. Vaccines against BTB are difficult to develop, research is currently looking to adapt the existing attenuated BCG vaccine used in humans for cattle and
Develop an oral formulation for badgers. The cattle vaccine could provide around 60% protection, although the protection afforded by the vaccine in UK field conditions is unknown. An oral bait vaccine is being developed for badgers, which would be more practical to deploy than the injectable vaccine. Deployment of a cattle vaccine is currently prohibited by EU and national legislation and as such will require approval from the EU, because BCG interferes with the main TB test used to detect infected cattle. Meat and milk from vaccinated cattle would enter the food chain and this will be verified to be safe before a cattle vaccine could be licensed for use.

Professor Christl Donnelly (CD)

Prof Donnelly was deputy chair of the Independent Scientific Group on Cattle TB, the group set up in 1998 to design, analyse and oversee the Randomised Badger Culling Trial consisting of 3 treatments; ‘proactive culling’ of badgers was used in a third of the trial areas, which involved widespread culling across areas of 100 km². The control treatment was no culling of badgers. The third treatment was ‘reactive culling’ which involved the identification and removal of high risk badgers using confirmed cattle TB as the sentinel. The results of the RBCT showed reactive culling resulted in an increased risk of TB infection of cattle, increased by 27% compared to the risk seen in the control treatment. Proactive culling areas showed a significant reduction of TB risk, down 23% compared to the unculled treatment. However, the surrounding area up to 2km outside the culled zone showed an increased (24.5%) risk of TB incidence. Recent estimates show that in the 5 years after proactive culling stopped the proactively culled treatment zone has 28% decreased risk of infection, and a negligible 4% reduction in the surrounding area compared to the comparable control areas. The outcomes of the trial present a complex picture, but suggest that a minimum area of 150km² for proactive culls to be confident of a net benefit, which may result in a 12% to 16% reduction, on average, in rates of infection over 9 years. Ideally, if a high-risk area undergoes a badger cull, it should be surrounded by an area with no cattle (i.e. coast). Boundaries of culled areas should be as impermeable to badgers as possible, preferably either a large river or a motorway.

Prof Rosie Woodroffe (RW)

Professor Rosie Woodroffe, who was a member of the Independent Scientific Group on Cattle TB, appreciated the pressure farmers are facing giving that she is based in West Cornwall and has worked with farmers there to address bTB problems they are having. However, she does not believe that the badger cull will be effective, as the two impacts on badger populations; a decrease in number and changes in behaviour may actually increase rates of infection. When there’s no culling, badgers defend their territories, preventing the spread of disease over geographical space. After culling, badgers are more likely to carry TB and no longer defend territories, making them more of an infection risk. In graph A (see below), the top dashed line shows the substantial reduction in badger numbers, but graph B shows how the proportion of infected badgers remaining in the population increases with each cull as the overall population decreases (graph C). This increase in the proportion of infected badgers explains why reactive and illegal culling increases the risk of TB. It also explains why cattle just outside the culling are has an increased risk, known as perturbation. There are complex licensing conditions in place to reduce the risk of pilot badger culls making the situation worse. The proposed culling methods may not overcome perturbation effects and there is a risk farmers may end up with more TB infections rather than less. Farmers with a culling licence face complicated licensing conditions. They are required to cul a set number of badgers, but it’s not
known how many badgers there are, therefore the quota could be set either too high or low. Overall a cull is likely to have a negligible effect or could make things worse and will not provide a solution to the current increasing rate of infection. There is increasing evidence that badger vaccination is a more effective option, as there is no associated perturbation, a fall in the proportion of infected animals territories stay in place and infected animals die off naturally. It doesn’t need to be as costly as has been estimated if conservation volunteers were used to administer the vaccination programme. Professor Woodroffe has been working with her local MP, Andrew George MP, and her local NFU and volunteers to set up vaccination programme for Cornwall.
Data sources:
Proceedings of the National Academy of Sciences of the USA 103: 14713-14717
Discussion session

Q: Would EU rules affect trade of live cattle if vaccinated? Could the proposed cull breach the Bern Convention?

NG: Exports of live cattle in general are limited and there would be no trade in live vaccinated animals to the EU as the regulatory situation remains unclear. Cattle products, including milk and meat would continue to be exported, but negotiations over the legality of this are ongoing with the EU. Culling as proposed would not breach the Bern convention as local eradication of the species would not be the aim.

Q: Will the monitoring and evaluation of the culls be scientifically valid and is there confidence in the efficacy of culling?

IB: The two pilot culls have not been designed to evaluate the impact of badger culling on BTB incidence in cattle. That was already established in the RBCT. The main objective of the pilots is to assess the deliverability of a cull by farmers under strict licensing conditions, including the ability to remove the minimum required number of badgers in each area in a humane way. The methodology being used can give statistical probability of reaching the target reduction of the badger population during a cull and the efficacy and humaneness of the culling methods is being overseen by an independent expert panel. Pilot culls have been designed to minimise perturbation effects on the basis of the RBCT findings. Less is known about the effect of badger vaccination on the incidence of BTB in cattle than is known about culling, this is the reality of where we are, there is a limited tool box and we need to develop and use all of the tools as part of a holistic approach. However, building up immunity in the badger population is less immediate than culling.

CD: It will not be possible with just two intervention areas to test any impact on cattle TB risks.

RW: Graph A shows 25 to 35% around mobility in infected badgers. Badger vaccination is known to reduce transmission among badgers and badgers only live 5 to 6 years, so it would not take that long to eliminate TB from a population, if it isn’t re-infected by cattle. However, we don’t know the effectiveness of vaccination in cattle.

Q: Has the methodology of the independent expert panel been peer reviewed? Will the methodology be published to increase public confidence? Will results be published alongside the government announcements?

RW: There are good wildlife experts on the independent panel.

IB: The development of the methodology was overseen by the independent expert panel and has not been published in full due to security concerns, but will be made public eventually. Yes, results will be published.

Q: How are vaccinated badgers marked?

RW: Vaccinated badgers are shaved, a mark that lasts 1 season, which is enough to avoid vaccinating the same badger twice during a year. Badger populations have to be revaccinated annually anyway. For research purposes they are micro chipped, but this can’t be done by volunteers.
Q: Is the intention to eradicate bTB? What is the expected timescale, as in Australia this took 20 years?

NG: Eradication (i.e. complete elimination of the disease agent from the cattle and badger populations) is an unrealistic goal in the UK, but our aim is to reduce BTB incidence to sufficiently low levels to achieve 'Officially TB free status' according to the criteria set out in EU legislation.

IB: It would take several decades of continuous effort to develop all the tools in the toolbox. Other tools will come along that should be implemented, so TB free status could be achieved somewhere between 2030 and 2040.

CD: It is a challenge to provide the models that can predict if and when eradication could be achieved but it is important that any such projections are realistic. Vaccinating cattle and badgers would have a significant impact, but in the first instance we need to move from a system with increasing levels of infection to one with decreasing levels.

RW: In Australia and New Zealand wildlife hosts were very different; they were buffalo and possums respectively, both non-native pests with very different biology and social structures to badgers in the UK. The approaches from Australia and NZ may not work here.

IB: Wildlife reservoir needs to be controlled and culling needs to be part of the toolbox. Vaccination is important but it’s also important to learn from other countries to ensure we adopt the best approach to culling badgers.

Q: Are we doing enough currently to prevent the spread of bTB? Some farmers don’t currently follow biocontrol guidelines.

NG: Movement control is very important. Farmers must understand the risks of trading live animals, and balance that with the impact on industry. At the moment pre-movement TB testing of cattle is mandatory for farmers who move animals from herds situated in areas of high BTB risk. Although current regulations are strict we are always looking at how they can be improved. The UK export trade of live cattle is not huge, mostly trade in germplasm (bovine semen and embryos), meat and milk products.

Q: What has driven the increase in bTB from early 1980s?

IB: A number of things have changed since the 1980s, including the intensification of the cattle industry and an increase in the badger population. These are probably not the only reasons for the increase in levels of TB but they may have helped the continuation of the increase. The current structure and behaviour of the cattle industry is important, with cattle being moved over much larger areas.

NG: There was a steady increase in TB from the 80s to the 90s. In 2001 the occurrence of foot and mouth disease meant cattle control measures were suspended and there was a change in trading patterns when FMD movement restrictions were lifted.

RW: Post foot and mouth, after cattle testing was suspended, prevalence of bTB in badgers doubled, demonstrating that increased levels of TB in cattle affects badger populations. The first TB infected badger was seen in 1971, the first badger culling took place in 1974. Policy from 1976 was reactive
culling, which probably contributed to the increase in bTB at this time. There is an inverse relationship between badger population size and the proportion of infected individuals, even in the absence of culling. In the RBCT, relative reductions in TB levels of culled areas compared to unculled areas were seen, so not sure an actual decrease occurred.

CD: It was hard to quantify absolutes as different treatments began at different times and it is not clear why there was a leap in within-herd infection rates after 2001.

**Q: Is the level of herd infection greater than tests suggested?**

NG: Disease dynamics vary among herds, so every herd is treated on its individual merits. Local epidemiology is important and it is hard to make blanket statements, but larger herds are at higher risk of maintaining bTB infections.

**Q: Skin tests- some cattle come up clear but are subsequently found to have lesions at slaughter, and the carcass is excluded from the food chain without farmers being compensated. How is the development of the PCR test coming along?**

NG: We are working to improve the accuracy of the skin test. It must be administered carefully, so the vet plays an important role, but it is inevitable it fails sometimes. The farmer checking the cattle is also important, as is the abattoir. PCR-based tests are good at detecting TB, but the choice of sample for testing is important. If the right tissue is selected PCR is great, but it’s possible to select an uninfected tissue sample, giving a negative test result, from an infected animal. PCR-based tests are also being developed that can be used to detect TB in samples from the environment, where again the choice of sample is important as infected animals may only excrete the bacteria intermittently.

CD: RBCT badger post mortem examinations underestimated badger infection initially, a subsequent study revealed twice as many infected badgers as had been previously identified.

RW: It would be impractical to cull only infected badgers, as tests aren’t perfect and we can’t sample all badgers. Mathematical modelling of perturbation shows the effect of test and slaughter approach may be negative on TB infection in cattle.

**Q: If badgers aren’t tested before vaccination, are there negative impacts of vaccinating an already infected badger?**

CD: Captive experiments didn’t show negative impact of vaccinating infected badgers.

NG: There is no evidence that vaccinating infected badgers will either cure them or make them more infectious.

**Q: Is bTB a single strain, is there the possibility of drug resistance?**

NG: It is illegal to treat bTB infection in cattle and as such antibiotics are not used, so there is no selective pressure for resistance in the UK. This approach is not likely to change. There are different subpopulations of the mycobacteria across geographical locations; which is used to track translocation of the disease from one area to another by cattle movements. It’s important to
monitor the effectiveness of the bTB test in case changes occur in the mycobacteria that affect the accuracy of the test, although this has not been observed to date.

CD: The proportion of bTB detected by the test and the identification of cases of TB by slaughter houses should stay the same if the skin test is maintaining its effectiveness.

**Q: Wales is vaccinating badgers, can we learn from their findings?**

CD: The Wales case combines badger vaccination and more stringent cattle controls in one area, meaning we can’t pull apart the effects of the different control methods. The Welsh Government Chief Vet has acknowledged the effects can’t be disentangled, they just want to stop the spread. It also hasn’t been going on long enough to detect any effects in cattle, now in its second year.

**Q: Would a vaccine cover all strains? Is there work to develop new vaccines?**

NG: The difference in strains is not significant enough to affect the efficacy of the vaccine and it should be effective across all strains.

An oral formulation for badgers could be easier to deploy and cheaper.

The licensing process for the cattle vaccine will include assessment of the available data to ensure safety of meat and milk from vaccinated animals entering the food chain. The method of deployment requires consideration and efficacy under UK conditions needs to be proved with large scale field trials. It will also require a change in EU regulations, which will take about a decade.

Vaccinating cattle will make them test positive for the skin test, so the alternative gamma-interferon based DIVA test would need to be approved as the main regulatory test. The DIVA test differentiates animals that have been vaccinated from those that are infected by looking for an element present in the mycobacterium but not in the BCG vaccine.

**Q: Are badgers the only UK TB wildlife reservoir?**

NG: Deer may be a localised significant reservoir under some circumstances, camelids (alpacas and llamas) can also be infected with the BTB bacterium and develop the disease. However, none of those other susceptible species act as a self sustaining wildlife reservoir in GB as badgers can.

RW: White tailed deer are the main wildlife reservoir in Michigan in the US, but the distribution of deer is much more patchy in the UK, and deer are only likely to be a local issue - badgers are more widespread.

IB: In New Zealand the possum was the main problem, once that had been dealt with alternative hosts did not become a problem.

RW: It’s not known if badger populations can self-sustain TB in the absence of cattle, there are no infected badger populations isolated from cattle.

**Q: Is the shape of a cull area significant?**
CD: The proportion of the cull area close the edge should be as small as possible, with coastline a good edge. Otherwise, the area should be as round as possible to reduce perimeter effects with long, thin shapes avoided.

RW: Hard boundaries are generally not well understood, they include major rivers and large motorways, but not railways as is believed by some. The boundary needs to be quite substantial to constitute an effective barrier to movement.

**Final comments**

NG: We need to focus on the whole range of tools that we are using to control BTB, of which badger culling is just one element.

CD: Any form of badger culling will be a trade off between the reduction of badger numbers and the change in behaviour of those badgers that remain. There is a risk that an ineffective cull does not provide enough suppression in density to achieve a favourable trade off.

IB: The status quo cannot continue. To move forwards we must use all tools available, use risk based approaches and adaptively use controls as evidence of what works increases. However, large scale trials to assess the efficacy of badger vaccine based approaches are not affordable.

RW: We need to look at the problem as an integrated whole. There is a significant problem for farming, but the evidence doesn’t support culling. These can both be right, Farmers are facing a significant threat, but badger culling may exacerbate the risks posed by this threat..