Kill or cure: blamed for the spread of TB among cattle, badgers have been culled or vaccinated to try and stop the prevalence of the disease.

Klaus Echle/naturepl.com

Out of the Woods?

By **James Fair**

After years of controversy, the government has announced it will phase out badger culling, but there's no guarantee that it, or the debates surrounding it, will end anytime soon.

It's a warm and wet Friday evening at the end of January 2020, and a good 150 people have gathered in Merton College's TS Eliot Theatre in Oxford, to listen to professor Christl Donnelly – a statistical epidemiologist with an expertise in modelling how diseases spread – deliver a lecture entitled 'Badgers and Bovine TB: Is it all black and white?'

Among the audience are professor David MacDonald, one of the country's leading zoologists, and the chief executive of the Badger Trust, Dominic Dyer.

Donnelly is an *éminence grise* of the science on badgers and bovine TB (bTB), having done the number-crunching for most of the key papers that have helped dictate policy on the issue for more than two decades. In this context, the title of her lecture is odd – government ministers, at least since 2010, have seen her conclusions as entirely black and white. Her science has shown that badger culling works, and the government has enthusiastically adopted it as a central plank of efforts to tackle bTB.

POINTS OF VIEW

Vanessa Mason

Somerset Badger Group

Badger vaccinator

"If you want to be a responsible farmer and don't want to cull badgers, then you should have them vaccinated to reduce the risk. But is it the golden bullet? Absolutely not. The golden bullet is to get accurate testing and spread it across the UK. But that would result in many more cattle being slaughtered. If vaccination is used in an appropriate manner, it will reduce the risk, but it won't stop the spread of TB in cattle."

Spreading far and wide

Badger culling in England is now permitted across more than 40 areas of the country and in more than half of the area of the counties of Devon, Dorset and Cornwall. Some 30,000–40,000 badgers are shot on an annual basis, with the total figure since 2013 estimated to be more than 100,000. But then, TB is a serious problem: on average, more than 30,000 cows are slaughtered every year after becoming infected with the disease and costs to the taxpayer top £100m.

Frederic Desmette

Proximity breeds contempt: farmland and badger habitat often overlap or neighbour each other.

POINTS OF VIEW

Rosie Woodroffe

The Zoological Society of London

Scientist

"The reason why I don't think vaccination is a red herring is because the government policy isn't to reduce cattle TB a bit, it's to eradicate it. There's this idea that because it's mostly cattle[-to-cattle transmission], that it's entirely cattle, but there's no doubt that badgers can and do give TB to cattle. They are not anywhere near close to being the main source of TB in cattle, but they are a source."

"The badger is an iconic, protected species and no one wants to be culling them forever."

Then, in early March this year, many media outlets report a screeching government u-turn. "Badger cull to be replaced by vaccines in bovine TB fight," says BBC online. Wildlife groups are equally enthusiastic about the new policy. "For the first time, the government has put forward a credible exit strategy from widespread indiscriminate cruel badger culling," tweets the Badger Trust's Dominic Dyer. "The badger is an iconic, protected species and no one wants to be culling them forever," says the Department of Environment, Food & Rural Affairs (Defra) in its 'Next steps' strategy document.

There's only one problem with this eruption of good news, says conservation ecologist Tom Langton – it's entirely fictitious. Promises to end culling are hollow and there's little money to support an increase in badger vaccination, he warns. Plans to develop a vaccine for cattle in five years' time are riddled with complications and have been heard before and never materialised.

Langton may have a point. An email to *BBC Wildlife* from the Defra press office concedes that culling will continue for some time. "Natural England issues intensive cull licences for a minimum of four years," Defra explains, "so we would expect any existing licences to run their course for these to be considered effective." Initiating new culls will ▶

TIMELINE

The history of bTB in Britain.

1966 About 1 per cent of UK cattle herds thought to be infected with bovine tuberculosis (bTB) – down substantially from 40 per cent in the 1930s.

1971 BTB found for the first time in badgers – in Gloucestershire.

1975 The Ministry of Agriculture, Fisheries and Food (MAFF) begins gassing operations using hydrogen cyanide – about 4,500 setts are targeted over the next seven years.

1979 Lord Zuckerman is commissioned to review the culling strategy. He concludes that badgers constitute a significant bTB reservoir. Culling stops while the review is under way.

1980 Gassing restarts after Zuckerman reports, but further investigation casts doubt on the humaneness of cyanide, which is found not to kill badgers immediately.

1982 Gassing is replaced by live-trapping and shooting as the official form of control. A new approach, termed the 'clean ring strategy', is introduced – badger groups are tested for bTB, and those that have it are completely removed.

1986 The so-called Interim Strategy is introduced following the publication of a review by professor George Dunnet. It only allows for the culling of badgers on farms where there have been TB breakdowns. Dunnet says the strategy should be reviewed when a more ▶

This is just the latest in a very, very long line of plans, strategies and responses.

In Derbyshire, Wildlife Trust volunteers have been working with landowners to run a badger vaccination programme since 2014.

"remain an option where epidemiological assessment indicates that it is needed," the strategy document says. Defra, in other words, reserves the right to carry on killing badgers for as long as it deems it necessary.

Langton has calculated that a further 200,000 badgers will be killed between now and 2030. "I see nothing positive in this," he says. "It's a spectacular can-kicking exercise."

It's worth noting that the NFU, which has consistently advocated badger culling as a way of tackling the disease in cattle, welcomes the retention of intensive culling where required. "Any move away from an intensive culling policy – whether that's in 5 years, 10 years or longer – should not be rushed, and sufficient science and evidence must support any such move," says deputy president Stuart Roberts in a statement.

POINTS OF VIEW

Dominic Dyer

The Badger Trust

Campaigner

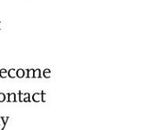
"The next decade will be crucial. The next 10 years will decide if badgers become locally extinct in some areas of England or if we come to terms with the idea that the livestock industry has to change. With more people moving to plant-based diets, it may not be viable in its current form in the long term anyway, and the farming industry needs to come to terms with this."

A long history

Whatever the truth, it's important to remember that this is just the latest in a very, very long line of plans, strategies and responses, as the government tries to stem the rising tide of TB in cattle. Indeed, you have to go all the way back to 1971, when the UK hadn't yet joined the EEC, let alone left the EU, to the discovery of a single dead badger riddled with TB to understand why we still cull badgers today. In nearly half a century, there have been only 10 years when badgers have not been killed somewhere, because, it's believed, they give TB to cattle.

30,000–40,000

NUMBER OF BADGERS SHOT ANNUALLY



POINTS OF VIEW

Stuart Roberts

National Farmers' Union

Farmer

"Controlling the disease in wildlife is a crucial element of tackling this devastating disease, with recent academic research and veterinary evidence demonstrating that badgers are a cause of over 50 per cent of TB infection in High Risk Areas. The latest peer-reviewed research definitively shows the phenomenal impact culling badgers has on reducing TB levels in cattle, and it is frustrating that too often culling and badger vaccination are given a false equivalence."

The ecologist (Lord) John Krebs noted in his report of 1997 that the old Ministry of Agriculture, Fisheries and Food (MAFF) had begun to suspect badgers were "a potential reservoir of *Mycobacterium bovis* infection for cattle" in the 1960s, as efforts to eradicate the disease – which affected 40 per cent of cows in the 1930s – stalled.

It wasn't until 2013 that someone – Donnelly, in fact – came up with a figure. She calculated that 5.7 per cent of TB breakdowns were attributable to badgers (with a range of anywhere from 1–25 per cent), though she also said that this rose to 50 per cent as a result of those cattle infected by badgers passing it onto other herds.

But Langton, who has spent a large part of the past seven years studying badger culling science, says no one has even shown how badger-to-cattle transmission occurs. Talking to scientists, he says he's heard theories of cows eating infected badger dung and inhaling their breath. He scoffs at both notions as regular events.

The critical point is this: many people believe that identifying badgers as a "reservoir" for bTB infection all those years ago has led to the government and scientists focusing disproportionately on them rather than the far more significant source: the cattle themselves – at least 94 per cent of new cases, if Donnelly is right.

But if 6 per cent of cattle herds do become newly infected with TB as a result of contact with badgers, what does the science say about the impact of culling them?

Results from the Randomised Badger Culling Trial, which ran from 1998 until 2004, is the best data we have for this. Using complex modelling, it found that culling badgers over four years resulted in declines of bTB of 20–35 per cent within the cull zones, but that levels of the disease rose in a narrow strip surrounding the area.

This may be because of the so-called perturbation effect. Professor Rosie ▶

Paul Hobson (x3)

TIMELINE

reliable way of testing for TB in badgers is available.

1993 Ministers agree a six-point strategy, which includes a plan for major research into the development of a badger vaccine, to improve the efficiency and cost effectiveness of diagnosis in cattle and the so-called 'live test' for badgers (as recommended in 1984).

1994 'Live test' trials begin. In the end, they run for only 18 months, with no firm conclusions drawn about its effectiveness.

1997 Lord Krebs recommends the setting up of a trial, later called the Randomised Badger Culling Trial (RBCT), which will "enable MAFF to carry out a cost-benefit analysis of killing badgers to control TB in cattle".

1998 The RBCT begins – 30 10x10km squares are selected in the highest-risk areas. In 10 of the grids, proactive culling is carried out; in another 10, culling only when TB breakdowns occur (reactive); and in 10 no culling at all. Culling in the rest of the country is suspended.

2004 RBCT ends – 11,000 badgers are shot and killed during the trials.

2007 The Independent Scientific Group (ISG) on Cattle TB reports and concludes that culling badgers "cannot meaningfully contribute to the future control of cattle TB in Britain." This is subsequently contradicted by the government's chief scientific advisor professor David King, who is himself then criticised by the ▶

"Culling increases the prevalence of the disease in badgers – it's the opposite of what an eradication programme should do."

Woodroffe, a behavioural ecologist at ZSL, was one of the scientists who discovered it while investigating the data from the RBCT data. "When you cull badgers, you lower their density and destroy their territorial behaviour," Woodroffe says. "Suddenly those badgers are ranging more widely and there's more opportunity for interaction, so the disease can move more widely, too."

As a result, the theory goes, any decrease in bTB rates is offset by increases on the edge of the cull zone by nearly 30 per cent. From these figures, it was estimated that should you cull over 150km² for four years, then the overall benefit over nine years would be a reduction in bTB in cattle of 12–16 per cent.

Crunching the numbers

More recently, some data from the culls that started in 2013 has emerged. Last year, a peer-reviewed paper (a study that has been read and approved by other scientists) looking at data from the first two culling zones found that levels of bTB in cattle had decreased by 66 per cent in Gloucestershire and 37 per cent in Somerset during the first four years. Which sounds promising, until you realise there are several caveats.

First of all, the modelled decreases observed were greater than those for the RBCT, suggesting, the authors say, "there are other mechanisms at play that amplify effects associated with badger controls. Implementing culling may lead to greater focus on cattle controls, TB testing quality and implementation of biosecurity." And then there's what happened in 2018 – bTB levels rose again in Gloucestershire, with measured TB-breakdowns standing at 23, just one below the level they were at in 2012, the year before the badger culls started.

Some people argue that there is a much better alternative to culling. They agree that badgers transmit bTB to cows and that we need to tackle it through vaccination if we are ever to eradicate it from our cattle herds. Chief among these people is Rosie Woodroffe.

We know that if you vaccinate a healthy wild badger it protects that individual from succumbing to the disease, but not whether it will reduce the prevalence of bTB in badger populations as a whole, or whether that translates into reduced levels of bTB in cattle.

Woodroffe is currently exploring the first of these unknowns in her Cornwall-based project, but she suggests that vaccination offers significant advantages over culling in a number of respects. Even if you accept that culling reduces levels of bTB in cattle (which she does), it definitely does the opposite in badgers. "Culling increases the prevalence of the disease in badgers," she says. "It's the opposite of what an eradication programme should do. In that context, vaccination is so much more promising."

Woodroffe adds that even if most transmission is cattle-to-cattle, it's still important to tackle the disease in wildlife. "It's hard to say to farmers, 'We know that badgers can give TB to cattle, but we're not going to do anything about it.'" And she points out that vaccination can cost about one quarter of the price of culling – roughly £600 per km² per year compared with £2,250 per km² per year. One of the reasons for this, says Woodroffe, is the high levels of policing needed where culls take place.

But for people who say it is unclear whether badgers give TB to cattle, vaccination is a waste of time. And they think they have some real, practical evidence for this in the shape of Gatcombe Farm, near Seaton in Devon. ▶

POINTS OF VIEW

Anne Brummer

Save Me Trust
Campaigner

"We came into this to protect the badgers but the only way to do that is to sort out the cattle. There is a way for badgers to transmit TB to cattle, but it's not significant – the transmission is cattle-to-cattle. Badgers at Gatcombe Farm [in Devon] are heavily infected with TB, but the cattle are TB-free, so we don't believe any infection is coming from them."

Intensive farming: Andrew Linscott/Alamy; syringe: Mike Powles/Alamy; protest: Wiktor Szymanowicz/Barcroft/Getty

Eradicating TB in cattle: The options

We look at the pros and cons of the various methods proposed over the years.

Culling badgers

PROS: There is evidence, from the Randomised Badger Culling Trial carried out between 1998 and 2004, that it reduces levels of TB in cattle by 12–16 per cent. Many farmers believe it is necessary.
CONS: Badgers are not the most significant factor in the persistence of TB in the UK's cattle, and culling them has proved very expensive. It involves reducing populations of a protected mammal in ways that are not always humane.

Vaccinating badgers

PROS: Addresses the issue of tuberculosis in badgers (there is not much dispute that a proportion are infected) without killing them. Potentially much cheaper and clearly more humane than culling them.
CONS: There is no evidence at present that vaccinating badgers either reduces the prevalence of the disease in badgers or has a knock-on effect on TB levels in cattle. Would it really be possible to vaccinate all badgers in hotspot areas against the disease and to keep vaccinating them?

Vaccinating cattle

PROS: It would at least partly remove the dispute over whether badgers transmit the disease to cattle, by protecting cattle from contracting the disease. Vaccinating humans against TB in the UK has been mostly successful.
CONS: At present, there is no reliable method of distinguishing between a cow that has been vaccinated against TB and one that has TB. Research published in 2010 concluded the efficacy of the BCG vaccine in cattle was between 56 and 68 per cent.

Testing cattle

PROS: Developing a better test for cattle would mean farmers would have a far clearer idea of if and when any of their cows had suffered a TB breakdown. The current skin test is simply not good enough.
CONS: The only real downside is, according to some experts, that it would reveal bTB to be even more widespread than feared, and it would cost the government millions in compensation payments.

Changing the industry

PROS: Some people believe the prevalence of bTB in the UK is down to the industrial nature of the way we farm – it's highly intensive, cattle are always in close proximity to one another and huge numbers of possibly infected cattle are moved around every year.
CONS: Farmers produce nearly 15 billion litres of high-quality milk for UK consumers, at amazingly competitive prices. Any changes would probably increase the cost of a pint.

Left: the intensive nature of cattle farming can play a part in the spread of disease. Below: protesting against the cull.

5.7%

PERCENTAGE OF TB ATTRIBUTABLE TO BADGERS

TIMELINE

respected journal *Nature* in an editorial.

2008 Environment secretary Hilary Benn refuses to authorise badger cull.

2010 Coalition government comes to power on a manifesto commitment to bring back badger culling.

2013 First two pilot culling trials – in Gloucestershire and Somerset – start in inauspicious circumstances as marksmen fail to kill the minimum number of badgers required under the licence conditions. Environment secretary Owen Paterson accuses badgers of "moving the goalposts".

2015 Dorset becomes the third region in England to implement the cull. By 2018, the cull is expanded to 32 other areas in 10 different counties. More than 32,000 badgers are culled in England in 2018.

2018 Godfray Review published – among many points, it says "moving from lethal to non-lethal control of the disease in badgers is highly desirable" and recommends a concerted effort is made to find out whether and how effective vaccinating would be as an alternative policy. The government says it will publish its response by the summer of 2019.

2020 In early March, the government's long-awaited response to the Godfray Review is published.

The future of badgers and cattle is still uncertain. Left: Brian May with Save Me Trust CEO Anne Brummer at Gatcombe Farm.

POINTS OF VIEW

Christianne Glossop

Welsh Assembly Government
Chief veterinary officer

"If you look at the Gloucester cull area in year five [after four years of culling], the TB level goes up again. If you look at the end of year five, which was 2018, TB incidents are 5 per cent higher than they were at the start of culling. Somerset presents a more favourable picture. If you put everything on the table, I don't think we have conclusive evidence that culling is having the impact that some headlines are attracting."

What does it all mean?

SICCT
This skin test is regarded as the definitive indicator of infection by the bacterium that causes TB in cattle.

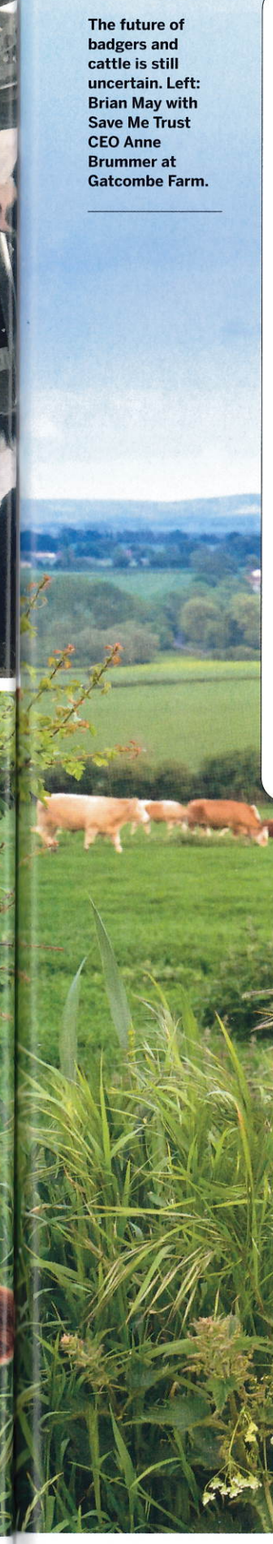
RBCT
The Randomised Badger Culling Trial was set up to assess the effectiveness of culling strategies.

KREBS REPORT
The 1997 report that set up RBCT.

INCONCLUSIVE REACTORS
Animals whose TB skin test results are not definitely clear or positive.

ACTIPHAGE BLOOD TEST
Actiphage is a new test for bTB that is said to be much more sensitive than the skin test and produces results in hours, not days. It tests for the presence of bTB bacteria in blood or milk, rather than the cow's immune response.

PERTURBATION EFFECT
The act of culling causes badgers in the area to travel further afield and move around more often than they usually would, which can therefore increase the spread of TB.



POINTS OF VIEW

Christl Donnelly

Imperial College London
Statistician

"The Randomised Badger Culling Trial (RBCT) is the clearest results we have about the impact of badger culling, but they are carrying out and co-ordinating the current culls in a different way, and that's why it's important to analyse what their impacts are. Reporting has shown reductions in Somerset and Gloucestershire after two years of culling, but we didn't see that in Dorset. We didn't see that level of variation in the RBCT – the RBCT was comparatively consistent in its impacts."

Here, the farmer Robert Read and his vet Dick Sibley say they have controlled TB simply by making sure that what the cows eat and drink is uncontaminated, where they live is kept clean and by introducing a better testing regime. Some of their badgers have TB, but they are not being vaccinated or culled.

By improving hygiene, Gatcombe has become TB-free without worrying about the badgers. Anne Brummer, chief executive of the Save Me Trust – the organisation set up by the Queen guitarist Brian May – wants to see this approach extended on a much wider basis. "If you have a herd, we can remove TB from it within 18 months to four years," she says.

But if Gatcombe is not just a one-off, and badgers do not give TB to cattle and culling them is ineffective, then how has the science got it so wrong? Langton argues that a series of errors and 50-50 calls in the Krebs Report in 1997, the Independent Scientific Group (ISG) report of 2007 and in other papers have led to the current scientific consensus.

Langton calls it a massive miscarriage of science. "In 2016, I went back to basics on this, and it was like going into a really dark cave without a torch – it took me two days with a photocopier just to print out and bind the RBCT study reports and papers. I emerged after two years, and after speaking to about 50 other specialists, thinking, 'There's something very wrong here.'"

Langton says the ISG chose to base its conclusions on which herds broke down with bTB by considering only reactors that had developed visible TB lesions. If they had also included the so-called "inconclusive reactors (IRs)", then the impact of culling would have been found to be insignificant. He has run a model on visible-lesion data and shown no significant culling effect.

"When you go through the evidence carefully, you realise that, along the way, decisions and mistakes have been made that collectively make the science on badger culling nine times more likely to be uncertain as valid," he says. "On that basis, science says culling should stop."

Gatcombe: Save Me Trust; cow: Alamy; badger: Frederic Desmette

The new strategy does promise a better and more regular cattle-testing regime.

If bTB is very largely a cattle-to-cattle transmission issue, then the problem lies in the testing regime. The current so-called SICCT 'skin' test, even by Defra's admission, has low sensitivity and misses infected animals. Many people believe that new developments, such as the Actiphage blood test, could revolutionise the way we deal with bTB and is our best hope for stamping it out.

While welcoming work on "non-validated tests" such as Actiphage, Defra cautions that there is a long way to go before it replaces SICCT and the newer 'Gamma' blood test. But the new strategy does promise a better and more regular cattle-testing regime. "The only sensible thing I found in the recent document was increasing annual surveillance testing to every six months in the High Risk Areas," says Langton.

Nearly 50 years on from finding that first bTB-ridden badger, we are still arguing about how much this beloved mammal contributes to the prevalence of the disease in cattle and whether killing them is worthwhile. While progress – on badger vaccination and, to some extent, cattle testing – has been made, it has been painfully slow, and there is no guarantee that the debates, and the culling, won't still be going on in another 50 years.

JAMES FAIR writes about wildlife, conservation and the environment. Jamesfairwildlife.co.uk

FIND OUT MORE The official response to the Godfray Review: **bit.ly/2TXrQPu**