EXECUTIVE SUMMARY AND SECTION SUMMARIES 2015

Extracted from the ‘Bovine tuberculosis in England in 2015’ epidemiology report*

Introduction

This report is extracted from the full ‘Bovine tuberculosis in England in 2015’ epidemiology report published at https://www.gov.uk/government/publications/bovine-tb-epidemiology-and-surveillance-in-great-britain-2015 on 30 August 2016. It presents the executive summary and boxed summaries that appear at the start of each section in the main report. Note that the 2015 data are gathered up to 31 March 2016, to allow data to be extracted and culture results, hence these reports are published later in the year.
1. Executive summary

This report and the companion GB data report replace the previous APHA annual report that collated and presented England’s bovine tuberculosis (bTB) surveillance data for the year. The revised format aims to present the ‘story’ of the bTB epidemic in England in text and graphics in this report, while ensuring all can see and use the full suite of data tables and complex statistics that are collated each year, and which are now brought together for England, Scotland and Wales in the GB data report. Although substantial detail remains, a more accessible overview of key points for each section is provided in boxed text at the beginning of each. All data for graphics presented in this report are included in Appendix 4.

bTB in England: bTB is one of England’s most pressing animal health problems, threatening the cattle industry and presenting health risks to other species including people. The Government’s Strategy for achieving ‘Officially bTB Free’ (OTF) status for England defines the approach to its control, based on different levels of disease in different parts of the country. It aims to eradicate bTB by 2038 while maintaining a sustainable cattle industry.

The current epidemic: The current epidemic of bTB in cattle in England dates back to the mid to late 1980’s despite repeated and widespread attempts to control it. Levels of disease appeared to plateau from 2011 to 2014 providing some hope that controls were taking effect, however the incidence of bTB in England increased slightly but significantly in 2015 (Figure 3.3.3). England is divided into three areas for control purposes, and this significant increase was driven by the epidemic in the ‘Edge Area’. It may, at least in part, be artefact caused by earlier detection of cases and longer periods of restriction due to the Edge Area enhanced surveillance and controls. The continued occurrence of new cases in the Edge Area reflects introduction of disease through purchased infected cattle from the ‘High Risk Area’ (HRA) and increasing areas of locally spread infection. The latter are attributed largely to the establishment of local transmission of infection, and the limited efficacy and/or uptake of biosecurity measures to prevent exposure of cattle to infection; this can be from other cattle or infected wildlife, most commonly badgers, and the consequent environmental contamination. Residual infection in previously infected herds (believed to have been cleared) also contributed.

The proportion of herds with new infections (‘breakdowns’): bTB infection was detected in 3,896 of the 51,249 herds in England (7.6%) in 2015; this is likely to be an underestimate of the true number of infected herds, due to the difficulty of detection (the sensitivity of the skin\(^1\) test and other diagnostic tests for bTB is less than 100% so not every infected animal will give a positive result). Due to the constraints of available diagnostic tests, some infected herds (most likely in the HRA) may have tested negative and so escaped control measures, and a much smaller number of herds (most likely in the ‘Low Risk Area’, LRA) that were not truly infected, may have tested positive.

Spread of the disease: The distribution of bTB in 2015 changed little in the HRA, with most of it remaining endemically infected. However spread of bTB into new areas occurred slowly in a few locations, mainly in the Edge Area and encouragingly some endemic parts of the Edge saw a retraction, though at a slightly slower rate than the spread (Figure 3.3.6). The median rates of

\(^1\) The main test used for surveillance in England is the single comparative cervical tuberculin (SICCT) test referred to as the skin test in this report
spread and retraction are very similar to those reported last year and in both cases the full picture is complex and local rates differ widely, which is unsurprising given the small numbers of predicted incidents in some areas.

The Low Risk Area: The incidence and prevalence of bTB in the LRA remained much the same between 2014 and 2015, with the flat rate for Officially bovine tuberculosis free status withdrawn (OTF-W) breakdown incidence of the previous six years continuing. This was despite an increase in the numbers of animals and herds tested, and in total new breakdowns detected, in 2015 compared with the previous year.

The likelihood of becoming infected: Herds were more likely to be found infected with bTB (i.e. ‘breakdown’) if they were situated in the HRA (87% of breakdowns), had been infected previously (53% of breakdowns), and/or were ‘large’ herds (>300 cattle). The reasons that larger herds are at greater risk of becoming infected are not well understood, but likely to be associated with increased exposure to infection through buying practices, higher between-animal contact rates within larger herds, land use and other management factors, together with the greater risk of hidden residual infection after OTF status has been restored, due to the limitations of the skin test. (Figures 3.4.1a and b)

The different picture in beef and dairy herds: About 60% of bTB incidents occurred in beef herds versus 40% in dairy herds, even though the latter was from only about 19% of all herds. The increased risk of bTB occurring in dairy herds is partly explained by their generally larger size and greater tendency to be located in the HRA; however this does not fully explain the increased risk shown for dairy herds in the Edge Area. This may, at least partly, be explained by ‘misclassification’ of many herds that have mixed enterprises as ‘dairy’, but is being investigated further.

Recurrent breakdowns: Recurrent breakdowns continued to be an important contributor to the epidemic in 2015, with herds that had been infected with bTB in the previous three years being six times as likely to have a breakdown in 2015 as those that had not. As a result 58% of new cases in the HRA (1,849 herds) were in herds with a history of bTB. Lower proportions were seen in the Edge (29%) and LRA (7%). Conversely the probability of a previously infected herd in England succumbing again to bTB in 2015 was 25%, compared to a probability of 4% for any herd that had no history of bTB.

Genotyping and the source of infection: Genotype analysis showed that 85% of all M. bovis isolates identified in 2015 were from infected cattle located within the ‘homerange’ of the genotype. That is, infection was acquired within the area covered by that homerange and therefore with a degree of locality (homeranges vary in size). Of the non-homerange isolates, 15% indicate a more distant source, potentially through cattle movements, particularly if the isolate came from a purchased animal.

Disclosure of infection: Most breakdowns in 2015 were disclosed by risk-based live animal testing (42%), followed by routine surveillance in live animals (34%) or abattoir surveillance (16%) (definitions in glossary). The high proportion detected by risk-based surveillance reflects its value. It is generally most effective where prevalence is high; however 45% of LRA cases were also found this way, reflecting the reduced frequency of routine surveillance and the value of targeting testing at individual herds at higher risk. Routine testing finds the most cases in the Edge Area (50%), with only 32% found by risk-based testing, suggesting there is opportunity for more targeted
testing in this part of England. An analysis of detection at abattoirs confirmed its efficacy in the LRA, and in compensating for the limitations of live animal testing in the HRA, though the fact that more than 500 breakdowns in the HRA were not disclosed until slaughter is a concern.

Pro-active testing to detect bTB before potentially infected cattle can introduce infection to new premises such as pre-movement testing, accounted for 8% of breakdowns disclosed in 2015. This translates to the prevention of at least 300 breakdowns, potentially of high impact if infection is prevented from being introduced into the LRA. This reflects the value of this control measure, which may be even greater as the recorded number of Pro-active tests (and breakdowns disclosed by them) is likely to be an underestimate as many are not recorded as such (e.g. herd tests are also used as pre-movement tests to improve efficiency).

Surveillance coverage: the great majority of herds in the HRA and Edge Areas underwent a herd level test in 2015, with coverage higher in dairy than beef herds, which is appropriate due the greater abattoir surveillance that beef herds are inevitably subjected to. However, although coverage has been increasing year on year, and close to 90% coverage was reached in the HRA in 2015, further analysis is in progress to assess if this is sufficient and to ensure that those with test exemptions do not present a risk.

Inconclusive reactors (IRs): In some herds the screening test will reveal animals with only a slight reaction to the test, which is insufficient to classify the animal as infected and to initiate herd breakdown measures. These animals are called ‘inconclusive reactors’ and action is taken only if the animal gives a second inconclusive reaction. Analysis of herds with only IRs (in which no initial intervention is taken) shows that in the HRA over 50% are found to be infected at the retest or the next test, and this proportion is significantly higher among herds with a previous history of bTB. Although the proportions are lower in the Edge Area, here too herds which have previously had IRs are significantly more likely to be found infected in the following 15 months, particularly if they have had a previous breakdown, than herds without IRs.

Cases of TB presenting with clinical signs: In 2015 two cases of suspect clinical tuberculosis in cattle were reported. These are unusual as the surveillance programme almost always detects infected animals before they can progress to clinical disease. Cases such as these highlight the limitations of the available tests. One case was in two cattle with respiratory disease in the same herd that had repeatedly tested negative for bTB but failed to respond to treatment. The second was in a heifer with nasal bleeding, that had also tested negative for bTB, and was slaughtered due to lack of response to treatment. Typical TB lesions were found and M. bovis was recovered.

Number of herds under restriction: Overall in England in 2015, about 5% of all herds were restricted at any one time, equating to over 2,370 herds in the HRA, and about 195 and 63 herds in the Edge Area and LRA respectively. Thus at any time in 2015 over 2,600 businesses were experiencing the direct impact of bTB. This national herd prevalence has remained stable over the past five years, which as the incidence (new bTb incidents in herds occurring) has increased, suggests that on average cases are being cleared more quickly. The progress made on reducing the number of ‘persistently infected’ herds will have contributed. Note however that there is substantial variation in prevalence at county level within the Edge Area and HRA.

Duration of movement restrictions: As bTB infection is usually sub-clinical and therefore inapparent, restrictions to prevent movement of animals out of the herd are imposed to prevent bTB spread while infection is being removed. The duration of such restrictions is longer when this
proves challenging to achieve. The median value for duration of restrictions was similar across all risk areas, though highest in the HRA where half of all breakdown herds were restricted for about 6 months or less, and a further 25% for between 6 to 8 months. This compared to Edge Area and LRA medians of 5.4 and 3.6 months respectively. Duration of restrictions was longer in herds with confirmation of infection from detection of lesions and/or isolation of *M. bovis* during post-mortem examination, in larger herds and in higher risk areas with the majority of ‘persistently’ infected herds (>18 months) being larger herds in the HRA. In 2015, in herds where infection was ultimately removed (i.e. ‘closed’), there were 210 persistent herds in the HRA, 9 in the Edge and 1 in the LRA (compared to 287, 6 and 2 respectively in 2014). Prolonged restrictions such as these have driven changes in business models that are also affecting both the way the epidemic behaves and how it is analysed. For example dairy herds with prolonged restrictions can only sell calves/store cattle via Approved Finishing Units (AFUs) and instead some become mixed enterprises with their own finishing herds to attract higher prices for their products. The logistics of cattle production mean that in such herds the number of cattle raised for beef may exceed those for dairy production and potential bTB transmission pathways change.

**Number of reactors removed:** In most bTB breakdowns only one or two infected cattle (‘reactors’) are detected and removed, however there are incidents in which much larger numbers of reactors are disclosed and this increases average numbers to about seven in the HRA, nine in the Edge and three in the LRA. The higher numbers in the Edge Area and LRA reflect the systematic mandatory use of the more sensitive gamma interferon (IFN-γ or gIFN) in parallel with the skin test in OTF-W breakdown herds in those areas. This increases the likelihood of finding all the infected animals at the expense of a higher probability of false positive results.

**The effect of controls:** Although overall the rate of occurrence of new cases did not reduce in 2015, controls were effective in:

- resolving new breakdowns in the LRA,
- finding infected herds earlier in the Edge Area, so reducing the potential for spread and the number of infected cattle in each breakdown, and
- limiting the spread of disease from the HRA into lower risk areas through pre-movement testing.

**Overdue testing:** Important progress has also been made by industry on the reduction of overdue tests, which between 2014 and 2015 fell from 233 to 5 in the HRA, from 55 to 3 in the Edge Area and 118 to 16 in the LRA. This ensured bTB was found as early as possible when herds became infected and limited the potential for further spread both within and beyond the herd.

**Differences at county level:** Within the HRA and Edge Area there are substantial county differences that can help inform local priorities; these are discussed in Sections 4.1 and 4.2 of this report and details for each county are given in Section 6. Section 4.1 shows the relative ranking of counties by various parameters, for example Wiltshire had the highest risk for an individual herd to become infected (incidence), Gloucestershire had the highest proportion of herds restricted at any one time (prevalence) while Devon had the greatest number of affected herds in any county. Outside the LRA, Nottinghamshire, Northamptonshire and Buckinghamshire are the counties most likely to progress towards Officially Tuberculosis Free (OTF) status in the next few years.
Table 3.2.1 Key bovine TB occurrence and other epidemiological parameters, by risk region, in 2015 (selected 2014 values given in brackets)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>High Risk Area</th>
<th>Edge Area</th>
<th>Low Risk Area</th>
<th>England Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of herds detected as infected (total new herd breakdowns, (2014 values))</td>
<td>3,401</td>
<td>339</td>
<td>156(^1)</td>
<td>3,896</td>
</tr>
<tr>
<td>(2014 values)</td>
<td>(3,292)</td>
<td>(337)</td>
<td>(109)</td>
<td>(3,738)</td>
</tr>
<tr>
<td>Number of open cases at the end of 2015</td>
<td>2,569</td>
<td>197</td>
<td>59</td>
<td>2,825</td>
</tr>
<tr>
<td>Herd incidence per 100 herd-years at risk (2014 values)</td>
<td>18.7</td>
<td>5.6</td>
<td>1.0</td>
<td>9.7</td>
</tr>
<tr>
<td>(17.1)</td>
<td>(3.9)</td>
<td>(0.5)</td>
<td>(7.7)</td>
<td></td>
</tr>
<tr>
<td>Average monthly prevalence (%) (2014 values)</td>
<td>10.5</td>
<td>2.7</td>
<td>0.3</td>
<td>5.2</td>
</tr>
<tr>
<td>(9.7)</td>
<td>(2.8)</td>
<td>(0.2)</td>
<td>(4.9)</td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median duration of all breakdowns(^2) restrictions (days) [25-75(^{th}) percentile]</td>
<td>179</td>
<td>162</td>
<td>110</td>
<td>175</td>
</tr>
<tr>
<td>[143 – 272]</td>
<td>[134 – 251]</td>
<td>[77 – 272]</td>
<td>[140 – 265]</td>
<td></td>
</tr>
<tr>
<td>% persistently infected herds(^3) (2014 values)</td>
<td>6.5</td>
<td>2.9</td>
<td>0.8</td>
<td>6.0</td>
</tr>
<tr>
<td>(8.3)</td>
<td>(1.8)</td>
<td>(1.7)</td>
<td>(7.5)</td>
<td></td>
</tr>
<tr>
<td>% persistently infected herds(^3) (OTF-W only)</td>
<td>8.1</td>
<td>4.5</td>
<td>0.0</td>
<td>7.8</td>
</tr>
<tr>
<td>% open cases at the end of 2015 with duration &gt;550 days</td>
<td>11.6</td>
<td>8.1</td>
<td>1.7</td>
<td>11.2</td>
</tr>
<tr>
<td><strong>Recurrence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% breakdowns involving previously infected herds, within last 36 months</td>
<td>58.0</td>
<td>28.7</td>
<td>7.1</td>
<td>53.2</td>
</tr>
<tr>
<td>(58.4)</td>
<td>(25.6)</td>
<td>(14.0)</td>
<td>(54.0)</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) 51 (33%) of bTB cattle incidents in the LRA were lesion- and/or culture-positive (OTF herd status withdrawn) compared to 77% and 53% in HRA and Edge respectively.

\(^2\) That closed in 2015.

\(^3\) Breakdowns that had lasted >550 days that closed in 2015
3.2 Current situation and geographic distribution

- The rate at which new farms became infected with bTB (incidence) plateaued from 2011 to 2014, but increased in 2015 particularly in the Edge Area.
- The highest levels of bTB in England were found in the HRA which had nine times more breakdowns than the Edge Area and 30 times more than the LRA. However the area of particular concern is the Edge Area where the epidemic is clearly expanding, as shown by the significant increase in incidence.
- Eighty-seven percent (3,401) of breakdowns occurred in the HRA, 9% in the Edge and 4% in the LRA.
- The median time to resolve a breakdown was nearly 6 months in the HRA, less in the Edge and LRA.
- The number and proportion of breakdowns that had persisted for more than 18 months by the time they closed reduced, down from 295 (7.5%) in 2014, to 220 (6%) in 2015.
- Much of the geographic distribution of bTB is explained by the distribution of cattle herds, particularly large herds, and increases in herd size in the most infected areas over recent years have likely contributed to maintaining the epidemic.
- However, there is a substantial population of cattle in the north of England that is not infected, showing that other factors are also important. These factors include the historical background level of infection in the local cattle population and the presence of bTB infection in other species and their environment, particularly badgers, to which cattle are exposed.
3.3 New breakdowns of bTB and trends over time

- Both the number of new breakdowns and the incidence rate of bTB increased in 2015 compared to 2014, across England overall and in every risk area.

- This may reflect a fluctuating plateau of the level of disease over recent years in the HRA and LRA, but appears to be a true increase in level in the Edge Area.

- There are substantial differences in epidemic behaviour at risk region and county level, and so likely reasons for the increase will differ, and are discussed in relevant sections of this report.

- Typical lesions of bTB and/or positive culture results are found in most breakdowns in the HRA and Edge, but not in the LRA where a proportion of apparent cases may not be infected.

- Between 1986 and 2000 the bTB epidemic doubled in size about every five years. There was then a substantial increase in breakdowns during and after the 2001 FMD epidemic when controls lapsed. Thereafter the epidemic slowed, with a doubling time of 10.5 years from 2003 to 2008, increasing to 40 years from 2009 onwards.

- The annual number of breakdowns has remained stable between 3,700 and 3,900 since 2011, however as herd numbers have reduced, this reflects an increased risk.

- The incidence rate in the HRA in 2015 was 18.7%, and in the Edge and LRA was 5.6% and 1.0% respectively. The increase in the HRA brings it back to 2013 levels, and in the LRA is largely due to unconfirmed breakdowns.

- The greatest increase was in the Edge Area, and at least partly reflects increased surveillance effort and greater success in detecting hidden disease. This is also reflected by the greater increase in incidence when measured using ‘herd years at risk’ which takes into account the effect of interventions such as historical testing frequency on the likelihood of detecting bTB.

- The spatial distribution of cases remained much the same as in 2015, however there was both expansion and retraction of endemically infected areas in the Edge Area, with expansion exceeding retraction.
3.4 Characteristics of new breakdowns found in 2015

- Large herds with over 300 cattle had the highest risk of a bTB breakdown in 2015, with over a quarter of those tested being found infected.

- Herds in the HRA, and dairy herds, had a similar high risk to each other, with almost a fifth of herds in each of these categories that were tested becoming breakdown herds.

- Adjusting for both herd size and location (i.e. looking at any herd of a given size in a given location) shows that dairy herds are in fact slightly less at risk of new infection than beef herds.

- The risk for dairy herds was almost entirely explained by the fact that they tend to be large herds located in the HRA, however, it remains the case that a large part of the burden of bTB is carried by the dairy industry; the risk of a beef herd being found infected was less than half that of a dairy herd.

- Population changes over time have led to increases in herd size, particularly in the HRA, which may partly explain the higher risk in this Area.

- A history of bTB infection is an important risk factor, and across England over half the herds that were found infected had had a previous breakdown within the last 3 years and the proportion has been rising steadily over the last 10 years in both the HRA and the Edge. Conversely 25% of all herds that had a bTB breakdown in the last three years did so again in 2015 and those that had not, had only a 4% chance of being found infected in 2015. The importance of history differed by risk area: in the HRA 58% of herds found infected in 2015 had a history of previous infection, in the Edge the value was 29% and in the LRA only 7% of such herds had a history of infection in the previous three years.

- Assessment of likely source of infection for breakdowns started late in 2015 so to date, there is only limited data. However assessments of breakdowns in the LRA showed the great majority were attributed to introduction of infection through purchased cattle. In the Edge Area similar proportions of cases were attributed to local exposure or to introduction by purchased infected cattle. Too few were assessed in the HRA for useful analysis to be performed.

- Most breakdowns (85%) from which an isolate is typed are attributed to infection with a type for which the home range includes the location of the breakdown farm.
3.5 Finding diseased herds: Surveillance efficacy

- bTB is hard to detect and cattle (and other species) can appear healthy for some time after they become infected. Therefore there is a widespread testing programme that uses two different approaches to try to find disease, with two different tactics in each:
  - a systematic programme that tests cattle without a particular expectation of them being more likely to be infected, and the two tactics are (i) to test live apparently healthy cattle on a routine basis (‘Routine’) and (ii) to check all cattle that are slaughtered for lesions of bTB (‘Slaughterhouse’)
  - testing of animals or herds thought either to be more likely to be infected (‘Area and Herd Risk’ testing) or that would have a greater impact if they turned out to be infected (‘Pro-active’ testing).

- Despite this widespread systematic testing, not all infected cattle are identified by the surveillance programme. For example in 2015, three cattle that had recently tested negative for bTB were confirmed to be infected at slaughter; two were in a herd already under restrictions, however the third was from an LRA herd believed uninfected; investigations showed no evidence of spread.

- The focus in the Edge Area on early detection has increased the proportion of breakdowns detected by Routine surveillance which in some parts is now carried out 6 monthly, and reduced the proportion that are not detected until slaughter by almost 50%.

- Area and Herd Risk testing now detects almost half of all breakdowns in the LRA, reflecting the move to standardised four-yearly testing across most of the area, and a focus on more testing in high risk herds and on follow-up when disease is found. Most Area and Herd Risk tests are carried out following a breakdown, and are applied to control or prevent spread; these are discussed in section 3.7. The remaining tests in this category are seeking to find disease in unrestricted herds when there is increased suspicion that infection is present. The vast majority of these are tests of inconclusive reactors and they form a very small proportion of all tests.

- This apparent low detection rate following repeat testing of IRs reflects the sensitivity of field tests in individual animals, as analysis of herds that have only inconclusive reactors confirms a much higher likelihood of infection being found in the herd in subsequent months compared to herds with no reactors or IRs, particularly if the herd has a history of a previous breakdown.

- Slaughterhouse surveillance detects around 15% of cases (less in the Edge) which in the HRA is concerning as it translates to over 500 breakdowns that were not detected during live animal surveillance potentially allowing more time in which hidden disease can spread.

- The proactive surveillance stream consists mainly of pre-movement tests, which disclosed over 300 breakdowns in 2015, preventing transfer of infection to lower risk farms.
Surveillance coverage remains relatively high with nearly 90% of herds in the HRA and Edge being subject to a whole herd test in 2015. There is however a need to maintain vigilance to ensure that test exemptions do not result in disease spread risk.

### 3.6 Impact of disease and control measures

- During 2015 at any point in time 5.2%, about 2,600 herds, were restricted due to a bTB breakdown. This national prevalence level is similar to previous years.

- In the HRA the level is higher with about 10% of herds under restriction at any one time, and has also been stable recently.

- Prevalence in the Edge Area has increased almost tenfold since 2003, with a particular rise since the introduction of a stricter regime for returning a herd to OTF status with the Edge area policy in 2013, and was 2.5% in 2015.

- Breakdown herds remained under restriction for a median of five to eight months in the HRA and Edge, reducing to just under four months in the LRA, however the range was wide and large herds, or those with more than one reactor were likely to be restricted for longer.

- The proportion of breakdowns that closed in 2015 in the HRA that were ‘persistent’ reduced from 8.3% to 6.5%, however this was still a substantial number of herds (220) that had been under restrictions for more than 18 months. The number increased slightly in the Edge, to 9, but reduced to one in the LRA.

- Half of all closed breakdowns across England in 2015 had only one or two reactors removed (median). However this statistic hides substantial differences between breakdowns and risk areas with high numbers in some breakdowns pushing up the average values. In 2015 an average of seven reactors were removed per breakdown in the HRA, almost nine in the Edge Area and three in the LRA.
3.7 Reducing transmission of disease: Control efficacy

- Progressive but proportionate disease control measures are implemented to eradicate bTB, in consultation with the industry and others. They include: controls on cattle, including finding and removing infected cattle; reducing exposure to other bTB infected animals and environmental contamination; controlling the disease in badgers and other non-bovine species and a comprehensive bovine TB research programme.

- New controls introduced in 2015 included:
  - Use of reduced subsidy payments to encourage timely testing, leading to a dramatic reduction in the number of overdue bTB tests over 2015, particularly in the HRA, from 233 to five. Despite a similar order of reduction in the Edge and LRA, there were still 11 and 16 overdue tests in these areas respectively at the end of 2015.
  - Continued or new badger culls in defined HRA areas
  - Six monthly routine testing in the Cheshire Edge area

- Most cattle removed for bTB control were reactors (26,466) with small numbers of inconclusive reactors (IRs, 1,160) and dangerous contacts (DCs, 518).

- Post mortem detection of lesions was much more effective for fully confirming bTB than culture, which when taken alone accounted for only 3% of fully confirmed cases.

- In all areas most cattle in which TB was fully confirmed were disclosed by standard interpretation of the skin test, however in the HRA the next most successful disclosure test was severe interpretation. In the Edge and LRA the interferon gamma test was the second most successful, reflecting it’s wider (particularly in the Edge) and effective use in these areas.

- Nearly three quarters of reactors and DCs across England were removed within the 10 day target, with performance best in the North Region and poorest in the South West, however the latter accounts for well over half of all such cattle. The impact of the delay is not clear.

- At the end of 2015, there were 227 ‘persistent’ breakdown herds in England, most in the HRA, mainly in the south west; 200 were subject to enhanced management measures.

- Tests carried out 6 and 12 months after a breakdown were the most successful of the risk based (‘Area and Herd Risk’) tests used to follow-up to find disease related to a known breakdown, finding 29% of all breakdowns, reflecting the high risk of recrudescence and/or reinfection in these herds. The next most useful were contiguous tests (used mainly in the HRA), followed by radial tests (used mainly in the LRA and Edge Areas). Tracing tests to assess source and spread from a breakdown herd found as many cases as radial tests.

- Analysis of the distribution of herds according to their risk of infection (based on infection history and cattle purchases), shows that there are substantial numbers of low risk herds in all areas, and that there are counties in the Edge and LRA that have surprisingly high proportions of medium and high risk herds.
The pilot badger culls conducted in three areas of the HRA in 2015 were successful in removing the planned number of badgers. However it is too early to draw conclusions about their impact on levels of bTB infection in cattle in these areas.

4.1 High Risk Area

- The High Risk Area (HRA) is the area of highest incidence of bTB in England and Defra’s objective for it is to stabilise and then start to reduce this.

- Among HRA counties:
  - The highest incidence rate (i.e. rate at which herds become infected with bTB) was in Wiltshire where over 2015 almost a quarter of all herds tested were found infected.
  - The highest prevalence was in Gloucestershire where 16% of farms (174) had herds under restriction at the end of the year.
  - Devon has the largest cattle population, with almost twice the number of cattle and herds as the next largest county (Cornwall). It therefore had the highest actual number of breakdowns (871), and number of herds restricted at the end of 2015 (712) so carries the most impact in terms of resources and number of businesses affected, though its incidence rate and prevalence were not the highest.
  - Most breakdowns in the HRA are detected by risk based testing (‘Area and Herd Risk’) followed by routine testing. A surprisingly high proportion is detected at slaughter, given the frequency of routine and other testing. This was particularly so in Devon, possibly reflecting the resource challenges in this county. However Devon also showed the greatest reduction in overdue tests in 2015 reflecting the effort being made here.
  - Oxfordshire had the highest median duration of restrictions, with half of all breakdowns that closed in 2015 under restriction for 216 days or more (over seven months), and Derbyshire had the lowest, with half of its herds restricted for just under five months or less.
  - In the HRA there were 507 herds restricted for the whole of 2015, a third of which were in Devon.
  - Very few gamma interferon tests are used in the HRA despite its availability, and its use is largely restricted to only three counties, with Shropshire making the most use and accounting for 60% of such tests.
4.2 **Edge Area**

- The Edge is the buffer zone between the HRA and the LRA and is subject to the strictest disease control measures. It is divided into three regions for reporting purposes and detailed reports for each for 2015 were published earlier in the year and can be seen via a link in Appendix 8. This section summarises those reports; additional detail about each county can be seen in the County Report section of this report.

- The incidence rate of bTB increased significantly, to 5.6% in 2015, after hovering around 4% from 2009 to 2014, although there is significant variability at county level.

- Some of this increase may be artefact, though there is little doubt that the epidemic continues to increase in six of the 11 counties/part-counties of the Edge Area. However some Edge counties are showing signs of progress in terms of achieving lower incidence (i.e. Hampshire, Northamptonshire) and Nottinghamshire, Northamptonshire and Buckinghamshire may become candidates for inclusion in OTF pathway in near future.

- Introduction of infection to herds is attributed mainly to the purchase of infected cattle in Nottinghamshire and Buckinghamshire, and to locally derived infection either from exposure to environmental contamination or residual infection following a previous breakdown, in most other counties.

- The presence of many large herds and/or dairy herds, the fragmentation of land use, and the establishment of locally spreading pockets of disease in some counties add to the challenge of controlling bTB in parts of the Edge Area.

- The enhanced control measures in the Edge Area have been successful in finding infected herds earlier, reflected by the increased proportion of cases that could not be fully confirmed (OTF-S) and a reduction in the number of reactors, which will have reduced the potential for spread from new breakdowns.

- However the varied level of interest and engagement in control efforts from farmers, the increasing level of bTB, and the development of areas of endemicity, particularly as several of these are close to the LRA, are a concern.
4.3 Low Risk Area

- The LRA is on track to achieve Officially Tuberculosis Free (OTF) status in 2019, having met the incidence and prevalence criteria for four consecutive years (six consecutive years required). A link to the report provided to the EU Commission on progress within the LRA can be found in Appendix 8.

- The incidence and prevalence of bTB in the LRA remained much the same between 2015 and 2014, with the flat rate for OTF-W breakdown incidence of the previous six years continuing one more year. This was despite an increase in the numbers of animals and herds tested, and total new breakdowns detected, in 2015 compared with the previous year.

- The high proportion of cases attributed to the introduction of infected animals from higher risk areas confirms the need for the additional movement controls introduced in 2016 when compulsory post-movement testing (in addition to the pre-movement testing already in operation) was implemented.

5 Forward look

- bTB is a complex disease with multiple potential transmission routes and a wide range of control measures, so future epidemic behaviour is very challenging to predict. This epidemiology report has presented a range of descriptive information that shows that in 2015, other than in the LRA, the epidemic either plateaued (at best) or expanded.

- New controls implemented in 2016 may help turn the course of the epidemic, but to predict their likely effect would requires more capture and analysis of observational data and/or the use of predictive models.

- Additional data capture has been implemented, and Defra are currently funding the development of two predictive models, so we hope to provide forward predictions in next year's report.