Animal &
Plant Health
Agency

Bovine Tuberculosis in England in 2020

Epidemiological analysis of the 2020 data and historical trends

October 2021

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1. Executive summary

1. Bovine TB in England is subject to a statutory eradication programme based on the government's strategy published in April 2014. Within the strategy, England is divided into three 'risk' areas as determined by the level of disease. The High Risk Area (HRA), mainly in the west and south-west, disclosed three quarters of new TB incidents in 2020. As in previous years, the Low Risk Area (LRA) in the north, east and south-east disclosed very few TB incidents in 2020. Approximately 31% of LRA incidents were fully confirmed by the presence of test reactors with typical TB lesions and/or one or more animals with positive bacteriological results (OTF status withdrawn – OTF-W incidents). Twenty-one per cent of new TB incidents in 2020 were found in the Edge Area, which lies between the HRA and LRA.
2. Eradication of bovine TB is based on controlling the infection in both cattle and the wildlife reservoir. In cattle, systematic skin (SICCT) testing of herds, supplemented by routine slaughterhouse surveillance, aims to quickly identify and remove infected animals. This is coupled with pre- and post-movement testing to curb the spread of disease between herds via movements of cattle. Infected cattle herds are subjected to movement restrictions and incident management procedures (e.g. IFN-γ tests used in parallel with SICCT testing) to eliminate the infection. These measures aim to reduce the risk of disease persistence in the herd and allow the herd to regain their OTF status. The frequency of routine skin testing varies across England. Most herds in the LRA are tested every four years, while in the HRA and Edge Area, most herds undergo routine annual tests. Within the higher incidence portions of the Edge Area, herds are tested every six months , with the exception of herds that have 'earned recognition' and remain eligible for annual tests. *M. bovis* infection in the wildlife reservoir is controlled through licensed badger culling and vaccination.
3. The incidence rate of bovine TB in England increased steadily from 1986 to 2010 and has since plateaued. In 2020, the herd incidence rate in terms of new cases per 100 herd-years at risk (100 HYR) decreased in the HRA for the third year running and remained very low in the LRA. The incidence rate has been increasing in the Edge Area since 2013 and this trend continued in 2020. The number of new TB incidents decreased in England in 2020, specifically in the HRA and LRA. However, the number increased in the Edge Area, mainly driven by an increase in the proportion of non-confirmed (OTF-S) incidents.
4. Over half of herds with new TB incidents in the HRA had suffered another TB incident in the previous three years, confirming that recurrent infection remains an important driver of the epidemic in this risk area. A greater proportion of HRA herds were found to be infected in the six to 12 month period after regaining OTF status, compared to post-incident herds in other risk areas.

5. In 2020, as in previous years, herds located in the HRA (where there is high infection pressure from cattle and badgers), herds with over 300 cattle (which have a greater tendency to be in the HRA) and herds that had a history of previous TB incidents, were the most likely to sustain a new TB incident. Dairy herds were found to have an additional risk of infection that could not be fully explained by their herd size, testing history or location.
6. In 2020, there was a 14% decrease in the number of interferon gamma (IFN-γ) blood tests completed in England compared to 2019. The decrease in tests occurred in the Edge Area, while in the HRA the number of IFN-γ tests continued to increase in 2020. Mandatory IFN-γ tests are carried out in the HRA for OTF-W herds located in Badger Control Programme (BCP) areas where at least two seasons of effective control have been completed. Despite the increase in the number of IFN-γ tests performed in the HRA, this was lower than expected given the expansion of BCP areas and increase in eligible herds. This was partly due to blood tests being cancelled due to social distancing measures imposed by the Government to fight the COVID-19 epidemic.
7. During the first COVID-19 national lockdown introduced in March 2020, APHA temporarily permitted the closing date of routine TB surveillance testing windows to be delayed on a case by case basis. Farmers were encouraged to liaise with their farm vet or Official Veterinarian (OV) if they were required to self-isolate, and rearrange cattle testing within the testing window. Referrals to the subsidy-paying agencies of cattle keepers with overdue TB tests were also suspended.

Table 1.1 Key bovine TB epidemiological parameters for all TB incidents (OTF-W and OTF-S) in 2020, with selected 2019 values given in brackets

	HRA	Edge Area	LRA	England
Overview				
Number of new TB herd incidents detected	2,358 (2,501)	672 (640)	135 (148)	3,165 (3,289)
Number of new TB incidents that were lesion and/or culture positive (OTF-W)	1,496 (1,613)	357 (374)	42 (36)	1,895 (2,023)
Number of open (continuing) TB incidents at the end of the year	1,684 (1,848)	462 (434)	69 (57)	2,215 (2,339)
Herd incidence per 100 herd-years at risk	16.2 (16.9)	10.1 (9.9)	1.0 (1.1)	9.5 (9.3)
Average monthly prevalence (%)	9.1 (10.5)	5.5 (5.9)	0.3 (0.4)	4.8 (5.5)
Duration				
Median duration of restrictions for incidents (days) (25-75th percentile) that closed in 2020	196 (160-294)	194 (159-274)	162 (98-220)	194 (160-286)
Median duration of restrictions for incidents (days) (25-75th percentile) that closed in 2019	205 (166-306)	197 (168-278)	164 (102-216)	200 (165-293)

	HRA	Edge Area	LRA	England
% persistent incidents (duration >550 days) that ended during the year	7.4 (7.9)	5.5 (4.6)	0.8 (1.3)	6.7 (7.0)
Number of persistent incidents (duration >550 days) ongoing at the end of the year	133 (192)	20 (29)	1 (1)	154 (222)
Recurrence				
% new TB incidents in the year in herds that suffered another TB incident in the preceding 36 months	56.6 (56.5)	41.3 (46.5)	13.4 (10.8)	51.4 (52.4)

Note: In 2020, 42 (31%) of TB cattle incidents in the LRA were lesion- and/or culture-positive (OTF-W), as opposed to 36 (24%) in 2019.

2. Preface

2.1 Intended audience

This report describes the level of bovine tuberculosis infection in cattle herds in England in 2020. Bovine tuberculosis is caused by the bacterium *Mycobacterium bovis* (*M. bovis*) and is referred to hereafter as TB. This report is intended for those involved in the eradication of TB in cattle, both nationally and locally. This includes, but is not limited to: farmers, veterinarians, policy makers and the scientific community.

This England level report is part of a suite of annual reports providing data and epidemiological analysis of TB in cattle in Great Britain. Other publicly available reports in the series include:

1. **Bovine tuberculosis in Great Britain: Surveillance data for 2020 and historical trends** (referred to hereafter as the 'GB TB data report'). This data report is published as an ODS file and provides supporting material in the form of detailed data tables and additional graphics. It presents all similar data for England, Scotland and Wales.
2. **Year End Descriptive Epidemiology Reports** for counties in the Edge Area and Low Risk Area of England. These reports provide a detailed epidemiological assessment of TB at a local level.
3. **Bovine tuberculosis in Great Britain in 2020: Explanatory Supplement to the annual reports**. This document provides more in-depth explanations about the data handling methodologies, terminology, surveillance and control measures used within Great Britain.
4. **Analysis of bovine tuberculosis surveillance at routine slaughter of cattle in Great Britain, 2016 to 2019**. This is a triannual report exploring the role of slaughterhouse surveillance in the detection of TB cases.

Data presented in these reports are derived from the same source as Defra's 'National Statistics' on the incidence and prevalence of TB in Great Britain. These include monthly statistical reports and other quarterly statistics on specific aspects of the TB surveillance regime, such as pre-movement testing. Whilst the data source is the same, additional time has been spent removing duplication and correcting other transactional data errors before compiling this report. As such, the data in this report may not exactly match the national statistics.

2.2 Purpose of this report

This epidemiology report includes commentary and analyses of TB statistics in England, in light of disease control and eradication policies. It reports both the frequency and geographic distribution of the disease in England in 2020, and trends over time. It also explores the different TB surveillance streams employed in cattle herds and the impact of the disease and its control measures.

Bovine TB surveillance and control is a complex process, and a wealth of jargon has emerged amongst those who seek to control and eradicate the disease. This report tries to limit the use of jargon, and to include explanatory text where required. Technical language is explained when first used, and there is a glossary within the Explanatory Supplement.

2.3 Interpretation of the data

The potential for finding herds infected with TB is directly related to (a) how hard we look (the type and frequency of surveillance), and (b) the underlying frequency of disease (prevalence of infection) in the cattle population, both of which differ by risk area.

Several factors also affect the probability of a herd becoming infected with TB, which are unevenly distributed in the cattle population. For example,

1. Herd size: large herds have an increased risk of infection
2. Herd type: dairy herds have an increased risk of infection
3. Presence of infection in the local cattle population, which increases the chance of local transmission between neighbouring cattle herds
4. Presence of TB (*M. bovis*) infection in other species to which cattle are exposed. The most important being the local badger population, which is endemically infected in much of the South West and West Midlands of England.

Furthermore, changes in surveillance intensity and control measures over time exert their own effects on the measures used to track changes in the epidemic.

This report aims to take such factors into account when measuring the relative risk and frequency of TB in different herds. This enables more accurate assessment of the efficacy of applied control measures.

2.4 Eradication of bovine tuberculosis (TB) in England

Bovine TB is one of the most pressing animal health problems in England. It is an infectious and contagious bacterial disease with a wildlife reservoir (e.g. badgers) present in much of England, which complicates the eradication of the disease in its natural host (cattle). TB threatens the cattle industry and presents risks to other susceptible livestock,

wildlife, zoological collections and domestic pets. TB in animals can also threaten human health, although the widespread use of pasteurisation of cows' milk largely protects the public from undisclosed cases of TB in cattle. Nevertheless, the TB epidemic in cattle and badgers, with occasional spill-over into other wild and domestic species, represents a low but ongoing public health risk.

In view of these impacts, TB has been subject to a statutory eradication programme in England since the 1950s. Substantial progress was made over the first three decades of the programme. However, progress stalled in the late 1980s and the incidence and range of endemic areas of disease increased steadily until 2010-11. In April 2014, the government published its Strategy for achieving Officially Bovine Tuberculosis Free Status (OTF) for England (summarised in Figure 2.1).

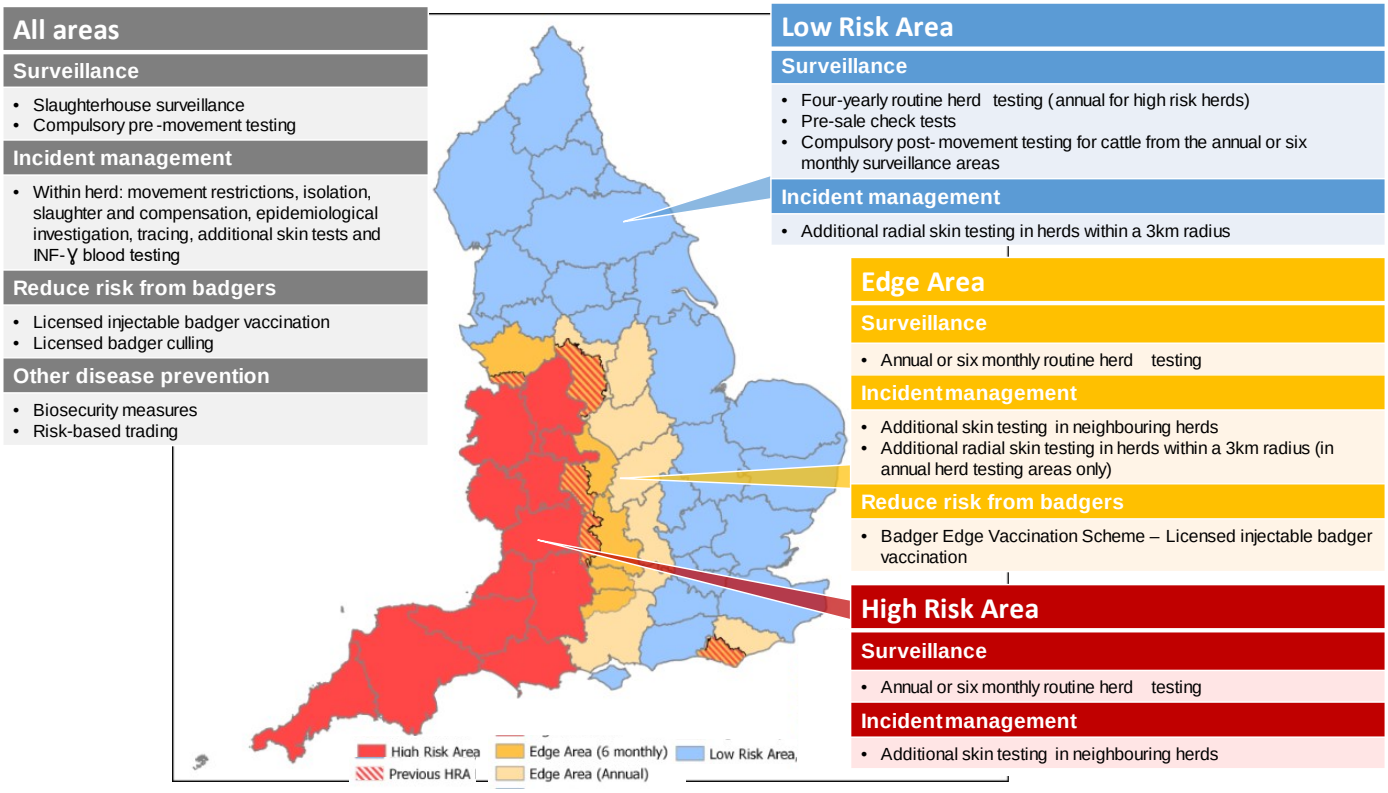


Figure 2.1 Summary graphic of the England TB Eradication Strategy

The Strategy defines disease control measures that aim to achieve officially TB Free (OTF) status for England incrementally by 2038. These measures are designed to be effective, whilst maintaining trade and an economically sustainable livestock industry. One of the key features of the current strategy is the division of the country into three 'risk areas'. These risk areas are defined by the level of TB, with bespoke control measures. Compulsory TB controls are based on the regular testing of herds, slaughter of positive animals and the imposition of movement restrictions following a failed test. Movement restrictions remain in place until there is sufficient evidence that TB infection has been

removed from the herd. Such evidence will differ according to local circumstances, in particular the risk area in which the herd resides.

In 2018 the government commissioned an independent review of the 2014 TB eradication strategy, the Bovine TB strategy review. The government considered the review in partnership with stakeholders and published its response in March 2020. The response sets out five priorities for the next five years, which are summarised below. Full details can be found in the response to the review.

Output 1: Acceleration of work to develop a deployable cattle bTB vaccine, as part of a wider programme of bTB research

Output 2: Evolving the strategy for preventing the spread of TB from wildlife. The government envisages that the current intensive culling policy would begin to be phased out in the next few years, gradually replaced by government-supported badger vaccination and surveillance. Culling would remain an option where epidemiological assessment indicates that it is needed.

Output 3: Improving diagnostics, surveillance and epidemiology to root out TB more effectively. Increasing the sensitivity of cattle surveillance testing, strengthening the management of infected herds and roll-out of new epidemiological tools to understand better the likely source of TB and better target delivery of disease control policies.

Output 4: Incentivising the uptake of effective biosecurity measures and managing the TB risks posed by cattle movements to reduce the risk of spread of TB within and between farms.

Output 5: Establishing a new 'Bovine TB Partnership' between government and industry to encourage shared ownership, coordination and decision making on TB eradication and harness the collective will to eradicate TB.

2.5 New TB surveillance and control measures introduced in England in 2020

Flexibility to delay routine TB tests during the 2020 COVID-19 Pandemic: during the first national lockdown introduced in March 2020, APHA temporarily permitted the closing date of routine TB surveillance testing windows to be delayed on a case by case basis. Farmers were also encouraged to liaise with their farm vet or Official Veterinarians (OV) if they were required to self-isolate, and rearrange cattle testing within the testing window. Referrals to the subsidy-paying agencies of cattle keepers with overdue TB tests were also suspended.

Official Vets granted Key Worker status during the 2020 COVID-19 Pandemic: During the COVID-19 epidemic, farm vets and Official Veterinarians (OVs) were designated by the

government as ‘key workers’, which enabled TB testing to continue largely unaffected. TB testing would only occur if, in the vet’s judgement, it could be done safely in accordance with COVID-19 public health guidance in force at the time. Vets were encouraged to have a conversation with farmers and carry out a risk assessment before visiting the farm, to ensure that it was safe and practical to carry out TB testing whilst observing the advice on social distancing.

Discretion to exclude calves under 180 days old from routine or targeted herd surveillance: In May 2020 OVs were given discretion to exclude calves under 180 days old from a routine or targeted herd surveillance TB skin tests of OTF herds if, in the vet’s judgement, such young animals could not be tested safely in line with COVID-19 public health advice. Calves 42 days old and over still had to be skin tested where social distancing requirements could be met and in the following circumstances:

1. in herds undergoing short interval or check testing due to a TB breakdown (in Wales, this also applies to calves under 42 days old)
2. if the animals were intended for export (private pre-export testing)
3. if they were identified by APHA as tracings to or from a TB breakdown herd
4. if they were inconclusive reactors from a previous skin test awaiting re-testing
5. if they were being moved off a holding and that movement normally requires pre-movement TB testing
6. if the animals require post-movement TB testing after moving to holdings in Scotland, the Low Risk Area in England or Low TB Area in Wales from a holding in an area of higher TB incidence

Slaughter of resolved inconclusive reactors: In June 2020 a new general licence was issued for the movement to slaughter of resolved inconclusive skin test reactors that are permanently restricted to their herd. This removed unnecessary bureaucracy for herd owners and APHA.

Approved TB Slaughter Gatherings in the LRA: From 31 August 2020, approved TB slaughter gatherings (markets and collection centres) for TB-restricted cattle from breakdown herds and Approved Finishing Units (AFUs), are no longer permitted in the LRA of England. This does not apply to cattle from Licensed Finishing Units (LFUs), which are still permitted to be sold at approved TB slaughter gatherings in the LRA.

Approved Tuberculin Testers: From November 2020, private veterinary practices in England were able to employ suitably trained lay technicians (Approved Tuberculin Testers - ATTs) following a successful field trial in 2019/2020.

Simplification of the TB surveillance testing regime in Shropshire and Staffordshire: The TB surveillance testing regime in Shropshire and Staffordshire was modified from 1st September 2020, as follows:

- six-monthly testing became the default surveillance regime for herds, replacing annual herd testing (with the first additional tests carried out in March 2021);

- for herds on six-monthly testing, other ad hoc TB tests (such as tracing tests, check tests, contiguous tests, etc.) will no longer be required.

Herds that have not had a TB breakdown for at least six years and/or are CHeCS accredited will benefit from earned recognition as lower risk herds and remain on 12-monthly surveillance testing.

Badger vaccination: Badger vaccination was carried out between 1 May and 30 November 2020, across a licenced area of 320.2 km^2; 91.6 km^2 in the HRA, 125.1 km^2 in the Edge Area and 103.5 km^2 in the LRA.

Licensed badger culling: Eleven new Badger Control Programme (BCP) areas were licensed by Natural England in 2020. Six of those areas were introduced in the HRA, four in the Edge and one in the LRA, bringing the total number of active BCP areas in 2020 to 44. In addition, 10 areas undertook licensed Supplementary Badger Control in 2020 (See Chapter 3.4, TB control in wildlife).

3. The TB epidemic in England

3.1 Incidence, geographic distribution and trends over time

- In 2020, there were 3,165 new TB incidents in England, the lowest number disclosed since 2007. As in previous years, most new incidents (74.5%) in 2020 occurred in the High Risk Area (HRA), with 21.2% in the Edge Area and 4.3% in the Low Risk Area (LRA).
- The number of all new TB incidents decreased overall in England, and specifically in the HRA and LRA. However, they increased slightly in the Edge Area, mainly driven by a rise in the proportion of non-confirmed (OTF-S) incidents in the region.
- Lower numbers of new TB incidents that were lesion or culture positive (OTF status withdrawn or 'OTF-W') were disclosed in England in 2020 compared to 2019, as well as in the HRA and Edge Area, as seen in the previous report. However, they increased non-significantly (by six cases) in the LRA.
- Since the start of 2011 the epidemic appears to have slowed in England, suggesting that it is plateauing. When considering the last four years (2016-2020), there is some evidence that the epidemic is decreasing (halving time of 14.1 years, p=0.016). However, the 2020 quarterly incident totals are still more than double the quarterly totals before the outbreak of foot-and-mouth disease in 2001.
- Within the HRA, the TB incidence rate has fluctuated between 18 and 20 incidents per 100 herd years at risk (100 HYR) since 2011 up to 2018, but fell to 16.2 incidents per 100 HYR in 2020. Since 2010, there has been a continued increase in TB incidence within the Edge Area with 10.1 incidents per 100 HYR in 2020, whilst incidence has remained very low and stable during the same period in the LRA (1.1 TB incident per 100 HYR). Overall, the TB incidence rate in England increased non-significantly to 9.5 incidents per 100 HYR (from 9.3 in 2019).
- Cattle with lesions typical of TB and/or positive culture results for *Mycobacterium bovis* were found in 63% of all new incidents in the HRA, 53% in the Edge Area and 31% in the LRA in 2020. This compares to 65% in the HRA, 58% in the Edge, 24% in the LRA.
- There was a net retraction of 156.02 km^2 in the size of the overall area considered to harbour endemic *M. bovis* infection in England (2019-20), i.e. retraction of certain parts of the 'endemic TB area' exceeded expansion elsewhere.

Number of TB-infected herds

The number of Officially Tuberculosis Free (OTF) herds in which a TB incident was detected in 2020 is referred to as the number of new herd incidents. The absolute number of new herd incidents is compared to previous years and between areas.

However, the number of cattle herds in existence, herds that are tested, herds already under TB restrictions (non-OTF) and the types of test used change between years and TB risk areas. These all affect the number of new TB incidents detected. Consequently, the herd incidence rate is a better way of assessing temporal trends in the epidemic and the differences between regions. This herd incidence rate is reported and examined in a subsequent section of this chapter.

The number of new herd incidents decreased in England in 2020 (3,165) compared to 2019 (3,298). This was driven by a decrease in the number of new herd incidents in the HRA (5.7% reduction) and LRA (8.8% reduction). By contrast there was an increase in the number of TB incidents detected in the Edge Area in 2020 (672) compared to 2019 (641) (Table 3.1.1). Although the total number of new TB incidents increased in the Edge Area, the number of new OTF-W incidents decreased, from 374 in 2019 to 357 in 2020. Looking more closely at the data, the overall increase in the Edge Area was due to increases in four counties (Derbyshire, East Sussex, Leicestershire, and Northamptonshire).

Derbyshire saw an increase of 29% in total incidents in 2020 compared to 2019, despite a decrease in the number of OTF-W cases. Leicestershire, Northamptonshire, and East Sussex saw an increase in both overall and OTF-W TB incidents. Confirmed TB hotspot HS23 straddles parts of Leicestershire, and exposure to TB in wildlife in the area may explain the increase in TB incidents in that county. In 2020, two thirds of the new OTF-S incidents in East Sussex were disclosed by an inconclusive result to a retest of an inconclusive reactor; while two thirds of the new OTF-W incidents were most likely attributed to a wildlife source. Northamptonshire experienced an increase in the number of cases for the sixth year in a row, with new clusters of infection emerging particularly along the borders with Leicestershire and Cambridgeshire. Cases in the area were mostly attributed to disease spill over from wildlife. See the Edge reports for more information.

Both the HRA and the LRA each contain 41% of cattle herds registered in England, while the remaining 18% of cattle herds are registered in the Edge Area. Approximately one in nine herds had a new TB incident in the HRA in 2020, compared to one in 13 in the Edge Area. For both areas this proportion decreased compared to 2019. In the LRA, one in 150 herds had a new TB incident in 2020 and one in 500 herds had a new TB incident that was OTF-W. However, it is important to note that approximately only one in four herds are routinely tested in the LRA each year.

The relatively high prevalence of TB in both the Edge Area and HRA means that a positive skin test result (i.e. a test reactor) is a very good indicator of infection irrespective of post-

mortem and laboratory results (see Explanatory Supplement for further details). The proportion of TB incidents that were OTF-W in the HRA and Edge Area was 63% and 53%, respectively in 2020. Overall, the proportion of new herd incidents that were OTF-W decreased in England in 2020, compared to 2019. This trend was observed in the Edge and HRA areas, however the proportion of OTF-W herds in the LRA increased (Table 3.1.1).

Table 3.1.1 Number of all new TB incidents and herd incidence rate in England, by risk area, during 2019 and 2020

	HRA	Edge Area	LRA	England
All new TB incidents in 2020	**2,358**	**672**	**135**	**3,165**
(Percentage of total for England)	**(74.5)**	**(21.2)**	**(4.3)**	
All new TB incidents in 2019	2,502	641	148	3,291
(Percentage of total for England)	(76.0)	(19.5)	(4.5)	
New TB incidents in 2020 that were lesion and/or culture positive (OTF-W incidents)	**1,496**	**357**	**42**	**1,895**
(Percentage of total incidents for risk area)	**(63.4)**	**(53.1)**	**(31.1)**	**(59.9)**
New TB incidents in 2019 that were lesion and/or culture positive (OTF-W incidents)	1,613	374	36	2,023
(Percentage of total incidents for risk area)	(64.5)	(58.3)	(24.3)	(61.5)
TB incidence rate (OTF-W and OTF-S) per 100 HYR in 2020	**16.2**	**10.1**	**1.1**	**9.5**
TB incidence rate **(OTF-W and OTF-S)** per 100 HYR in 2019	16.9	9.9	1.1	9.3
Percentage change in TB incidence rate per 100 HYR from 2019 to 2020	**-4%**	**2%**	**0%**	**2%**

Temporal trends in the number of new herd incidents in England

From 1986 to 2000, before the foot and mouth disease (FMD) outbreak in 2001, the number of new herd incidents was rising at an annual rate of over 14%. The time it was taking for the epidemic to double in size was estimated at 5.3 years (see Figure 3.1.1a in Bovine tuberculosis in England in 2018).

Surveillance testing, control measures and movement patterns in cattle herds across GB were disrupted during and immediately after the FMD epidemic in 2001. The number of new herd incidents increased rapidly over this period; increasing from 363 in the last quarter of 2000 to 662 in the last quarter of 2002, with a 25% annual rate of increase.

The rate of increase in TB incidents reduced once controls were re-established after the FMD epidemic (Figure 3.1.1b). From 2003 to 2010 the epidemic continued a steady but significant (p=0.005) upward trend. The annual rate of increase for all incidents at this time was 5.6% (doubling time of 12.8 years). Between 2011 and 2016 the epidemic appeared to plateau in England as a whole. There is evidence that the epidemic has been decreasing since 2017. Between 2017 and 2020 there was a decreasing trend in quarterly

TB incidents, with a halving time of 14.1 years (p=0.021). Note that the current quarterly number of incidents is still more than double that before FMD.

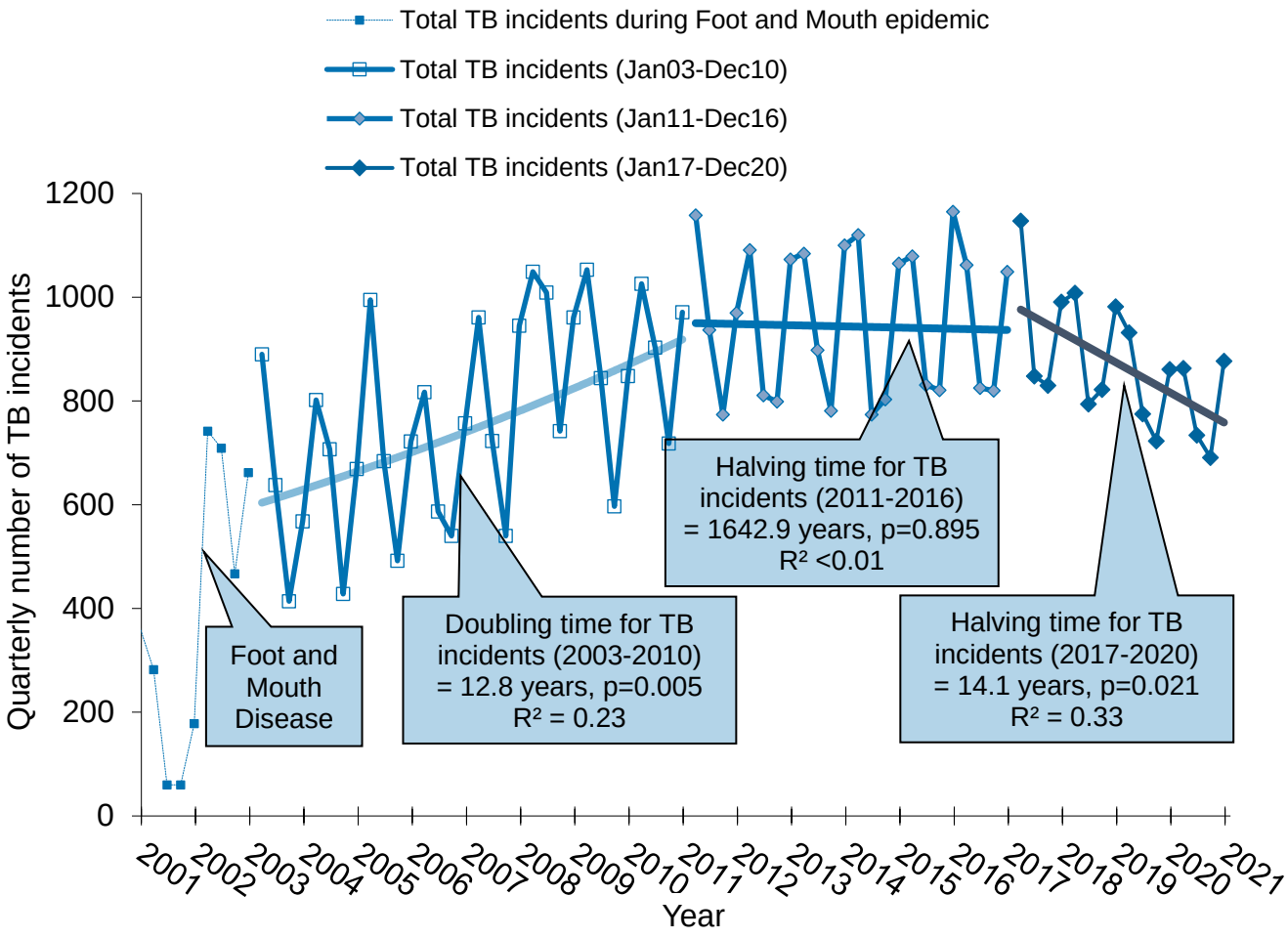


Figure 3.1.1 Quarterly totals for new TB incidents detected in England between January 2001 and December 2020

- Trend lines are shown for the three periods 2003-2010, 2011-2016 and 2017-2020. The doubling time for the period 2003-2010 indicates the time it would take for incidents to double in number, given the trend of the data. The R^2 value indicates 'goodness of fit' of the superimposed trend line to the raw data. The trend was quite erratic in all time periods, largely due to seasonal trends (an R^2 of 1 would indicate a perfect fit).
- The upward trend observed between 2003 and 2010 was significant (p=0.005), as is the decreasing trend for the period 2017-2020 (14.1 years, p=0.021).

The total number of new TB herd incidents in England decreased in 2020 to 3,165. This is the second consecutive year in which this statistic has fallen, with the number at its lowest

since 2006 (2,701). Generally, the level of TB has been fairly stable in recent years at between 3,600 and 4,000 from 2010 to 2018 (Figure 3.1.2).

In the Edge Area, the number of new herd incidents increased in 2020 compared to 2019, from 641 to 672. This was driven by an increase in the number of OTF-S incidents (Table 3.1.1.). However, single inter-year changes should be interpreted with caution and to explore TB trends multiple measures should be used, rather than considered in isolation.

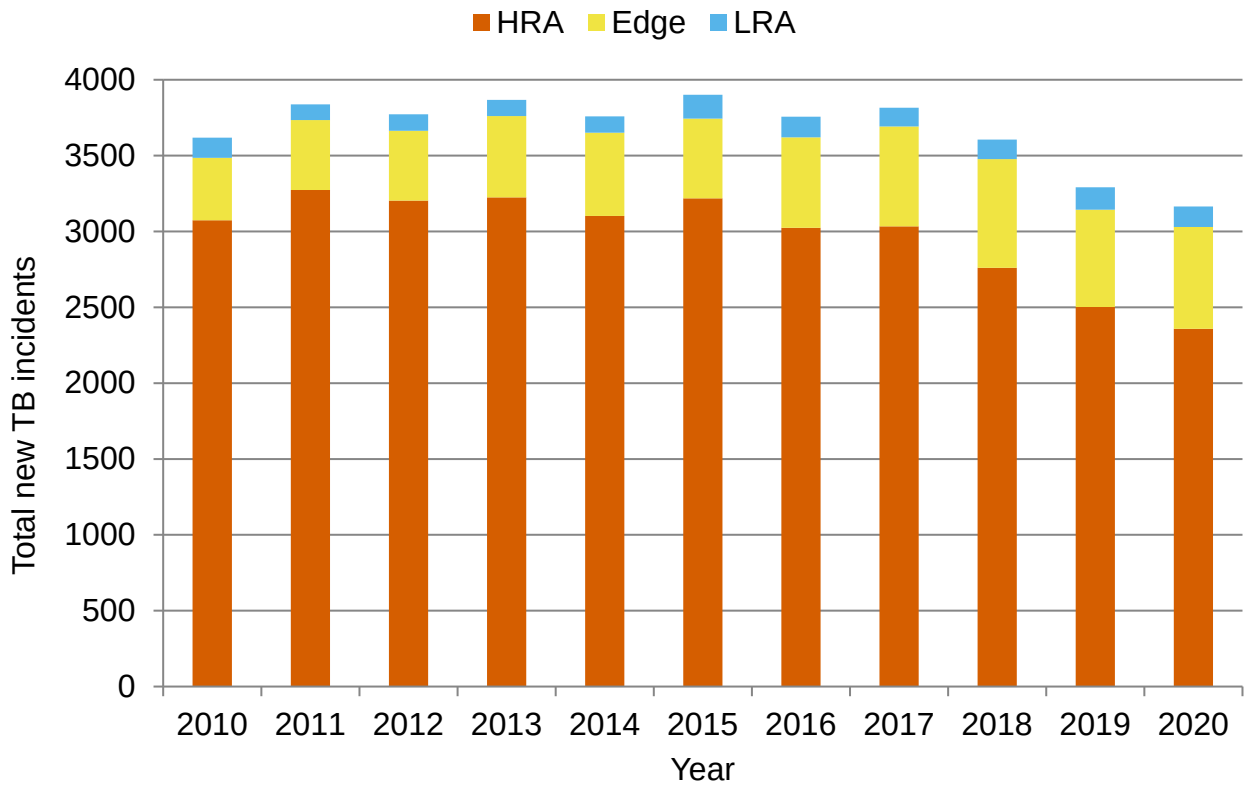


Figure 3.1.2 Annual trends in the total number of new TB infected herds, by risk area

- The total number of new TB incidents in England overall decreased for the third year running.
- The number of new TB incidents in the HRA also decreased in 2020 for the third year running.
- The number of new TB incidents in the Edge Area increase in 2020 compared to 2019.

In the HRA and LRA the total number of new TB incidents decreased in 2020 compared to 2019. However, there were more OTF-W incidents in the LRA in 2020 (n=42) compared to 2019 (n=36) and 2018 (n=37) (Figure 3.1.3).

Counties of the LRA with notable increases in the number of OTF-W incidents were Lincolnshire (10 incidents in 2020 out of 22 total incidents), North Yorkshire (8 OTF-W of 17 total incidents) and West Yorkshire (3 OTF-W of 11 incidents).

Although many incidents were attributed to cattle movements in Yorkshire and Humberside, this was not the case for all in the region. Radial testing identified other TB incident herds in the vicinity of two OTF-W cases with no clear source, particularly in West Yorkshire, highlighting this as an area of concern. The introduction of radial testing zones in the LRA around hotspot areas will help prevent the lateral spread of infection in the area, and continued wildlife TB surveillance in these hotspots is crucial to provide information around the potential local spread of infection from wildlife.

More detail about incidents in the LRA is available in Chapter 4.3 of this report, as well as in the individual LRA Year End Descriptive Reports for specific counties.

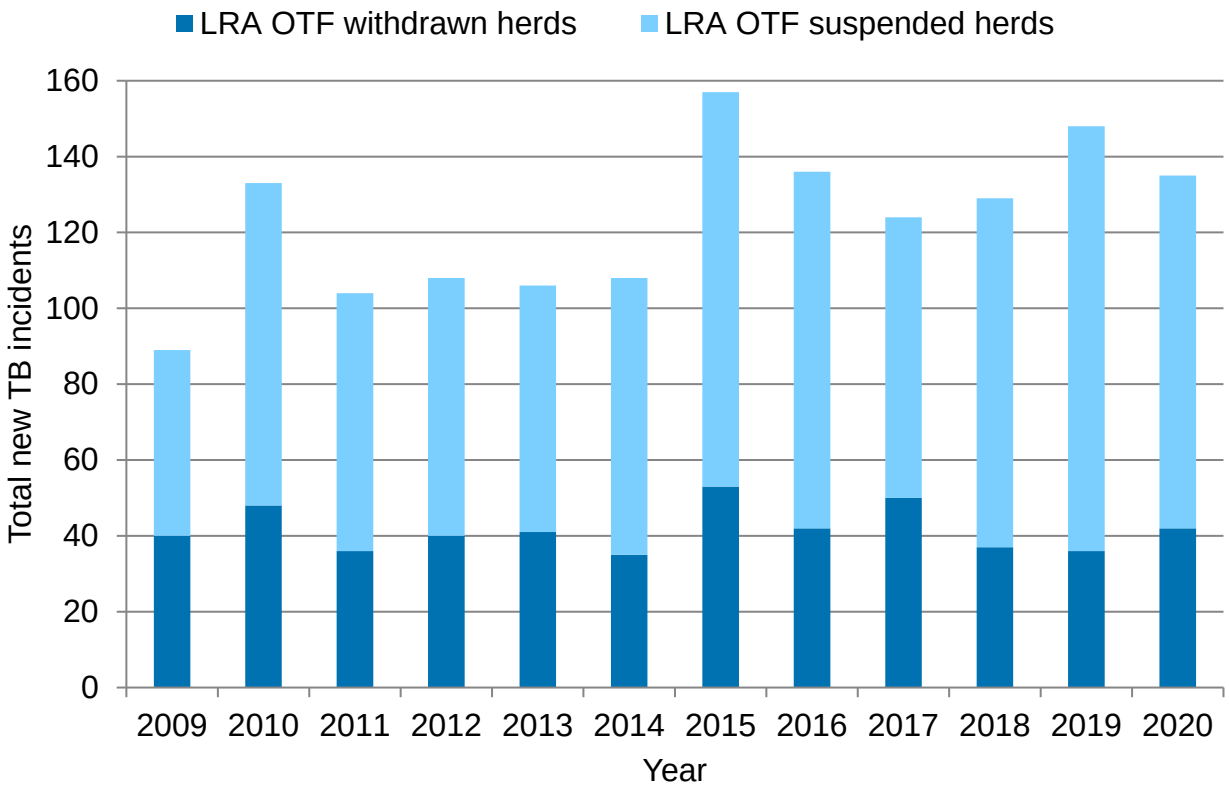


Figure 3.1.3 Annual total number of TB incidents in the LRA, by post-mortem result status (OTF-W and OTF-S)

- The number of herds in the LRA with fully confirmed *M. bovis* infection at post-mortem and/or bacteriological culture (new OTF-W incidents) has not varied much over the past ten years. Although it was highest in 2015 (n=53), there is no obvious temporal trend.
- The proportion of new TB incidents in the LRA that were OTF-W increased in 2020 (31%) compared to 2019 (24%).

Annual herd incidence rate and geographical distribution of new TB incidents

The TB epidemic in England is also measured by the herd incidence rate. This is the rate at which herds become newly infected with TB. The incidence rate in this report is calculated as the number of new TB incidents per '100 herd-years at risk' (100 HYR). This measure adjusts for differences in the time that herds are at risk of infection. Herd-years at risk takes into account the number of herds tested, when and how often herds are tested, and also periods when herds are under TB movement restriction due to test reactors or culture-positive slaughterhouse cases (and therefore not at risk of a new incident). While this statistic enables a more accurate comparison between areas than the number of new incidents that occur, it is sensitive to changes in testing intervals within an area. This is relevant when considering incidence rate trends in those parts of the Edge Area that moved from annual to six-monthly surveillance testing in 2018. A detailed description of the methodology used to calculate the incidence rate per 100 HYR is available in the Explanatory Supplement.

Figure 3.1.4 shows the annual incidence rate for England and by risk area, from 2011 to 2020. Annual rates are also presented separately for the six-monthly and annual testing portions of the Edge Area (according to parish testing status in 2020). Overall, the incidence rate of TB in England in 2020 was 9.5 TB incidents per 100 HYR. This rate has fluctuated by one or two percent over the past decade, with a slightly increasing trend overall, and a drop every fourth year (2010, 2014, 2018). Since 2018 the incidence rate in England has been very stable.

The level and trend in TB incidence varies between risk areas in England. In the Edge Area, the TB incidence rate has been increasing every year since 2013. This trend continued in 2020, despite a fall in the number of OTF-W incidents. Both the number of herd-years at risk (denominator) and the number of new TB incidents (numerator) increased slightly in 2020. TB incidence per 100 HYR increased by 2.3%, from 9.9 in 2019 to 10.1 in 2019 (Table 3.1.1 and Figure 3.1.4), but this increase was not statistically significant (p= 0.685).

When considering incidence trends in the six-monthly and annual testing parts of the Edge Area separately, incidence in the former was more than double that reported in the latter (14.7 and 6.2 TB incidents per 100 HYR, respectively). In both parts of the Edge Area the incidence per 100 herd years at risk has been increasing over the past decade, almost doubling since 2014. Fluctuations in incidence in the six-monthly testing portion between 2018 and 2020 are thought to be the result of changes to TB surveillance and case management policies impacting the herd-years at risk denominator. In 2019 a simpler measure of incidence was explored, looking at the trend in incidence per 100 unrestricted herds tested to account for these changes. In 2020, incidence reverted to be primarily measured by incidence per 100 HYR, as in previous years.

Incidence per 100 HYR in the HRA decreased by 3.7%, from 16.9 in 2019 to 16.2 in 2020, but this was not statistically significant (p=0.184). Both the denominator (herd-years at risk), and the numerator (number of TB incidents) declined in the HRA in 2020.

In the LRA, the incidence rate for all TB incidents remained the same between 2020 and 2019 (1.056 to 1.101, p=0.727). However, around 70% of the new TB incidents were not confirmed by post-mortem tests of TB suspect animals (Figure 3.1.3). When considering the incidence rate for OTF-W herds only, the increase between 2019 and 2020 was marginal and not statistically significant (0.26 to 0.34 incidents per 100 HYR, respectively (p=0.207)).

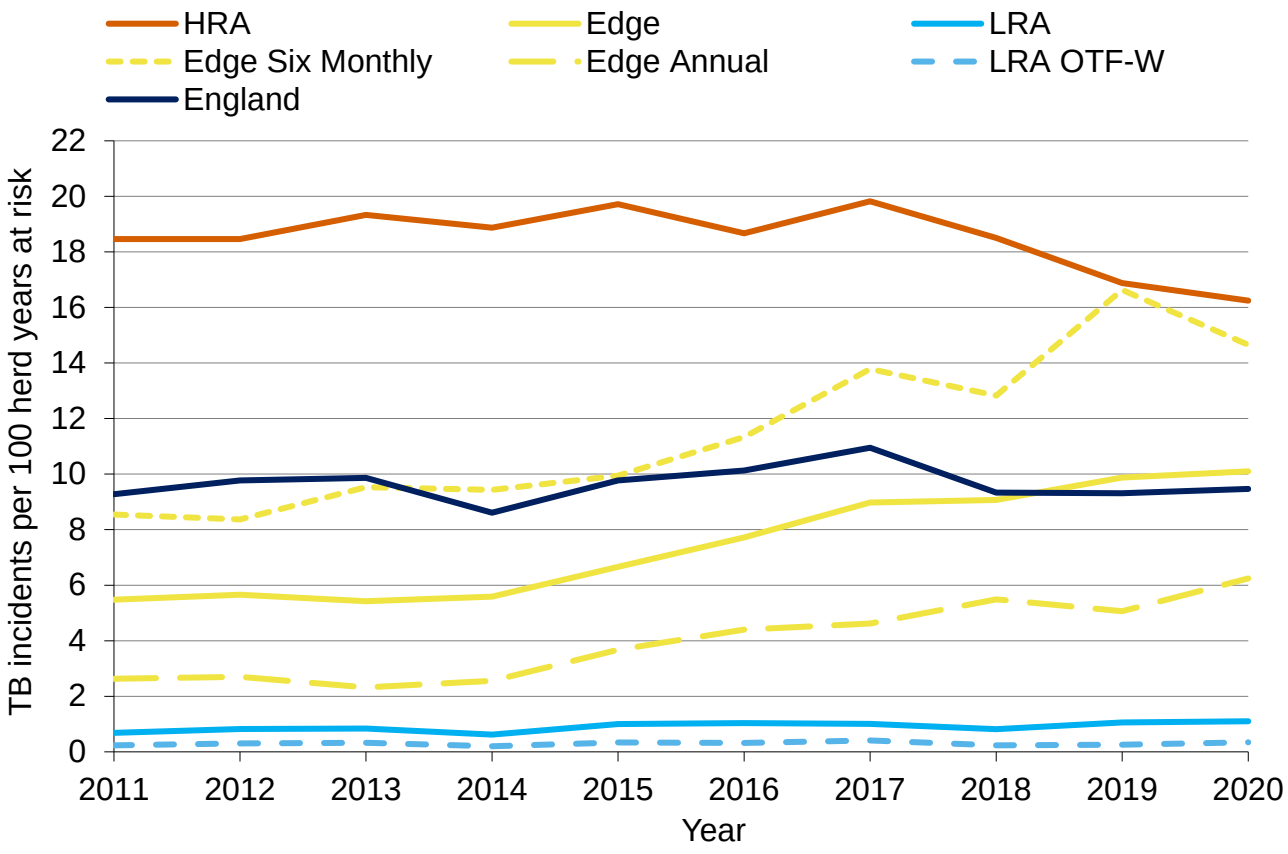


Figure 3.1.4 Annual incidence rate (per 100 HYR) for England and by risk area, from 2011 to 2020.

- The increase in incidence rate in England overall was not significant in 2020 compared to 2019 (p=0.512)
- The incidence rate decreased for the third consecutive year in the HRA, but this drop was not significant (2020 compared to 2019, p=0.184).
- The incidence rate continued to rise in the Edge Area, however the difference between the overall incidence rate in 2020 compared to 2019 was not significant (p= 0.685).

- In the LRA, the incidence rate remained very low. A small non-significant increase was seen in 2020 compared to 2019 (p=0.727), while for OTF-W only incidents a non-significant increase was observed (p=0.207).

Figure 3.1.5 shows the incidence rate per 100 HYR for individual counties in England during 2020. The highest incidence rates were recorded in the HRA county of Shropshire (20.9) followed by the Edge Area county of Oxfordshire (19.7) and the HRA county of Staffordshire (19.1). For HRA counties in the south-west, Cornwall, Devon, Somerset, Dorset, and Hereford & Worcester, the incidence rate per 100 HYR was at its lowest level since pre-2013. Gloucestershire saw a slight increase in incidence in 2020 (16.8) compared to 2019 (16.5). In the Edge Area, the incidence rate decreased in 2020 in Berkshire, Cheshire, Hampshire, Oxfordshire and Warwickshire, where six-monthly testing was fully or partially adopted in 2019. The exception to this group is Derbyshire, where the incidence rose slightly from 9.3 in 2019 to 10.7. This is due to an increase of TB incidents overall in the county, despite a decrease in the number of confirmed TB incidents. Incidence also increased in East Sussex, Northamptonshire, Leicestershire, and Nottinghamshire. This was due to increases in both overall and confirmed TB cases in cattle for three counties, and a decrease in the overall number of TB cases whilst confirmed TB cases remained stable for Nottinghamshire. All remaining Edge Area counties saw their incidence fall in 2020.

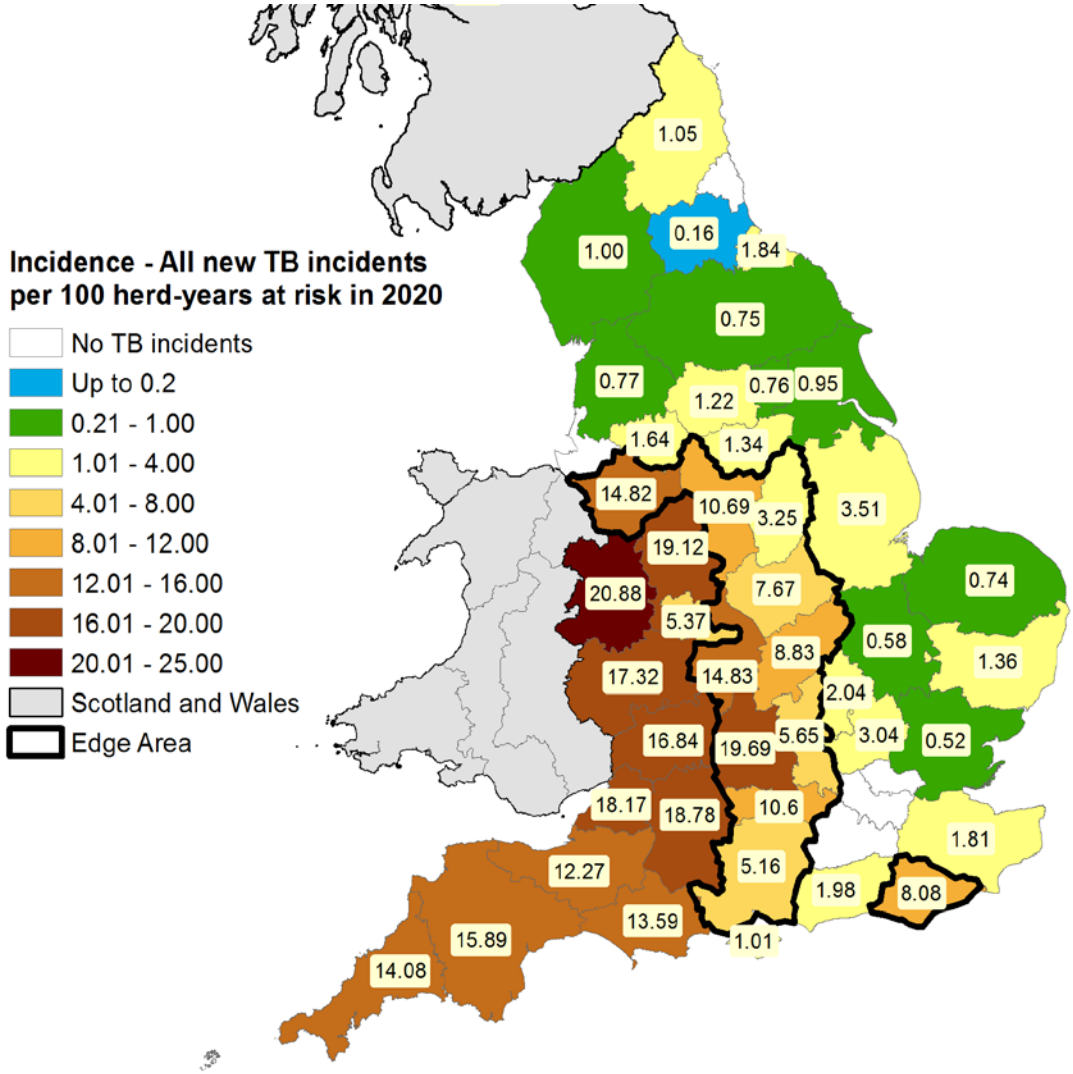


Figure 3.1.5 County herd incidence (all new TB incidents per 100 HYR) in England in 2020

- There was wide variation in incidence rates by county and risk area. Incidence was highest overall in the HRA county of Shropshire, followed by Oxfordshire in the Edge Area and Staffordshire in the HRA.

Spatial changes in the TB epidemic

Changes between 2019 and 2020 in the areas of England that can be defined as ‘endemically infected’ have been assessed (see Explanatory supplement for definition and methodology for endemic infection). The results of this methodology can be influenced by areas of low cattle density and local purchasing behaviour, which in isolated cases may give the appearance of spread or retraction as the result of these factors, and not the endemicity of TB in cattle populations. Overall, the comparison shows that the majority of the HRA is, and remained, ‘endemically’ infected, along with parts of the Edge Area,

particularly where they border the HRA. Small amounts of spread within the LRA were seen in Lancashire, North Yorkshire, and Lincolnshire, however the endemic region in south cumbria (HS26) have disappeared in the period 2019-2020. As seen in previous years, most of the rest of England, particularly the LRA, is not ‘endemically’ infected.

Veterinary assessment has highlighted that the small changes around the coasts, moorlands and conurbations in the South West of England are associated with lower herd densities. This decreases the threshold for changes in potential spread and retraction during the period studied. True retraction appears to have occurred along the southern border of Dorset and south Wiltshire, although this is balanced against spread in east Dorset. In the Edge region, the small islands of expansion seen in south Hampshire and mid Buckinghamshire are most likely to be associated with increased incidents related to cattle purchases rather than a true increase in spread (see the Edge County Reports for more information). Elsewhere, spread and retraction observations broadly reflect the situation observed locally.

In England there was calculated to be approximately 2,645.45km² of spread in some parts of this endemically infected area and 2,801.47km^2 of retraction in other parts, resulting in a net change of -156.02 km^2 from 2019-2020 (overall retraction). The net change refers to the area for which rate of spread was able to be calculated, which does not include a few isolated areas that have appeared but not joined up with previous endemic areas yet.

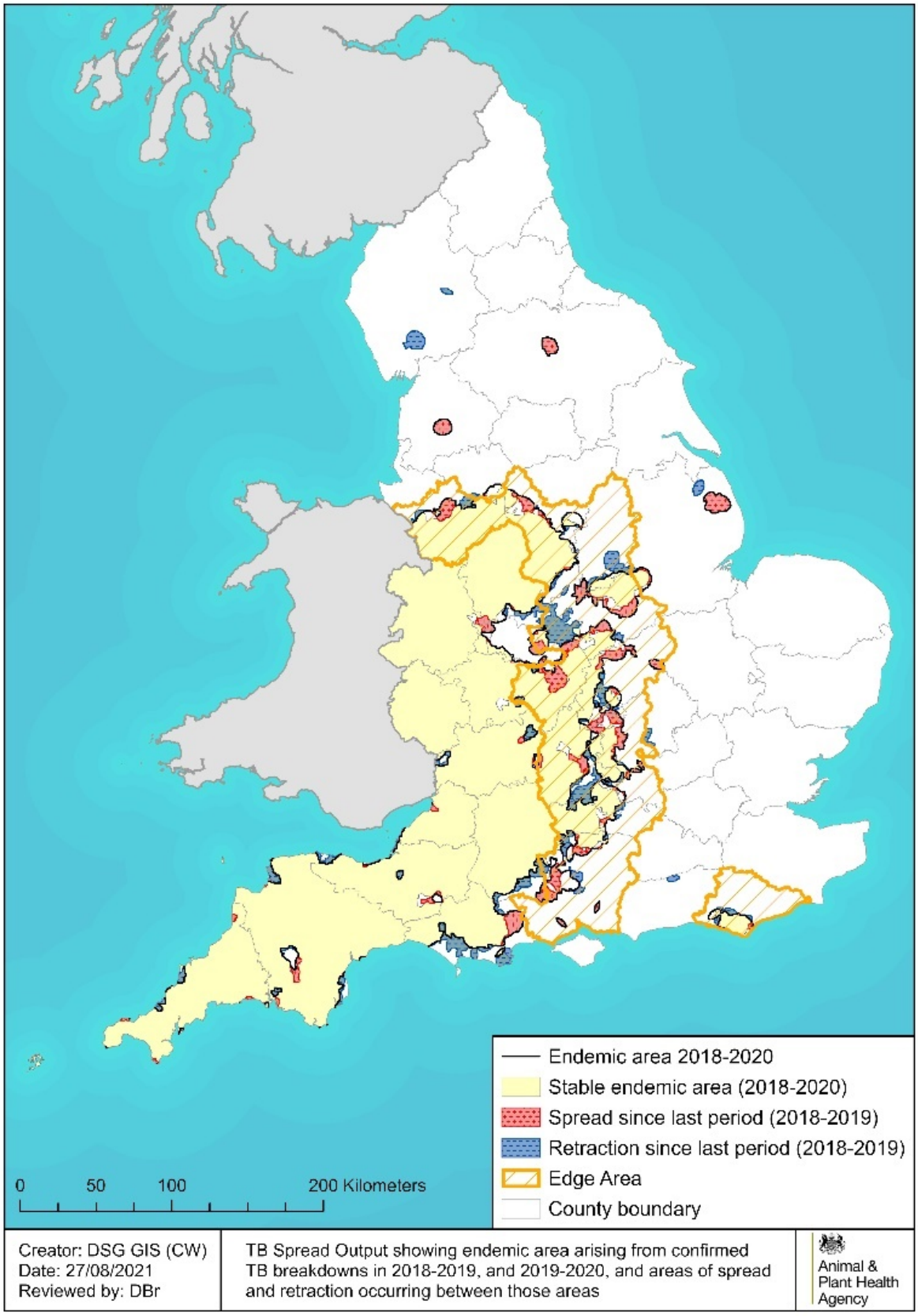


Figure 3.1.6 Spread and retraction of endemic TB areas in 2020 compared to 2019

TB in non-bovines in 2020

Mammals other than bovines are also susceptible to *M. bovis* infection and can develop TB. Table 3.1.2 summarises the data collected by APHA from TB surveillance efforts in non-bovines in England between 2019 and 2020, already published on GOV.UK in the Statistics on TB in Non-Bovine Species. It includes the number of *M. bovis* isolations from notified suspect clinical and post-mortem cases of TB.

The number of total tests carried out on individual animals in England for all non-bovines was 23,555 in 2020, a 3.5% decrease compared to 2019. The biggest increase in the number of tests conducted on non-bovines was seen in pigs, where tests rose significantly in 2020 to 4,149 compared to 264 tests in 2019. Since 2011 the number of tests in pigs has been increasing in England, but this is the highest number of tests in pigs in England since 2011.

This is followed by number of tests conducted in sheep which increased by over 500% (2,130 in 2020 compared to 326 in 2019). The number of total tests conducted in sheep has been variable with no discernible pattern between 2011-2020, fluctuating heavily in the last four years. All other non-bovine categories saw decreases in the number of tests conducted in each species.

The number of TB positive non- bovine animals slaughtered has decreased by over a third between 2019 and 2020. The number of TB positive deer slaughtered almost doubled in 2020 (n=32) and is at its highest level since 2011 (n=44). Similarly, the number of sheep slaughtered has increased to nine in 2020 (n=1 in 2019) and is at the highest level since 2013 (n=22). All other TB positive non-bovine animals slaughtered in 2020 decreased in comparison to levels in 2019, with the biggest drops seen in pigs (93%) and goats (86%).

Culture positive tests in non-bovines also halved in 2020 (n=44) compared to 2019 (n=85). In sheep, culture positive tests increased non significantly in 2020 (n=4) compared to 2019 (n=1). For all other non-bovines, the number of culture positive tests decreased. The largest decreases were seen in the “other” category, where 2020 levels (n=4) dropped by almost 70%. A similar rate of decrease was observed in pigs (64% decrease in 2020, n=5), despite an increase in total tests conducted, indicating that the increased tests have been efficient at detecting disease and preventing further spread.

Laboratory confirmed TB incidents in non-bovines halved in 2020 (n=23) compared to 2019 (n=42). In pigs and South American camelids, the number of laboratory confirmed TB incidents was at the lowest rate since 2015 for pigs (n=5), and 2011 for South African camelids (n=6).

Table 3.1.2: Results of TB surveillance in farmed and captive animal species other than cattle in England in 2019 and 2020.

	2019	2020
Total TB tests carried out on individual live animals (skin and blood tests)		
South American Camelids	9,433	5,290
Sheep	326	2,130
Goats	12,348	10,059
Pigs	264	4,149
Deer	1,557	1,308
Other	183	92
Total for all non-bovines	24,111	23,028
Total TB test positive animals slaughtered (% of individual live animals tested)		
SA Camelids	207 (2.2%)	199 (3.8%)
Sheep	0 (0.0%)	9 (0.4%)
Goats	142 (1.1%)	20 (0.2%)
Pigs	27 (10.2%)	2 (0%)
Deer	11 (0.7%)	32 (2.4%)
Other	2 (1.1%)	2 (2.2%)
Total for all non-bovines	389 (1.6%)	264 (1.1%)
Total individual animal specimens that were culture positive for *M. bovis* (% of specimens that underwent laboratory culture)		
SA Camelids	30 (37.0%)	7 (20.0%)
Sheep	1 (33.3%)	4 (50.0%)
Goats	3 (13.0%)	4 (44.4%)
Pigs	14 (19.4%)	5 (7.9%)
Deer	22 (62.9%)	18 (48.6%)
Other	10 (23.8%)	4 (14.3%)
Total for all non-bovines	80 (31.3%)	42 (15%)
Total new laboratory confirmed TB incidents (herd level)		
SA Camelids	10	4
Sheep	1	2
Goats	0	1
Pigs	7	3
Deer	13	6
Other	11	7
Total for all non-bovines	42	23

3.2 Characteristics of herds found infected with TB

- Four key factors significantly increased the risk of a herd having a new TB incident in England in 2020 namely: having over 300 cattle, being in the HRA, being a dairy herd and having experienced a TB incident in the previous three years. These factors often co-exist on many cattle farms, with herds in the HRA tending to be larger, and many dairy herds being large, located in the HRA and having a history of TB.
- 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 existing level of infection in the local cattle population and the presence of a reservoir of *M. bovis* infection in wildlife (particularly badgers) and their environment, to which cattle are exposed.
- Analysis shows that the probability of TB being found in a dairy herd was more than three times that of a beef herd. This is continued evidence that a large part of the burden of TB is carried by the dairy industry.
- Even after adjusting for both herd size and location (i.e. looking at any herd of a given size in a given TB risk area), dairy herds had a twenty-nine per cent greater risk of infection than beef herds ($p<0.001$). This contrasts with years prior to 2016 when the differences in risk between beef and dairy herds could be explained by their location and size. Since 2016, an upward trend in risk of infection was observed, with the adjusted risk in dairy herds peaking in 2020.
- A history of TB infection was also an important risk factor in all risk areas, and across England over half the herds (51%) that were found infected in 2020 had a previous TB incident within the last three years. Recurrence was highest in the HRA (57% of herds with new incidents in 2020) followed by the Edge Area (41%) and LRA (13%).
- The most likely source of infection for TB incident herds, assessed for each new TB incident in 2020 by epidemiological veterinary assessment, varied by risk area. Within the HRA, badgers constituted 56% of the attributed sources, weighted by the level of veterinary certainty. In the Edge Area, new TB incidents were still most strongly ascribed to badgers (49%), but cattle movements (21%) were also identified as a common source of infection. In the LRA there was a high degree of uncertainty around the source of infection, however incidents were most commonly attributed to inward movements of cattle with undetected infection (39%).
- Most TB incidents (81%) from which *M. bovis* was recovered and typed occurred within the ‘home range’ of the genotype of the bacterium identified in the infected animals, indicating that the detected genotype was locally prevalent and not unexpected in that area.

Factors associated with the likelihood that a herd will become infected

Many factors may be associated with the risk of a herd becoming infected with TB. These include local herd density, herd size and type, TB history and the geographical location of a herd. Other factors that can contribute towards the distribution of TB include contiguous herds (and their TB history), herd management (such as cattle purchasing) and local environmental/wildlife factors.

Local herd density

Herd size and the local density of herds are closely associated with the risk for a particular herd to become infected with TB. These factors make a strong contribution to the spatial pattern of the TB epidemic in England (Figs 3.2.1a and b).

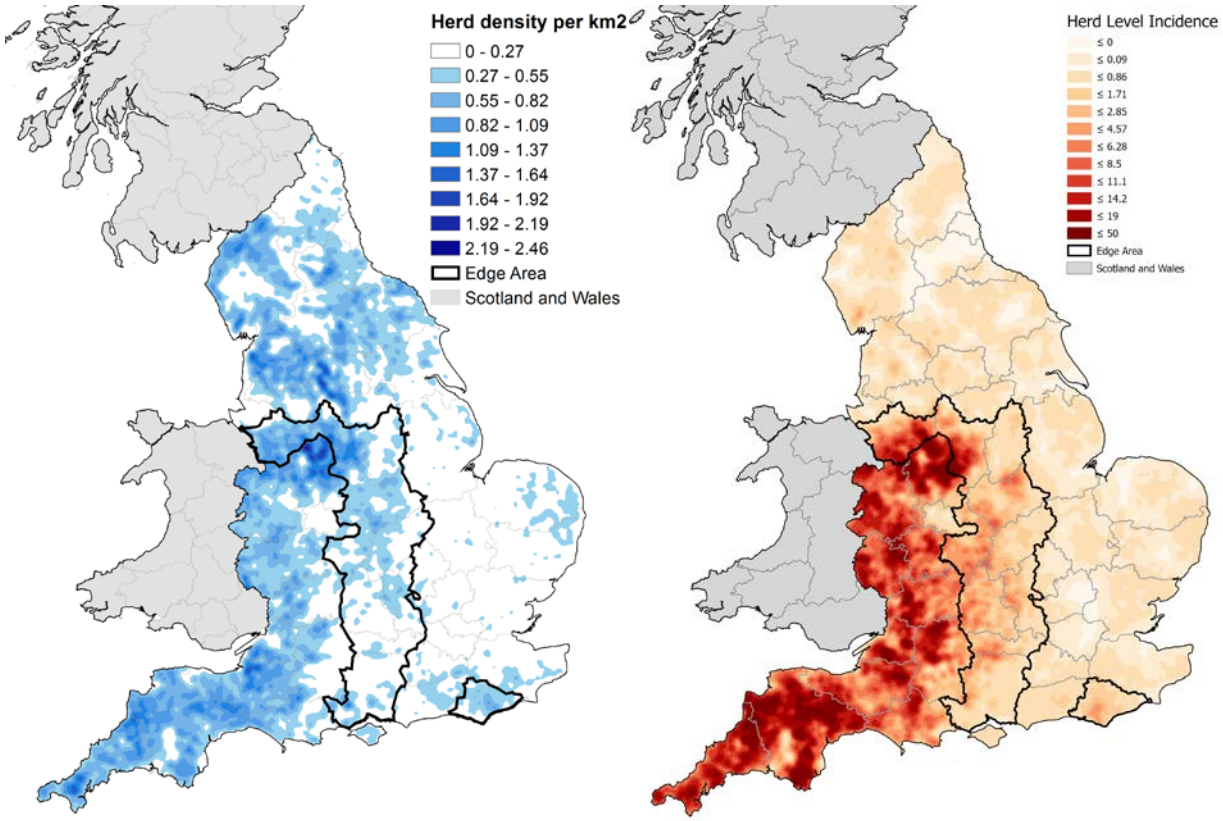


Figure 3.2.1(a) Herd density and (b) herd level incidence of TB in England in 2020. Herd density is measured as the number of herds per square kilometre; herd incidence is the average incidence in the 100 closest herds to each herd location which 'smooths' the effect of political boundaries

- The highest numbers of cattle and density of herds are mostly found in the HRA and parts of the Edge Area. The sparsest population in terms of both holding and cattle numbers is found in Eastern England portion of the LRA.
- However, cattle demographics alone cannot explain the distribution of TB, as cattle density is high in parts of Northern England where TB incidence is low.

Other factors important in explaining the distribution of TB, including herd size, type and TB history, will be explored in greater detail.

Herd size and type

Figure 3.2.2 shows the distribution of herds within each surveillance risk area by size and type. This has remained similar in recent years. Large herds with over 300 cattle have been shown to have a higher risk of infection with TB. These large herds constitute 11%, 10% and 8% of all herds in the HRA, Edge Area and LRA, respectively. There was a slight decrease in the proportion of large herds (>300 cattle) compared to 2019.

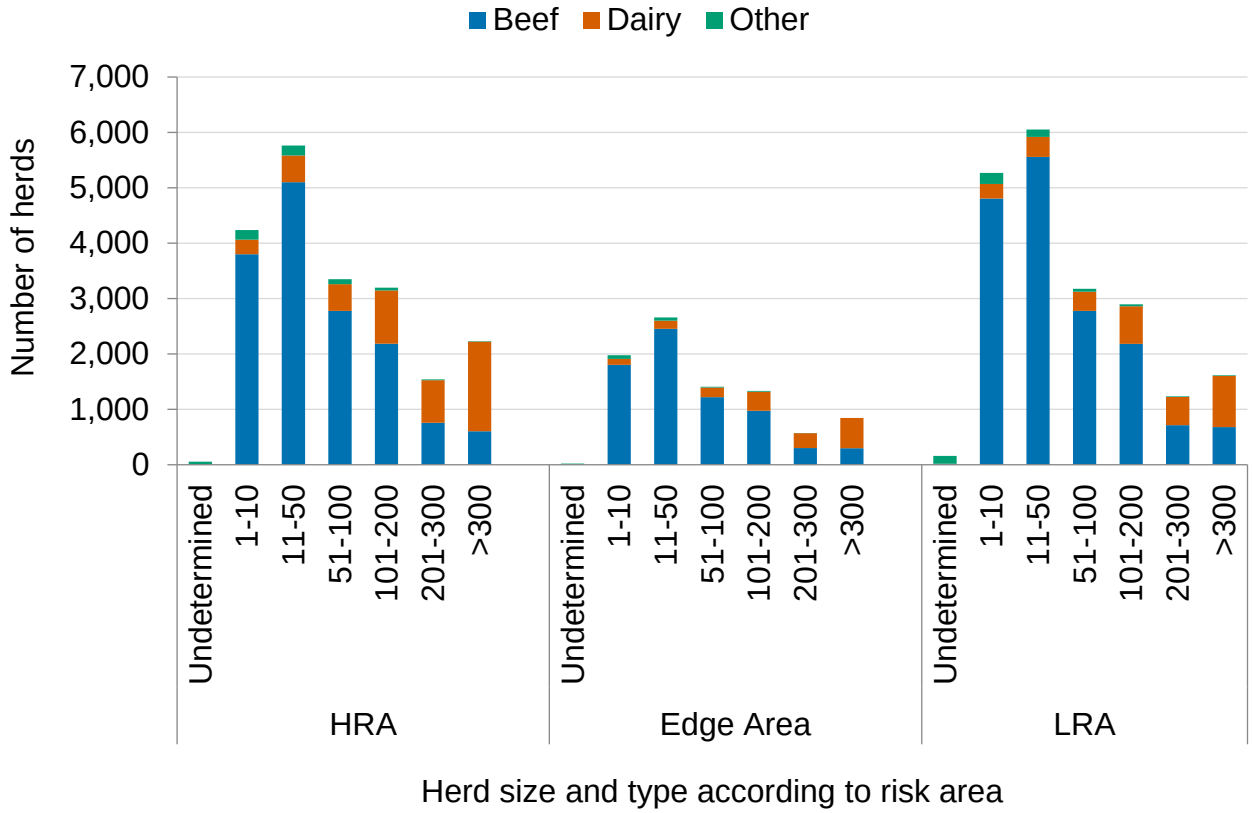


Figure 3.2.2 Number of herds by herd size and type in each risk area of England in 2020

- More large herds, and dairy herds are located in the HRA compared with the other two risk areas. This may explain some of the spatial distribution of TB infection.

The percentage of TB incidents that were disclosed in beef, dairy and “other” herds in 2020 was about 75%, 23% and less than 3% respectively. In previous years (since 2007) it has consistently been close to 60% in beef and 40% in dairy (one percent or fewer in herd types classed as ‘Other’).

However, there are many more beef than dairy herds in England, so this does not reflect their likelihood of becoming infected. Figure 3.2.3a shows the incidence rate according to

different characteristics (size, production type and location) of herds in England. This demonstrates that dairy herds were nearly three times more likely to become infected with TB than beef herds in 2020. However, dairy herds also tend to be larger and are more commonly located in the HRA, both of which are risk factors for TB infection (Figure 3.2.2).

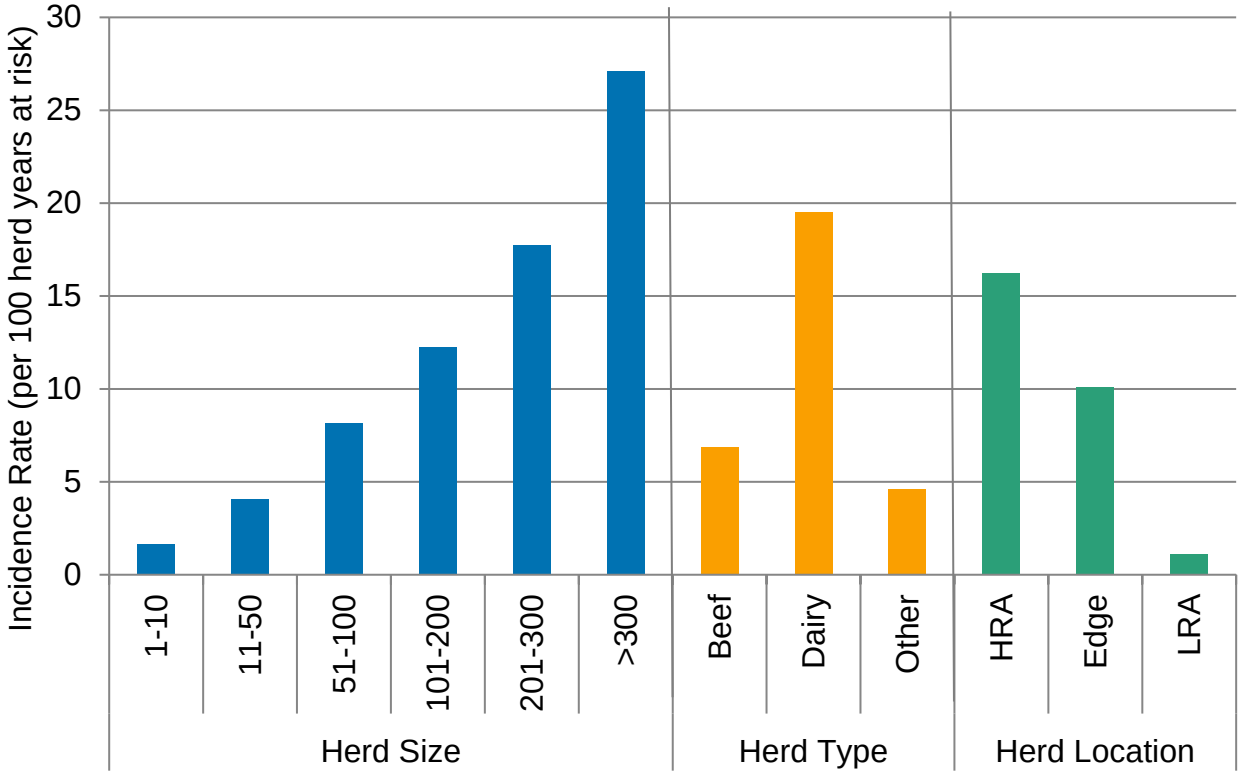


Figure 3.2.3a Rates of new TB incidents in herds of different size and type, and in each risk area of England, in 2020

- All three factors appear to be strongly linked to the risk of TB infection.
- Herd size was strongly associated with the likelihood of a herd becoming infected with TB; herds with over 300 cattle had an incidence rate of 27 new TB incidents per 100 herd-years at risk in 2020, while it was a little less than 6 in herds with 50 or fewer cattle.
- Dairy herds were 2.8 times more likely to be found infected in 2020 than beef herds.
- Incidence rates in the HRA were over 1.8 times greater, compared to the Edge Area and approximately 15 times greater than those in the LRA.

Potential risk factors are explored further by comparing incidence rate ratios (IRR). This is the comparative proportion of herds in each category that become infected. Other factors that could affect the rate of infection can then be considered. These comparative ratios are shown in Figure 3.2.3b. The adjusted IRR shows that if location and herd type are taken into account when calculating the IRR for herd size, the rate ratio hardly changes

compared to the unadjusted IRR. This indicates that herd size may be a more important explanatory factor than herd type.

The IRR for herd size ranged from 0.06 to 0.69 times the rate of TB infection in herds with over 300 animals. As seen in previous years, the rate ratios increased with herd size.

The high incidence rate in dairy herds is largely caused by the fact that they tend to be larger and more commonly located in the HRA than beef herds. Adjusting for both herd size and location greatly reduced the estimated risk associated with being a dairy herd. Even so, as in previous years, dairy herds were at higher risk of new infection in 2020 than beef herds of the same size and in the same risk area (IRR=1.29, 95% CI 1.19-1.40, $p<0.001$).

The incidence rate was significantly lower in the Edge Area and LRA compared to the HRA, even after adjusting for the effects of herd size and type. This indicates that geographical (risk area) location remains an important risk factor. In 2020, the adjusted IRR for herds in the Edge Area compared with herds in the HRA was 0.64 (95% CI 0.59-0.70). In recent years there has been an increase in the estimated risk for herds in the Edge Area compared to the HRA. In 2017 the adjusted IRR was 0.41 (95% CI 0.37-0.46), increasing to 0.49 (95% CI 0.45-0.54) in 2018 and 0.6 (95% CI 0.55-0.66) in 2019.

It is important to note that the Poisson regression analysis used to calculate the IRRs uses aggregated time at risk data. This aggregates the risk for herds that have had multiple whole herd tests in each year. The denominator value (time at risk) is slightly higher overall for the aggregated dataset (Figure 3.2.3b) than the non-aggregated dataset (Figure 3.2.3a). This results in slightly lower incidence rates. For more details about the Poisson analysis, see Appendix 4c in the 2015 report. Tabulated data can be seen in the GB data Report.

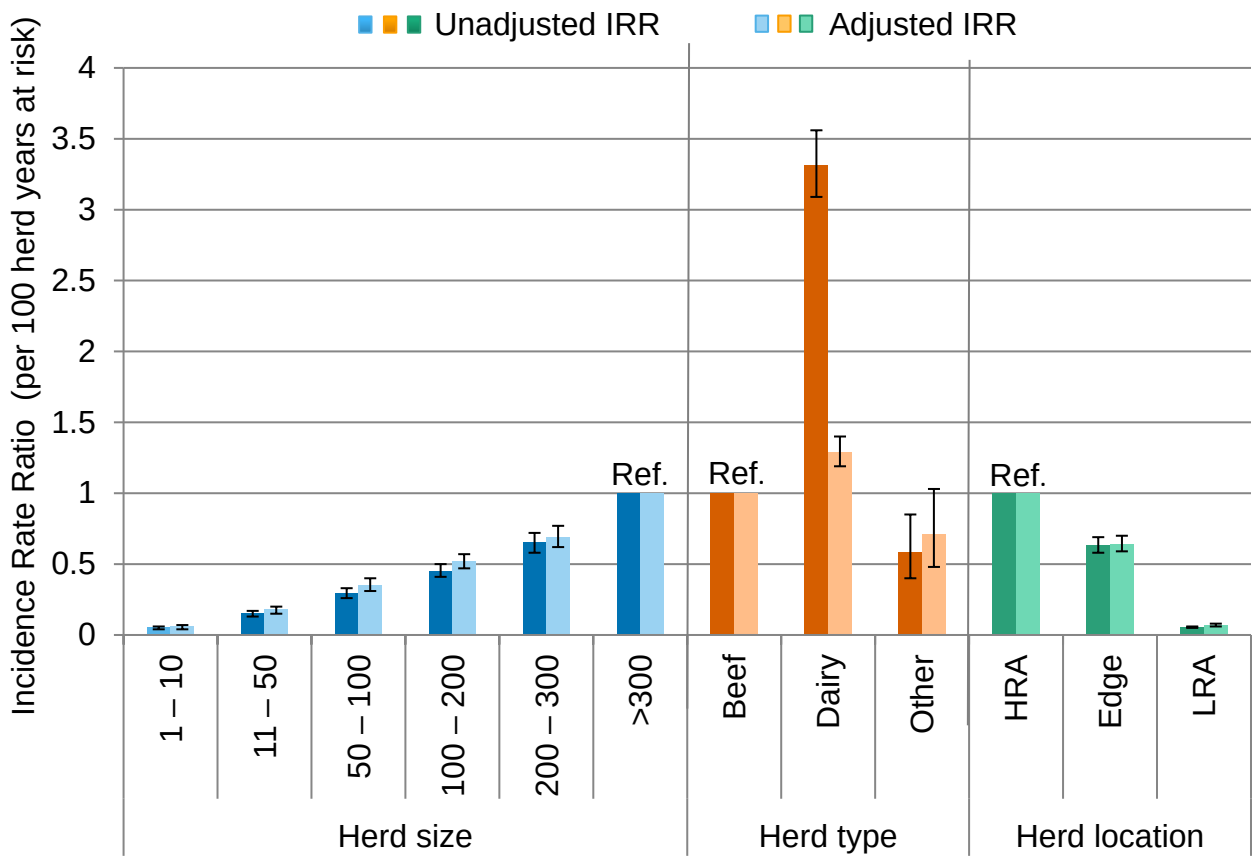


Figure 3.2.3b Incidence Rate Ratios (Unadjusted and Adjusted) for new TB incidents (OTF-W and OTF-S) in herds of different size, type and risk area in 2020

- Herd size and location are the most important explanatory (risk) factors for the incidence rate.
- The incidence rate for herds in the Edge Area was just over half the rate for herds in the HRA.
- The unadjusted incidence rate in dairy herds was over three times greater than beef herds. However, dairy herds are consistently larger, and more concentrated in the HRA than beef herds.
- After adjusting for herd size and location, dairy herds were 29% more likely to have a TB incident than beef herds.

Recurrent TB incidents

A herd's history of TB is linked to increased odds of infection occurring in any given year. A new TB incident in a herd that had a TB incident in the previous three years is called a recurrent incident. The proportion of recurrent herds are explored in two ways. Firstly, by looking at the proportion of all herds *with* a history of TB that went on to experience a TB incident in 2020 compared to the proportion of all herds *without* a history of TB that went

on to have a TB incident in 2020 (forward-looking recurrence). Secondly, recurrence is explored within TB incident herds in 2020 only. Those herds with an incident were examined to see what proportion had previously had a TB incident in the previous three years (backward-looking recurrence).

Figure 3.2.4 shows the annual trend in the proportion of TB incidents in 2020 that had a history of TB. Recurrence was consistently highest in the HRA, and lowest in the LRA. Within the HRA, 56.6% of herds that had a TB incident in 2020 also had at least one other TB incident in the previous three years. In the Edge Area, the percentage of recurrent incidents was lower (41.3%). In addition, the increasing level noticed in recent years (2017-2019) was reverted in 2020 where a minor decrease was highlighted. In the LRA, the percentage of herds with a TB incident that had a history of TB was much lower than in the other two TB risk areas of England, at 13.4%, but increasing with respect to 2019 (Figure 3.2.4).

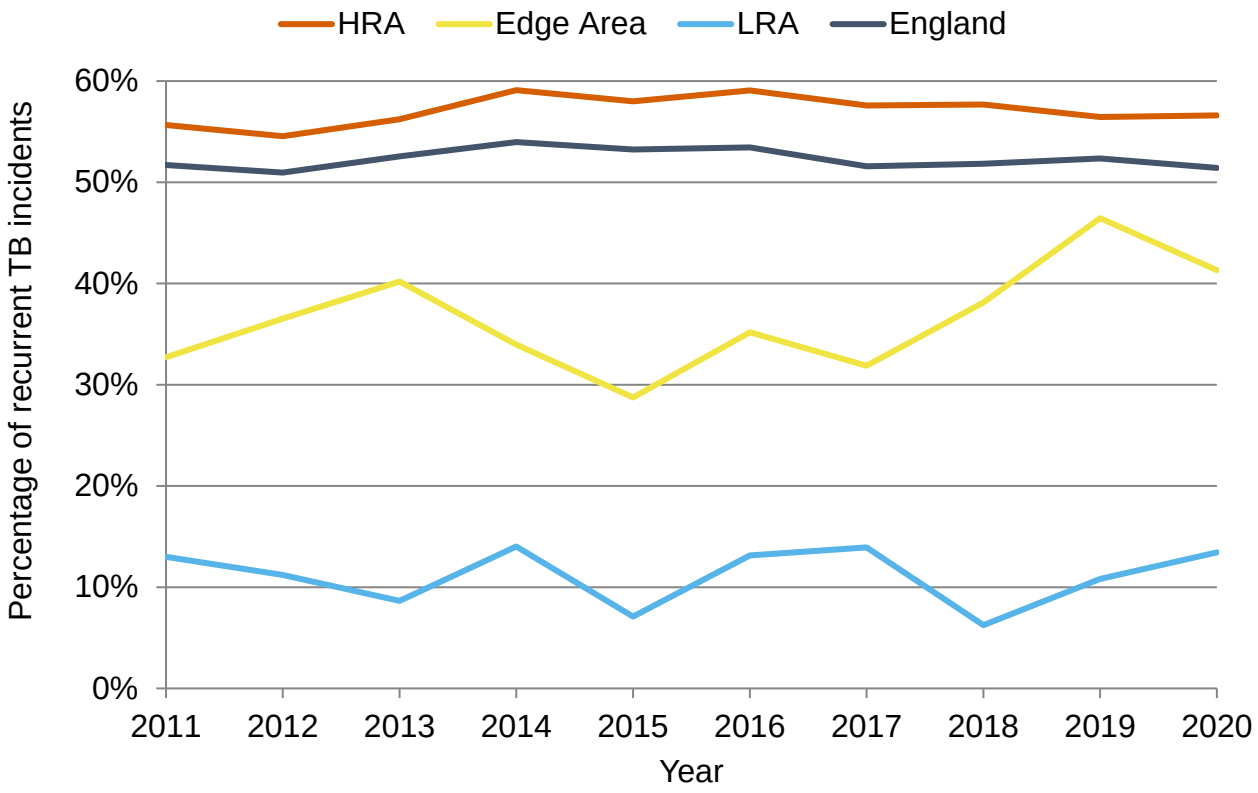


Figure 3.2.4 Annual percentage of TB incidents with a history of TB in the previous three years, by risk area, from 2011 to 2020

- The percentage of recurrent TB incidents has remained relatively stable in the HRA and LRA over the past ten years.
- The percentage of recurrent TB incidents decreased in the Edge Area in 2020 (41.3%), the first decrease since 2017 (31.9%).

- In the LRA, the percentage of recurrent TB incidents increased between 2018 (6.3%) and 2020 (13.4%).

In 2020, the odds ratio for recurrent incidents compared to new incidents in herds with no history of TB (forward-looking recurrence odds ratio) was lowest in the HRA (OR 1.7, 95% CI 1.6-1.9). For the Edge Area, the odds were higher at 2.3 (95% CI 1.9-2.7). The recurrence odds ratio was highest in the LRA, albeit with wide confidence intervals (OR 5.3, 95% CI 3.2-8.8).

The recurrence odds ratio has been relatively stable in the HRA in recent years (close to 2), but more variable in the Edge Area. In 2020, the Edge Area recurrence odds ratio decreased after a period of increase from 2017 (OR 1.7, 95% CI 1.9-2.9) to 2019 (OR 3.5 95% CI 2.9-4.2).

Some parts of the Edge Area have endemic infection, while some areas have a low incidence of TB. When recurrence is calculated for the area as a whole, the odds of herds with a TB history having a new incident in 2020 is high (higher than the odds in the HRA). However, the odds of TB in herds with no TB history is lower than the HRA. This causes a higher odds ratio for the Edge Area.

When the same analyses were run for previous OTF-W incidents only, the odds of a recurrent incident increased in the LRA. Having any TB incident in 2020 was almost eight times more likely in herds with a history of OTF-W incidents, compared to herds with an OTF-S incident or no TB history (OR 7.8 95% CI 3.8-15.8).

The odds of having a TB incident in herds with a TB history, compared to herds with no TB history was close to double for all herd sizes (Figure 3.2.5a). For small herds (10 cattle or less), the odds of having a TB incident in herds with a TB history compared to herds with no TB history decreased in 2020 compared to 2019 (2019 OR 4.8 95% CI 2.9-7.9 and 2020 OR 2.3 95% CI 1.8-2.8).

When comparing herd type, the odds of having TB was roughly two times higher in both beef and dairy herds with a TB history, compared to herds with no TB history. The odds of recurrent TB was higher in the ‘other’ category (OR 2.5 95% CI 1.0-6.4). The ‘other’ category only had 21 new TB incidents in 2020, and accounts for less than 3% of all herds in England. The odds ratio increased in comparison to 2019 (OR 0.4 95% CI 0.06-3.3), although the 95% confidence interval was wide in both years.

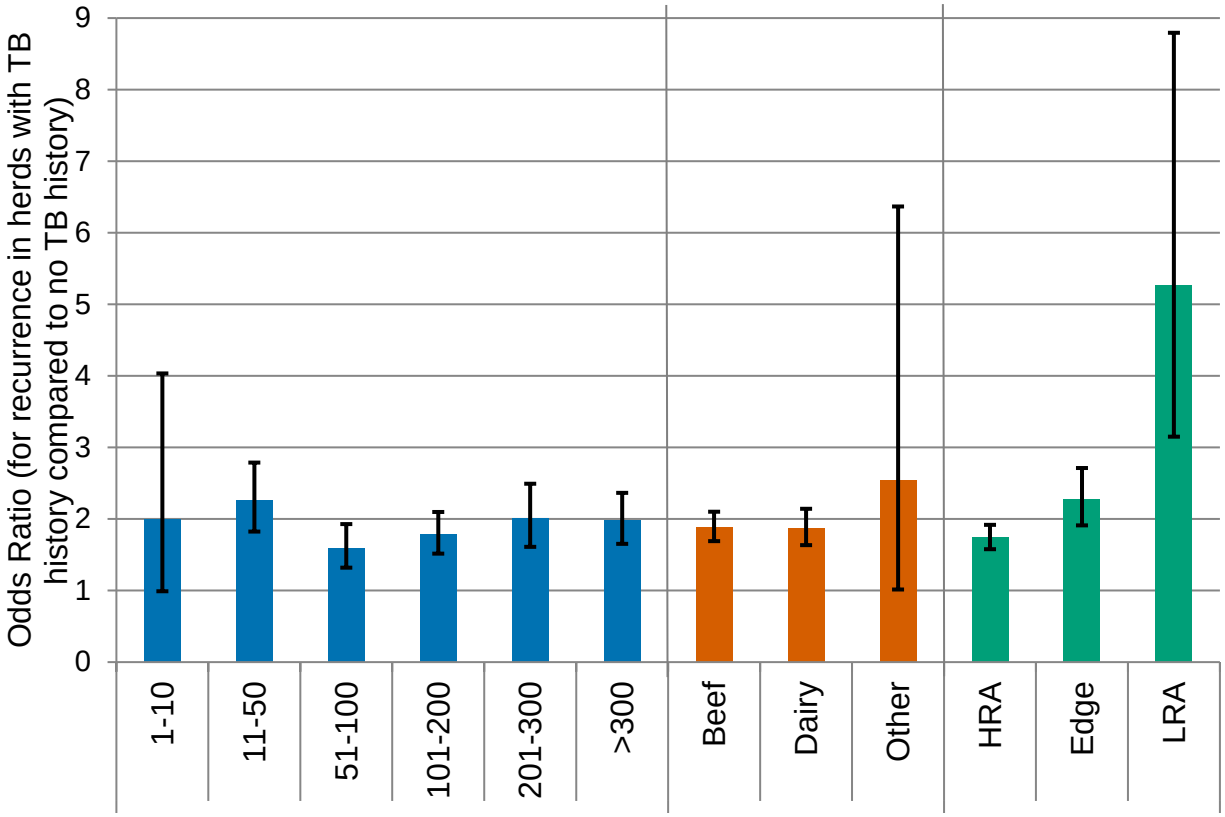


Figure 3.2.5a. The odds of recurrent infection in herds with a history of TB compared to herds with no TB history in 2020, by herd size, herd type and risk area (error bars show 95% confidence intervals)

- Beef and dairy herds, and herds in most size categories that had a history of TB all had similar odds of recurrent infection (around double).
- In the HRA, the odds of recurrent infection in herds with a history of TB compared to herds with no TB history was just under double.
- In the Edge Area, the odds of recurrent infection were more than double for herds with a history of TB compared to herds with no TB history.
- In the LRA the odds of a TB incident in a herd with TB history were more than five times greater than herds with no TB history, however the confidence intervals were wide.

Backward-looking recurrence as a percentage of all herds that were positive in 2020 only, was examined within each risk area and herd type category separately (Figure 3.2.5b). Herds with an incident were examined to see what percentage had sustained another TB incident in the previous three years. In all three risk areas, the percentage of recurrent TB incidents was highest in dairy herds, with around half the percentage of beef herds enduring a recurrent infection.

Recurrence may have several causes, likely relating to herd location, biosecurity, residual (undetected) cattle infection from a previous TB incident affecting the same herd, exposure to local wildlife reservoirs, and/or cattle buying or other management practices. The increased risk of recurrence for particular farms as described here will be used in ongoing work to develop more targeted interventions determined by farm characteristics. Farmers' knowledge of their herds' increased risk, may also help those keepers with a history of TB infection make informed decisions about their management practices using advice from initiatives such as the TB Hub to help promote safer buying practices and improved biosecurity.

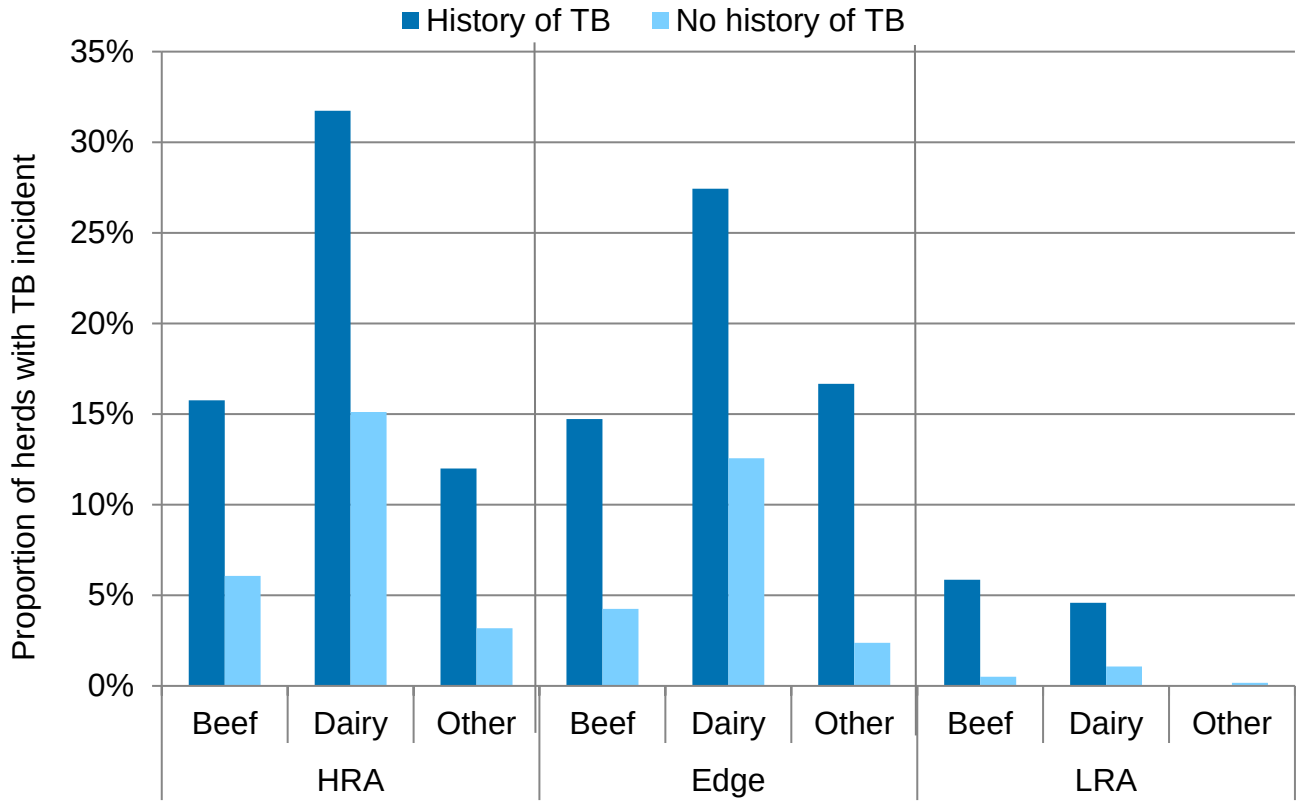


Figure 3.2.5b. The proportion of herds with and without a history of TB in the previous three years, that went on to experience a TB incident in 2020, by risk area and herd type

- The proportion of beef and dairy herds with a TB incident in 2020 was higher among herds with a TB history in the previous three years than those without, for all risk areas.
- In the HRA and Edge Area, dairy herds with a history of TB had the highest proportion of recurring TB incidents, compared to beef and 'other' herds, and this is consistent with previous reporting years.
- In the LRA, beef herds displayed a slightly higher proportion of recurrent TB incidents compared to the all other herd types, in contrast to 2019.

Molecular typing

Attempts are made to recover *M. bovis* from all TB incidents and to subject at least one isolate per TB incident to a combination of spoligotyping and Variable Number Tandem Repeat (VNTR) typing in order to identify its molecular type (genotype). This knowledge is used to describe areas where particular genotypes are common, so-called 'home ranges' and then to compare isolates from new TB incidents with the previous known distribution, including the home range, of the particular genotype identified.

In total, 1,748 isolates from TB incidents that started in 2020 had a genotype identified; of which 1,681 isolates had a calculated home range. Most isolates occurred in their home range (1,362, 81%), with 319 out-of-home range isolates identified. The most frequent genotype found in England in 2020 was 25:a, which accounted for 20% of the *M. bovis* isolates subjected to genotyping. This was followed by 17:a (19%) and 11:a (14%). These three genotypes accounted for 53% of all genotypes disclosed and their home ranges cover extensive areas in the South West and West (Figure 3.2.6).

Further information about genotyping is given in the Explanatory Supplement. The assessments described in the next section on source of infection have been informed by knowledge of the genotype where available. Further statistics on the outcomes of *M. bovis* genotyping carried out in 2020 is included in the GB Data Report.

Molecular typing through analysis of the entire sequence of the bacterium's DNA, known as Whole Genome Sequencing (WGS), can provide greater discrimination between strains of *M. bovis* than genotyping, which analyses only specific regions of the bacterial genome. This will be particularly important in the HRA where it is generally not possible to distinguish local sources of infection because they are defined by the same genotype using the current methodology. This could potentially allow explicit identification of transmission pathways between some farms or confirm whether recurrent incidents have been caused by residual infection in the herd from a previous incident, or by a new introduction from a local cattle or wildlife source. Isolates sent for genotyping at APHA have also been sequenced since mid-2017 and the APHA now has ISO accreditation for high-throughput sequencing, although WGS from non-bovine species is very limited due to the availability of submissions. Work is currently ongoing to facilitate replacement of genotyping with WGS in routine TB control and surveillance operations.

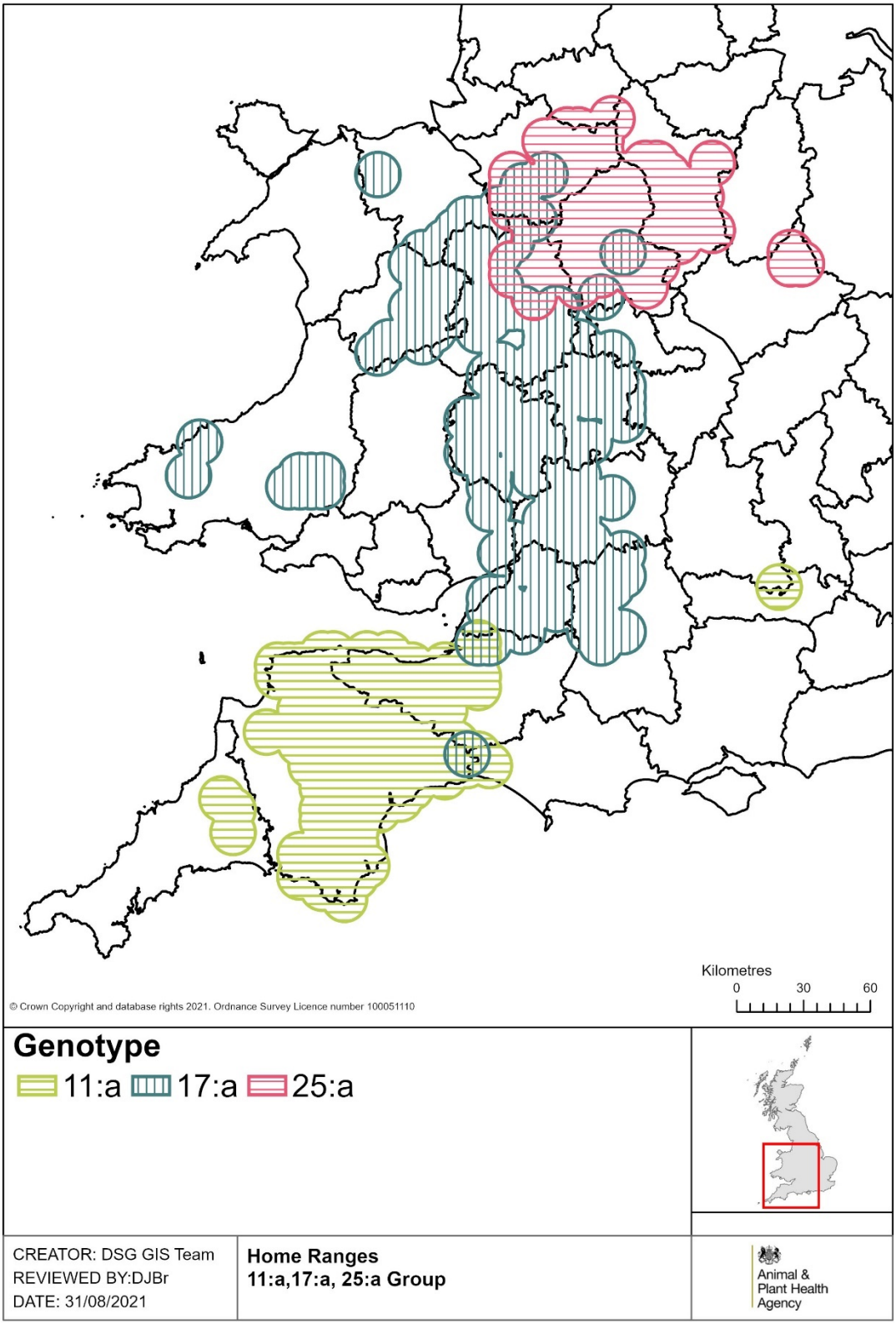


Figure 3.2.6. Homeranges of genotypes 11:a, 17:a and 25:a of M. bovis, based on data from 2020.

APHA veterinary assessment of the sources of infection for herds with a new TB incident in 2020

It can be challenging to retrospectively establish the route of infection for a TB incident herd. The aim is to complete an epidemiological assessment for all TB incidents in the Edge Area and LRA (both OTF-W and OTF-S). However, where resource constraints exist, it may not be possible to investigate all incidents (especially in the HRA) so that a proportion will be randomly selected or 'triaged' for a visit. In the HRA one third of new incidents are randomly selected, as well as those that meet specified criteria (e.g. those with more than 15% of the herd or 20 cattle removed as test reactors in a single round of testing). Epidemiological assessments typically include a thorough on-farm investigation and scrutiny of routinely collected data such as cattle movement records, and the results of molecular analyses where available. In 2020, however, epidemiological assessments were carried out remotely, by telephone, to minimise contact due to COVID-19.

During the assessment up to three risk pathways of infection are selected for each herd. These are captured on a Disease Report Form (DRF). Each risk pathway is given a score that reflects the likelihood of that pathway bringing TB into the herd. The score is recorded as either definite (score 8), most likely (score 6), likely (score 4) or possible (score 1). Risk pathway data is then explored both at the herd, county and risk area level.

The weighted source of infection

To consider the contribution of all sources of infection within an area, the source(s) for each incident are weighted by the certainty ascribed. Any combination of definite, most likely, likely or possible sources can contribute towards the overall picture for possible routes of introduction into a herd. If the overall certainty score for a herd is less than six, then the score is made up to six using the 'Other/Unknown Source' option. Buffering up to six in this way helps to reflect the uncertainty in assessments where only 'likely' or 'possible' sources are identified.

Figure 3.2.7 shows the percentage of risk pathway investigations that had a high degree of uncertainty in the selected risk pathway(s). Both the proportion of investigations with sufficient evidence, and those where additional 'other or unknown' source was applied are shown. For OTF-W incidents in the HRA that were selected for an investigation, 76% had sufficient evidence, and 24% required some additional uncertainty buffering. In the LRA, there was less certainty around the OTF-W risk pathways; 22% did not have sufficient evidence and additional uncertainty was applied. For OTF-S incident investigations, where genotyping or WGS evidence is not available, the percentage of investigations that had insufficient evidence was in general higher, especially for the LRA where 51% of OTF-S investigations had uncertainty applied. In the HRA and in the Edge Area respectively 31% and 32% of the investigation carried out had an additional buffer of uncertainty applied. Overall, this demonstrates that the confidence in the veterinary assessments is highest in

the HRA and Edge Area and lowest in the LRA. It is important to keep this in mind when interpreting the aggregated outputs in this section.

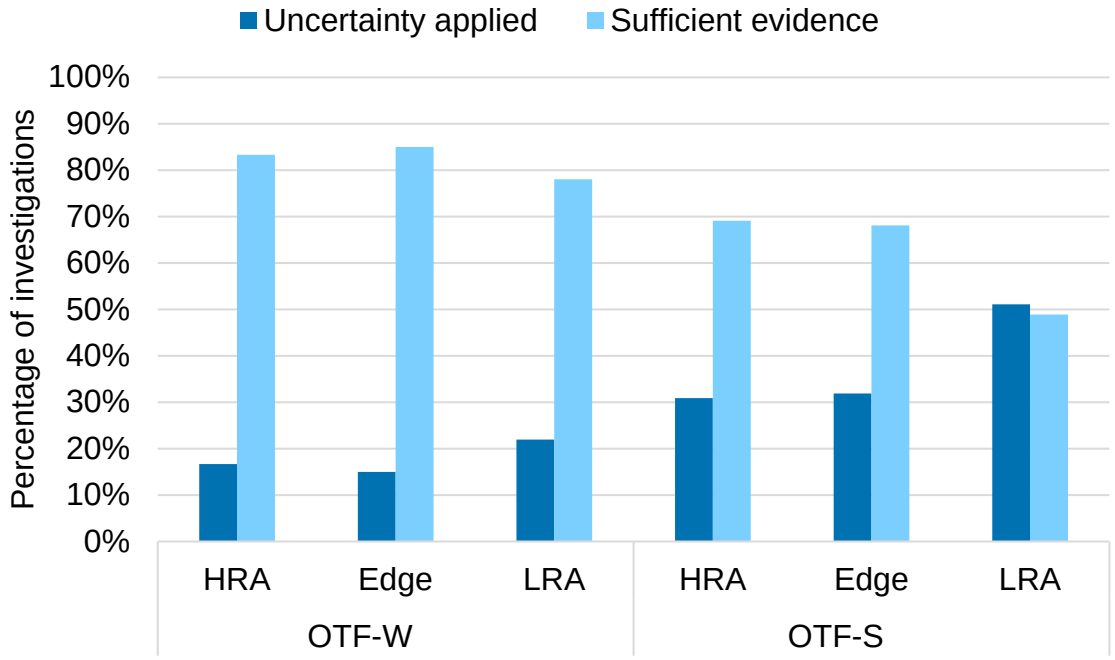


Figure 3.2.7. Percentage of risk pathway investigations (OTF-W and OTF-S incidents) that had sufficient evidence or required additional uncertainty to be applied in the LRA, Edge Area and HRA in 2020

The weighted assessments of infection sources outputs in Table 3.2.1 and Figures 3.2.8 to 3.2.10 are produced by combining the data from multiple herds. This presents the proportion of pathways in which each source was identified, weighted by the level of certainty that each source caused the introduction of TB. The outputs do not show the proportion of herds where each pathway was identified (this is skewed by the certainty calculation). Genotyping of *M. bovis* isolates can be a powerful tool in helping identify a likely source of infection, however genotypes are not determined for OTF-S herds. The inclusion of OTF-S herd incidents in these calculations increases the uncertainty in the outputs. As a result, the relative proportions of each risk pathway are very approximate and only broad generalisations should be made from these data. A more detailed description of this methodology is provided in the Explanatory Supplement.

At county level, the most common source of infection attributed within the HRA was badgers, with over or close to 70% in West Midlands (79%), Cornwall (73%) and Staffordshire (68%) (Table 3.2.1).

Within the Edge Area, the source of infection with the highest contribution varied between counties. Derbyshire (58%), Cheshire (65%), Oxfordshire (54%) and Northamptonshire (56%) all had more than half of the weighted source attributed to badgers. In some other

Edge Area counties, most notably Buckinghamshire (51%), the largest weighted proportion of source of infection was cattle movements (Table 3.2.1).

Investigations for the LRA are not aggregated to county level because of the low number of incidents and the high degree of uncertainty in each county.

Table 3.2.1 Number of incidents (OTF-W and OTF-S) that started in 2020, and the weighted contribution each source of infection made to those incidents, by Risk Area and HRA and Edge Area county

County	Badgers	Cattle movement	Contiguous infection	Residual infection in the herd	Domestic animals	Non-specific reactor	Fomite source	Other wildlife	Other or unknown	No. of DRFs
Cornwall	73.15%	4.81%	0.53%	3.23%	0.00%	0.73%	0.00%	5.76%	11.80%	137
Devon	46.76%	12.13%	1.17%	11.81%	0.09%	0.77%	0.14%	13.60%	13.54%	272
Dorset	49.85%	9.47%	0.38%	10.54%	0.00%	0.00%	0.00%	7.89%	21.88%	48
Gloucestershire	53.51%	10.82%	2.57%	6.95%	0.00%	1.39%	0.28%	5.15%	19.34%	60
Hereford & Worcester	53.10%	13.29%	1.26%	9.08%	0.00%	0.44%	0.70%	8.81%	13.31%	119
Avon	52.90%	2.85%	5.22%	13.81%	0.00%	2.99%	0.00%	4.71%	17.52%	39
Shropshire	65.77%	14.09%	1.88%	7.51%	0.09%	0.22%	0.09%	3.94%	6.41%	141
Somerset	49.46%	18.88%	3.46%	10.44%	0.00%	0.00%	0.15%	4.94%	12.68%	110
Staffordshire	67.54%	14.23%	1.50%	9.63%	0.00%	0.27%	0.00%	2.32%	4.52%	107
Wiltshire	43.46%	12.14%	1.28%	14.94%	0.00%	1.62%	0.00%	6.20%	20.34%	59
West Midlands	79.17%	14.58%	0.00%	0.00%	0.00%	0.00%	0.00%	6.25%	0.00%	2
HRA Overall	**56.11%**	**11.96%**	**1.64%**	**9.43%**	**0.03%**	**0.66%**	**0.15%**	**7.43%**	**12.58%**	**1,094**
Berkshire	49.73%	32.11%	2.88%	11.11%	0.00%	0.00%	0.00%	1.04%	3.13%	16
Buckinghamshire	8.67%	51.16%	0.71%	21.00%	0.00%	0.00%	0.83%	0.00%	17.62%	20
Cheshire	64.72%	8.21%	2.99%	8.57%	0.00%	0.69%	1.31%	0.46%	13.04%	138
Derbyshire	57.76%	18.08%	3.37%	7.94%	0.00%	0.44%	0.19%	1.85%	10.37%	143
Hampshire	15.77%	36.72%	3.41%	19.61%	0.00%	0.00%	0.00%	4.02%	20.48%	36
Leicestershire	34.89%	29.86%	2.47%	4.96%	0.29%	0.00%	3.29%	1.23%	23.01%	57
Northamptonshire	56.05%	26.62%	0.58%	6.59%	0.00%	0.45%	0.58%	2.82%	6.31%	37
Nottinghamshire	9.72%	20.34%	0.00%	2.78%	0.00%	0.00%	1.39%	3.82%	61.95%	12
Oxfordshire	53.62%	21.07%	0.18%	20.11%	0.00%	0.00%	0.00%	0.97%	4.05%	69
East Sussex	36.97%	27.03%	3.81%	6.57%	0.00%	3.71%	1.15%	0.00%	20.77%	40
Warwickshire	43.57%	19.44%	1.44%	9.00%	0.00%	0.00%	1.06%	6.52%	18.96%	57
Edge Area Overall	**48.91%**	**21.04%**	**2.38%**	**10.15%**	**0.03%**	**0.52%**	**0.89%**	**1.84%**	**14.24%**	**625**
LRA Overall	**8.90%**	**39.36%**	**5.56%**	**3.22%**	**0.13%**	**4.52%**	**2.85%**	**5.48%**	**29.98%**	**131**
England Overall	**50.21%**	**16.89%**	**2.14%**	**9.19%**	**0.03%**	**0.88%**	**0.58%**	**5.38%**	**14.32%**	**1,850**

The calculated contributions of each source of infection for the HRA, Edge Area and LRA TB incidents are depicted in Figures 3.2.8 to 3.2.10 respectively. Within the HRA, badgers constituted 56.1% of the weighted opinion, while cattle movements accounted for 12.0% of the weighted opinion (Figure 3.2.8). In the Edge Area, the source was still most strongly ascribed to badgers (48.9%), but cattle movements (21.0%) were also identified as posing a high risk of introduction (Figure 3.2.9). Conversely, in the LRA the contribution of badgers was much lower at only 8.9%. Overall, TB incidents in the LRA were most strongly attributed to cattle movements (39.4%). However, in the LRA 'Other or Unknown' sources were highest, at 30.0% compared to 12.6% in the HRA and 14.2% the Edge Area (Figures 3.2.8 to 3.2.10).

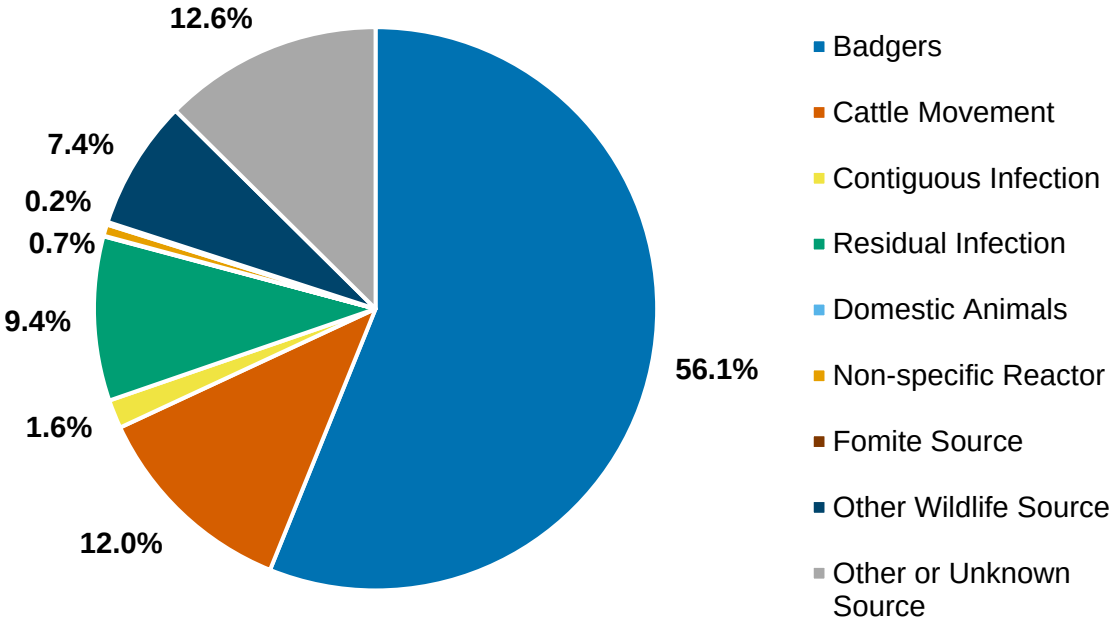


Figure 3.2.8 Summary of the weighted source of infection attributed for all TB incidents (both OTF-W and OTF-S with a provisional or final pathway) that started in 2020, in the HRA (n=1,094)

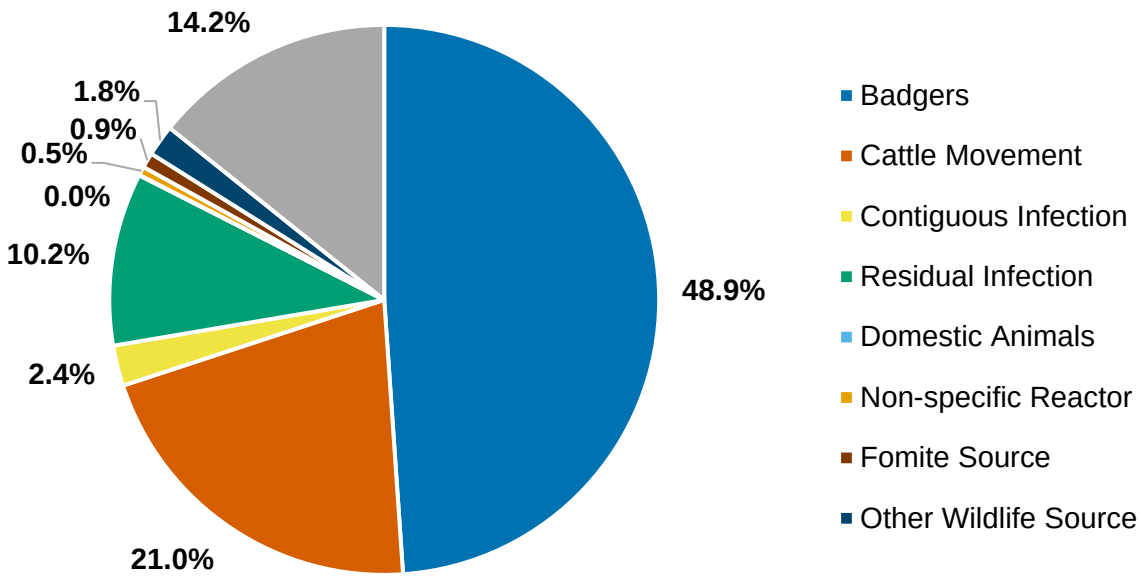


Figure 3.2.9 Summary of the weighted source of infection attributed for all TB incidents (both OTF-W and OTF-S with a provisional or final pathway) that started in 2020, in the Edge Area (n=625)

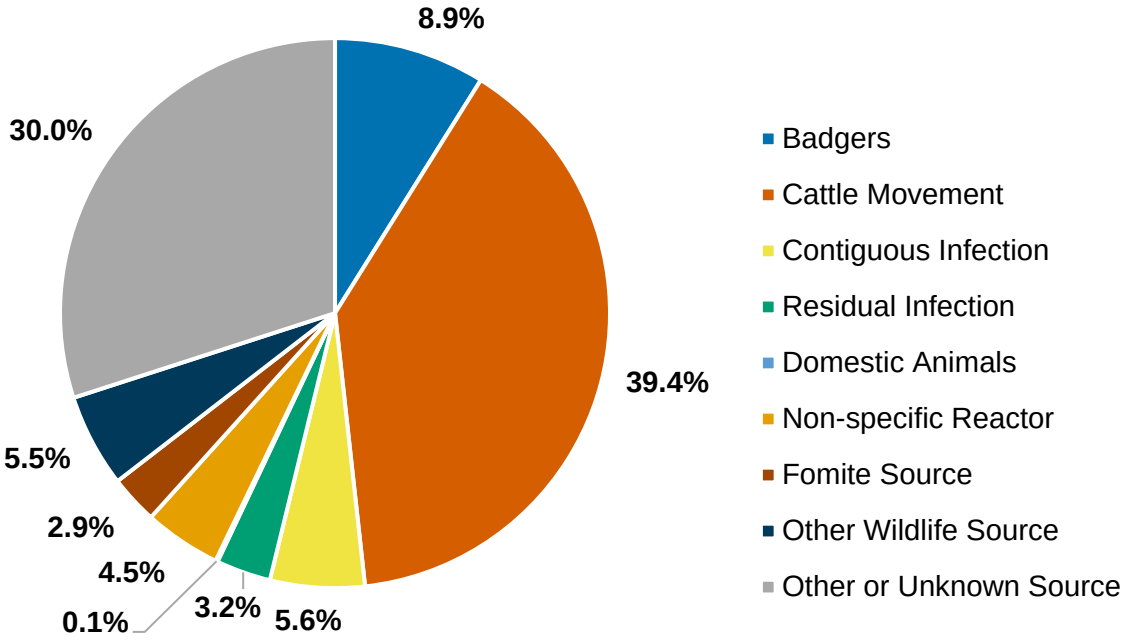


Figure 3.2.10 Summary of the weighted source of infection attributed for all TB incidents (both OTF-W and OTF-S with a provisional or final pathway) that started in 2020, in the LRA (n=131)

The most likely source of infection in individual TB incidents

Spatial differences in the most likely source of infection for new TB herd incidents in 2020 are examined in Figure 3.2.11. TB incidents that did not have a single source achieving more than 50% of the ascribed certainty are marked as an unclear source. Where two sources were ranked equally as the most likely source for an incident, the incident is also reported as ‘unclear’. TB incidents within the HRA were most often attributed to wildlife.

In the LRA, cattle movements were the most significant source of infection, although in the LRA the percentage of incidents with an unclear source is high. This is not surprising as most TB incidents in the LRA are OTF-S, where no *M. bovis* isolates are available for genetic analysis. A small number of incidents in the LRA with a likely wildlife source (including OTF-S incidents where the evidence may be limited) occurred in Cumbria, Greater Manchester, West Yorkshire, Lincolnshire and West Sussex. These are all located in potential or confirmed hotspot areas, or specific areas of concern identified in 2020. For more details see chapter 4.3 (Epidemiology of TB in the Low Risk Area.

Within the Edge Area, TB incidents bordering the HRA, and in the north of the area were more often ascribed to badgers, while those towards the LRA and in the south and east were more commonly linked to the movement of cattle. In contrast to this trend, a few notable clusters of badger attributed infection persist close to the LRA border in Leicestershire and Northamptonshire, close to the southwest Lincolnshire hotspot area (known as ‘HS23’). Further details on the relevant risk pathways for each county within the Edge Area and LRA can be found in the 2020 Edge Area and LRA year-end epidemiology reports.

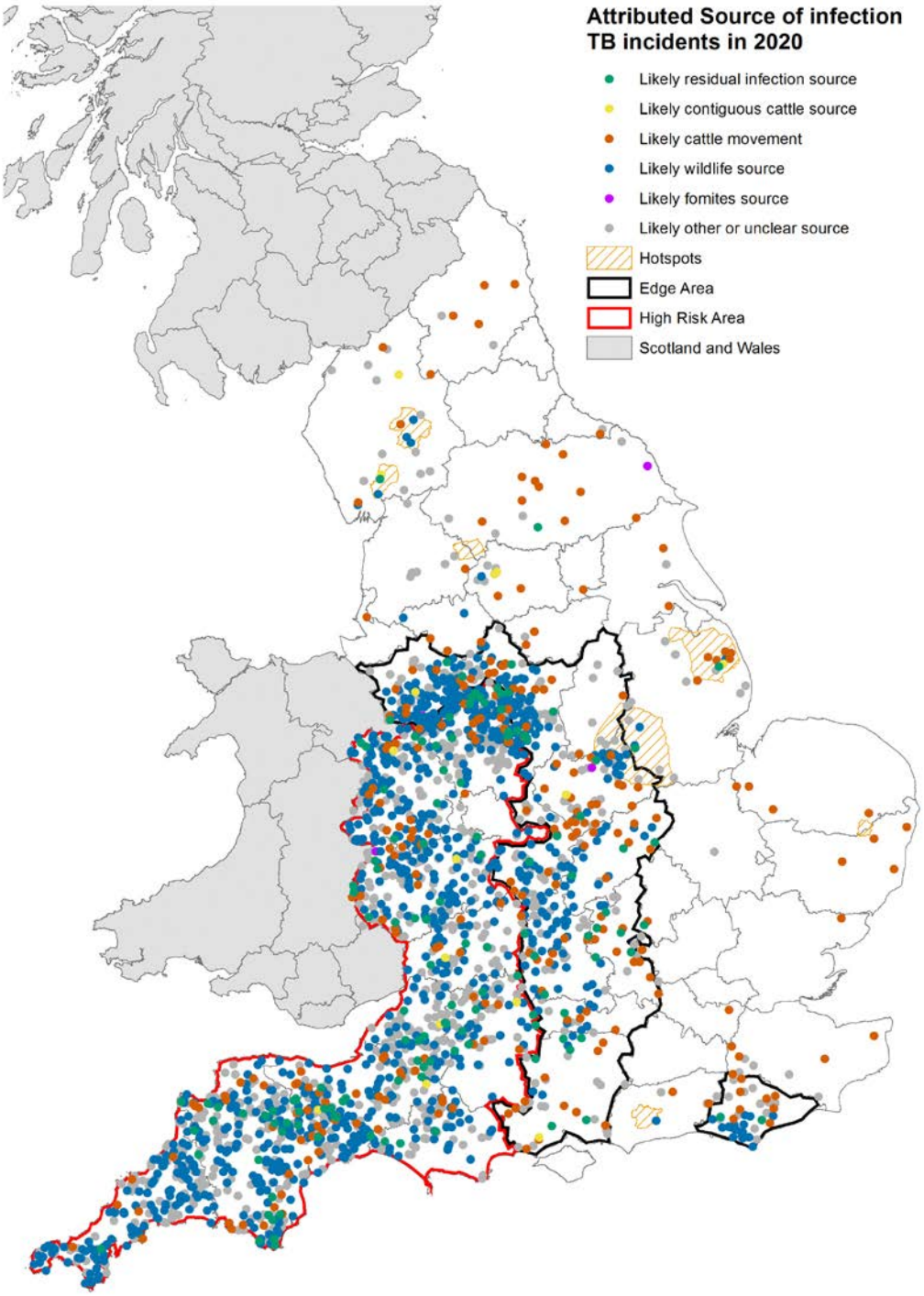


Figure 3.2.11. The source of infection recorded with the highest level of certainty, selected by informed veterinary opinion, for all TB incidents (both OTF-W and OTF-S) that started in 2020 and had the disease report form (DRF) survey completed.

Wildlife was the most likely source of infection ascribed to most TB incidents in the HRA.

- Cattle movements were the predominant most likely source of infection ascribed to new TB incidents in the LRA, closely followed by unclear sources.

3.3 Finding infected herds: Effectiveness of different TB surveillance streams

- In 2020, a total of 5.3 million TB tests (including carcases of commercially slaughtered non-reactor cattle subject to *post mortem* meat inspection) were carried out in bovine animals in England; half of which were in the HRA.
- In the HRA, almost half (42%) of all TB incidents were detected by Area and Herd Risk surveillance tests, whereas in the Edge Area 56% of all TB incidents were detected by Routine surveillance tests. In the LRA, half of all TB incidents and OTF-W TB incidents were detected by Area and Herd Risk surveillance.
- In England overall, the total number of incidents disclosed by Slaughterhouse (SLH) surveillance stayed the same in 2020 compared to 2019, but the proportion of confirmed TB incidents increased from 19% to 29% in the same period. The proportion of TB incidents disclosed through SLH surveillance marginally decreased in the LRA in 2020 compared to 2019. In the HRA and Edge Area, the proportion of all TB incidents that were disclosed through SLH surveillance decreased slightly in 2020 compared to 2019.
- Within the Area and Herd Risk surveillance stream, 81% and 59% of TB incidents in the HRA and Edge Area, respectively, were detected by post-incident tests compared to 15% in the LRA. This reflects the difficulty of clearing infection from incident herds (and avoiding re-infection from environmental sources) in the HRA and Edge Area. It also highlights the need for better understanding of the factors that lead to recrudescence on farms.
- Radial tests made up the majority (59%) of TB incidents detected by Area and Herd risk tests in the LRA, but this was a decrease compared to 2019 (79%). Some of the incidents detected this way are likely to be the result of lateral spread. As such, reducing transmission from local cattle movements and contact with contiguous cattle could reduce TB incidence in the LRA.
- In the HRA, 39% of OTF herds with only Inconclusive Reactor (IR) test results went on to have an incident within the following 15 months. A substantial proportion was similarly affected in the Edge Area (32%). This indicates that IRs are an important predictor of the presence of infection and supports the policy of restricting IRs to the herd in which they are disclosed for life.
- Trade & other surveillance tests disclosed less than 10% of the TB incidents in the HRA and Edge Area (mainly pre-movement tests), but a higher proportion of incidents in the LRA (18%, although representing only 24 TB incidents).
- Cattle in all risk areas are predominantly moved within, rather than between, risk areas. A total of 291 new TB incidents were detected in 2019 by pre-movement tests (81% occurred in the HRA; 18% in the Edge Area and 1% in the LRA).

Surveillance Overview

Bovine tuberculosis (TB) is usually a slowly progressing disease in which infected individuals rarely display clinical signs, although they can spread infection during that time. Surveillance for TB is based on detecting changes that occur before clinical signs become evident. This includes looking for immunological markers of infection in live cattle and pathology (lesions) characteristic of *M. bovis* infection in dead animals. The TB surveillance programme involves both active and passive surveillance. Active surveillance is comprised of live animal tests carried out on the farm. Passive surveillance occurs in the slaughterhouse, where commercially slaughtered non-reactor animals undergo routine post-mortem meat inspection for TB and other notifiable diseases. Slaughterhouse inspection is carried out by the Food Standards Agency (FSA) meat inspectors and veterinarians. On-farm testing is generally carried out by Official Veterinarians appointed by the APHA or, occasionally by APHA vets or Animal Health Officers. The main screening test for TB is the Single Intradermal Comparative Cervical Tuberculin test (SICCT). This test measures the animals' immune response to an injection of bovine tuberculin into the deep layer of the skin compared to another injection of avian tuberculin and is frequently referred to as 'skin testing'.

TB surveillance activities in England have been categorised into four different streams for the purposes of this report (see detailed description of the surveillance streams and associated tests in the TB Explanatory Supplement). In brief, the four surveillance streams are:

- **Routine:** active surveillance through systematic field (skin) testing of OTF herds at a pre-defined interval of six, 12 or 48 months.
- **Area and Herd Risk:** more targeted active surveillance with additional field (skin) testing of OTF herds or individual cattle because of evidence that they are at greater risk of being infected; including contiguous herd tests, radial tests, hotspot tests, tracing tests and check tests after a TB incident.
- **Slaughterhouse:** *post mortem* inspection of all cattle commercially slaughtered for human consumption, as well as cattle that die on farm and are disposed of at an animal-byproduct processing facility.
- **Trade and Other:** active surveillance through skin tests of individual animals moved between OTF herds. Generally conducted to enable cattle trade such as: compulsory pre- and post-movement testing of individual cattle, private tests requested by farmers and tests at artificial insemination centres. This surveillance stream was referred to as proactive surveillance in earlier reports.

Over 5 million cattle were kept in nearly 45,000 active cattle holdings in England in 2020. Just under 4 million individual TB skin tests were carried out on live animals in OTF herds. Furthermore, over 1 million cattle from cattle holdings in England were inspected at *post mortem*. These are all similar to levels seen in 2019, suggesting that the public health

measures adopted to control the COVID-19 outbreak and the extensions granted by APHA for routine skin testing (see Preface 2.1) did not disrupt the TB surveillance programme in cattle.

Overall, this equated to over 74,000 OTF herd testing events in 2020, which resulted in the detection of 3,165 new TB incidents. Table 3.3.1 displays the number of tests performed and TB incidents disclosed through surveillance of OTF herds in each risk area.

Figure 3.3.1 and Table 3.3.1 show the relative proportions of individual cattle tests, herd tests, reactors and incidents for the four surveillance streams. For the purposes of this analysis, each test has been recorded as a test in the herd, even if it was an animal-level test, e.g., Tracing tests (Area and Herd Risk surveillance stream) or pre-movement tests (Trade & other surveillance stream).

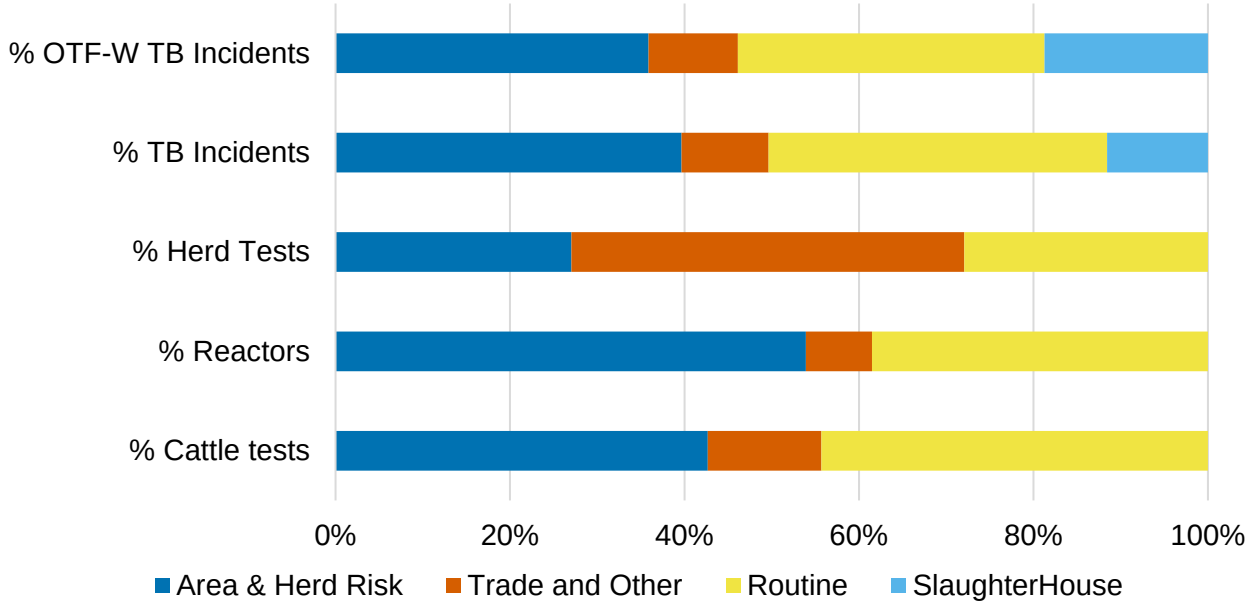


Figure 3.3.1. Proportion of herd and cattle tests, TB incidents in herds and individual reactors in England detected through each TB surveillance stream

In addition to the tests reported in Table 3.3.1, a further 2,353 herds received tests while under movement restrictions due to a TB incident, or in parallel to routine surveillance and control tests (for example interferon gamma (IFN-γ) testing). These have been excluded from Tables 3.3.1-3.3.4 as they are not generally used to detect new infection in OTF herds. Excluded test types include: short interval (SI) tests used to eradicate infection from a TB incident herd, inconclusive reactor (IR) re-tests, IFN-γ tests, and tests occasionally used on an approved segregated group (ASG) of a herd, often during a TB incident. Twenty four new TB incidents were disclosed by these test types, mostly through the testing of cattle at epidemiologically-linked premises during IFN-γ testing (n=11).

Table 3.3.1 shows all tests and herd tests, whether they are:

- herd-level and conducted on all or the majority of animals in a herd e.g. whole herd test (WHT) or routine herd tests (RHT) conducted as part of Routine Surveillance
- animal-level, e.g. tracing tests conducted as part of Area and Herd Risk Surveillance
- pre-movement tests conducted as part of Trade & Other Surveillance
- slaughterhouse *post-mortem* inspection of all cattle slaughtered for human consumption.

In England overall, Area and Herd Risk surveillance testing detected more reactors, in 2020 (Figure 3.3.1), but was followed closely by Routine surveillance testing when detecting TB incidents and OTF-W incidents. Inversely, Routine surveillance contributed to a slightly higher proportion of overall cattle tests in England than Area and Herd risk surveillance. This highlights the value of targeting higher risk herds through specific tests e.g. tracing tests (Table 3.3.1).

In the HRA, almost half (42%) of all incidents were detected by Area and Herd Risk surveillance and just over one third of incidents by Routine (annual) surveillance, in contrast to the Edge Area, where most (55%) TB incidents were detected by Routine (six-monthly or annual) surveillance.

In the LRA, half of all TB incidents and OTF-W TB incidents were detected by Area and Herd Risk surveillance. Just over one in four TB incidents were detected by Routine (four-yearly or annual) surveillance (27%), reflecting the number of tests conducted in the risk area. Routine testing is only conducted every four years in the majority of LRA herds because of the lower force of infection compared to elsewhere.

The proportion of incidents detected through Trade & other surveillance was almost twice as high in the LRA than in the other TB risk areas. This highlights the importance of pre- and post-movement testing of cattle moving into the LRA from areas with a higher TB risk. The proportion of TB incidents disclosed by Slaughterhouse surveillance in the LRA was 6%, a marginal decrease compared to 2019. However this type of surveillance is more important in the LRA than in the other risk areas, because of the lower frequency of Routine surveillance (Table 3.3.1).

Table 3.3.1.a Total number of tests, reactors, and TB incidents by risk area and surveillance stream in 2020 in the High Risk Area of England.

Surveillance Stream	Herd tests N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Routine	10,741 (24.7)	822 (34.9)	474 (31.7)	7.7	2.3
Area & Herd Risk	12,325 (28.3)	985 (41.8)	561 (37.6)	8.0	0.0
Slaughterhouse	0 (0)	312 (13.2)	305 (20.4)	0.0	0.0
Trade & other	20,506 (47.1)	239 (10.1)	154 (10.3)	1.2	1.4

Surveillance Stream	Herd tests N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
HRA Total	**43,572 (58.6)**	**2,358 (74.5)**	**1,494 (78.9)**	**4.2**	**0.9**
England Total	**74,354**	**3,165**	**1,893**	**2.0**	**1.7**

Table 3.3.1.b Total number of tests, reactors, and TB incidents by risk area and surveillance stream in 2020 in the Edge Area of England.

Surveillance Stream	Herd tests N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Routine	6,837 (36.6)	370 (55.1)	187 (52.4)	5.4	1.1
Area & Herd Risk	4,339 (23.3)	203 (30.2)	96 (26.9)	4.7	1.9
Slaughterhouse	0 (0)	46 (6.8)	43 (12)	0.0	0.0
Trade & other	7,479 (40.1)	53 (7.9)	31 (8.7)	0.7	1.1
Edge Total	**18,655 (25.1)**	**672 (21.2)**	**357 (18.9)**	**2.7**	**1.0**
England Total	**74,354**	**3,165**	**1,893**	**2.0**	**1.7**

Table 3.3.1.c Total number of tests, reactors, and TB incidents by risk area and surveillance stream in 2020 in the Low Risk Area of England.

Surveillance Stream	Herd tests N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Routine	3,181 (26.2)	36 (26.7)	5 (11.9)	1.1	0.1
Area & Herd Risk	3,433 (28.3)	67 (49.6)	21 (50.0)	2.0	0.3
Slaughterhouse	0 (0)	8 (5.9)	7 (16.7)	0.0	0.0
Trade & other	5,513 (45.5)	24 (17.8)	9 (21.4)	0.4	0.3
LRA total	**12,127 (16.3)**	**135 (4.3)**	**42 (3.4)**	**0.9**	**0.2**
England total	**74,354**	**3,165**	**1,236**	**2.0**	**1.8**

Over the past five years, the relative proportion of new TB incidents detected by different surveillance streams has varied more in the LRA and Edge Area compared to the HRA. This is due in part to statistical fluctuations due the relatively low number of TB incidents, especially in the LRA. In the Edge Area, recent surveillance policy changes are also likely to be a contributing factor.

The proportion of new incidents detected by Routine surveillance in the Edge Area increased between 2016 and 2017 (Figure 3.3.2). This rise followed the introduction of routine annual surveillance testing in the area in 2013. Between 2018 and 2020, following the introduction of six-monthly testing in parts of the Edge Area, the proportion of new incidents detected by Routine surveillance fell slightly.

The proportion of incidents detected through Trade & other surveillance in the LRA doubled in 2017 compared to 2016 (following the gradual bedding in of mandatory post-movement testing in April 2016), decreasing slightly between 2018 and 2019 before rising back to similar levels from 2017 in 2020 (17.8%).

In the LRA, the proportion of new TB incidents detected through Slaughterhouse surveillance decreased in 2020 compared to 2019, continuing the downward trend which has been occurring since 2015. In England overall, the proportion of TB incidents detected by Slaughterhouse surveillance has dropped by more than a quarter over the past five years (15.7% in 2015 vs 11.6% in 2020). This could be explained by enhanced on-farm surveillance and control regimes adopted since 2013/14, detecting infected cattle at earlier stages of infection on farm.

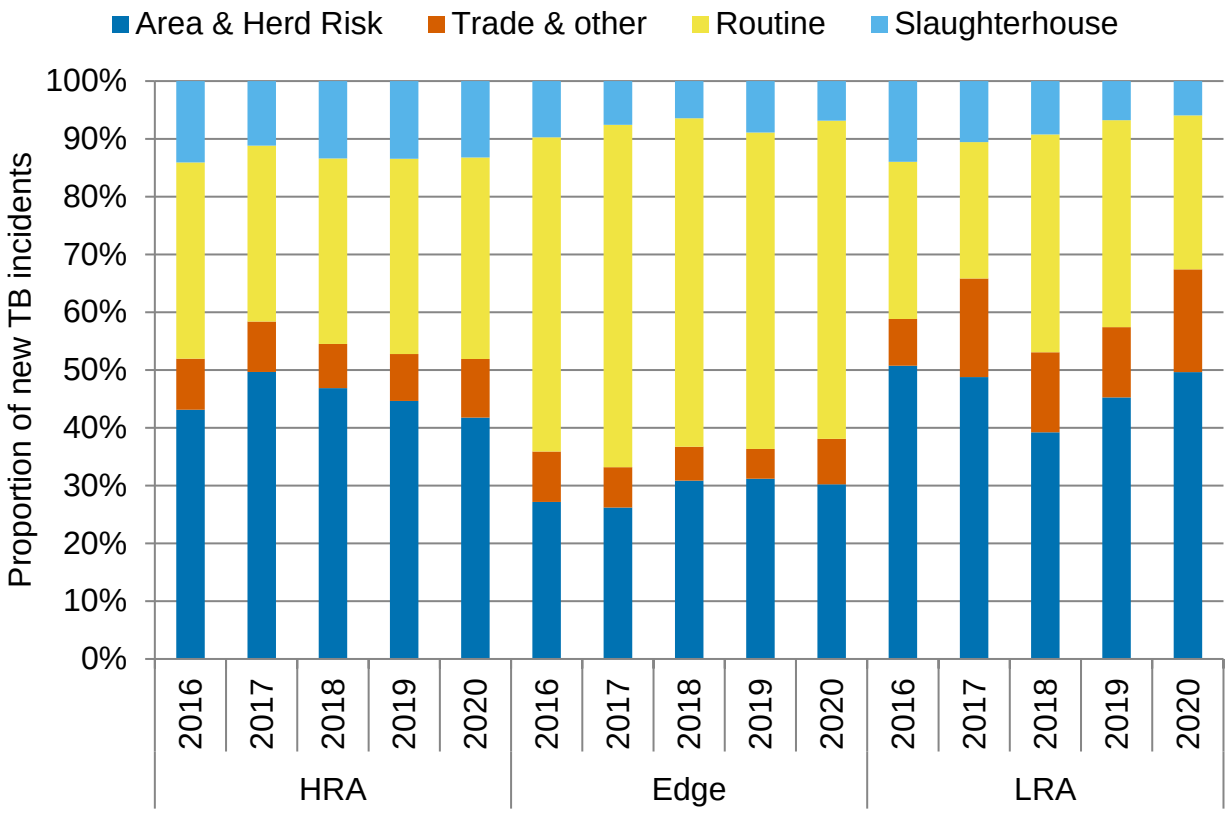


Figure 3.3.2 Annual proportions of new TB incidents detected by different surveillance streams within each risk area from 2016 to 2019

Routine Surveillance Stream

The Routine surveillance stream includes WHTs and RHTs conducted in OTF herds and tests conducted in new herds (NH). WHTs and RHTs are performed at scheduled intervals of six months or one year (WHTs) and four years (RHTs). WHTs are conducted in all cattle over six weeks old in the HRA and Edge Area; and in high risk herds in the LRA. RHTs in the LRA are conducted mainly in breeding stock.

Proportionally more TB incidents were disclosed per herd test in the HRA than in the Edge Area, by both WHT and NH tests. This is likely to be due to a higher background force of infection in the HRA (Tables 3.3.1 and 3.3.2a and b).

In the LRA, most herds receive RHTs at four-yearly intervals. New Herd tests disclosed 5.6% of all TB incidents in this risk area, but none were OTF-W TB incidents. Just under twice as many TB incidents per 100 herd tests were detected by WHTs (1.9) compared to RHTs (1.1), as herds receiving WHTs in the LRA are higher risk (Table 3.3.2c).

Table 3.3.2.a Performance of main test types within the Routine surveillance stream in the HRA in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
New Herd Tests	464 (4.3)	16 (1.9)	13 (2.7)	51 (2.6)	3.4	2.9
Whole Herd Tests	10,277 (95.7)	806 (98.1)	461 (97.3)	1,943 (97.4)	7.8	2.3
HRA Routine Total	**10,741**	**822**	**474**	**1,994**	**5.6**	**2.6**

Table 3.3.2.b Performance of main test types within the Routine surveillance stream in the Edge Area in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 herd test events	Reactors per 1000 cattle tested
New Herd Tests	214 (3.1)	5 (1.4)	3 (1.6)	3 (0.4)	2.3	0.5
Whole Herd Tests	6,622 (96.9)	365 (98.6)	184 (98.4)	777 (99.6)	5.5	1.1
Edge Routine Total	**6,836**	**370**	**187**	**780**	**3.9**	**0.8**

Table 3.3.2.c Performance of main test types within the Routine surveillance stream in the LRA in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 herd test events	Reactors per 1000 cattle tested
New Herd Tests	348 (10.9)	2 (5.6)	0 (0)	0 (0)	0.6	0.0
Whole Herd Tests	211 (6.6)	4 (11.1)	0 (0)	2 (7.4)	1.9	0.1
Routine Herd Tests	2,622 (82.4)	30 (83.3)	5 (100)	25 (92.6)	1.1	0.1
LRA Routine Total	**3,181**	**36**	**5**	**27**	**1.2**	**0.1**

Note: Test types include: New Herd Tests (VE-CT-NH1, VE-CT-NH2), Whole Herd Tests (VE-WHT, VE-WHT2), Routine Herd Tests (VE-RHT24/36, VE-RHT48).

Area and Herd Risk Surveillance Stream

The Area and Herd Risk surveillance stream comprises tests carried out in higher risk situations. This surveillance stream includes tests in unrestricted herds defined as higher risk such as herds subject to post-incident testing and in permanently restricted herds (Approved Finishing Units (AFUs)); as well as tests for assessing potential source and

spread following the detection of a TB incident, for example tracing, contiguous herds, hotspot, and radial tests. Only post-incident tests at six and 12 months after regaining OTF herd status are included here, short interval tests are excluded.

In the HRA, most Area and Herd Risk TB incidents and OTF-W TB incidents were detected by post-incident tests, followed by contiguous herd tests (Table 3.3.3a), as in 2019. Relatively few source tracing tests were carried out in the HRA (less than one per cent of the Area and Herd risk surveillance stream). However, these tests detected the highest amount of incidents per 100 herd tests (22.1) and the highest detection rate for reactors, with 5.7 positive reactors disclosed for every 1,000 cattle tested (Table 3.3.3a).

In the Edge Area, over half of TB incidents and over three quarters of OTF-W TB incidents were detected by post-incident tests in this surveillance stream, similar to in 2019 (Figure 3.3.3). Similarly to the HRA, source tracing tests detected the high number of TB incidents per 100 test events despite representing less than 0.5% of all test events.

In the LRA, just over half of Area and Herd Risk herd tests carried out were radial tests, and they disclosed a similar proportion of TB incidents and OTF-W incidents (although not necessarily confirmed as the same *M. bovis* genotype as the index case). Radial tests enable the early detection of any local lateral spread of infection from the index OTF-W incident herd. They also provide evidence of the presence or absence of endemic disease around such incidents in the LRA. As for the other risk regions, source tracing tests detected the highest proportion of TB incidents per 100 test events despite representing less than 1% of total test events.

Post-incident tests, radial tests, contiguous herd tests and tracing tests will not be recorded as such if conducted at the same time as another herd test (e.g. a WHT) and so will be underreported as test types.

Potential TB Hotspot tests are used in the LRA, in response to an OTF-W incident (or cluster of incidents) of obscure/uncertain origin. These tests apply to herds identified in an area delineated by APHA, comprising at least a 3 km radius around the index herd. A total of 345 herd hotspot tests were carried out in the LRA in 2020 (totalling 59,900 cattle tests) with eight TB incidents each disclosed by a single reactor, four of which were OTF-W. One further TB incident was disclosed by hotspot testing following the detection of an inconclusive reactor at two tests (2xIR).

Table 3.3.3.a Percentage of main test types within the Area and Herd Risk surveillance stream in the HRA in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
Contiguous tests	964 (9.0)	121 (12.5)	79 (14.2)	345 (12.2)	12.6	3.0

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
Forward Tracing tests	5,193 (48.5)	38 (3.9)	21 (3.8)	66 (2.3)	0.7	2.7
Backward tracing tests	86 (0.8)	19 (2)	14 (2.5)	86 (3.0)	22.1	5.7
Post-incident tests	4,329 (40.4)	782 (80.8)	439 (78.7)	2,584 (91.4)	18.1	3.0
Check tests	118 (1.1)	7 (0.7)	5 (0.9)	42 (1.5)	5.9	1.7
AFU tests	15 (0.1)	1 (0.1)	0 (0)	1 (0)	6.7	0.6
HRA Area and Herd Risk Total	**10,705**	**968**	**558**	**3,124**	**11.0**	**2.8**

Table 3.3.3.b Percentage of main test types within the Area and Herd Risk surveillance stream in the Edge Area in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
Contiguous tests	18 (0.5)	1 (0.5)	79 (14.3)	4 (0.1)	5.6	1.9
Radial tests	1,387 (36.4)	69 (35.0)	0 (0)	148 (4.7)	5.0	1.0
Forward Tracing tests	1,604 (42.1)	8 (4.1)	21 (3.8)	12 (0.4)	0.5	1.9
Backward tracing tests	17 (0.4)	2 (1.0)	14 (2.5)	3 (0.1)	11.8	1.0
Post-incident tests	744 (19.5)	115 (58.4)	439 (79.2)	427 (13.7)	15.5	2.7
Check tests	43 (1.1)	2 (1.0)	1 (0.2)	7 (0.2)	4.7	0.9
Edge Area and Herd Risk Total	**3,813**	**197**	**554**	**601**	**7.2**	**1.6**

Table 3.3.3.c Percentage of main test types within the Area and Herd Risk surveillance stream in the LRA in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
Radial tests	1,678 (52.0)	39 (59.1)	11 (52.4)	55 (32.7)	2.3	0.3
Hotspot tests	345 (10.7)	9 (13.6)	4 (19.0)	8 (4.8)	2.6	0.1
Spread Tracing tests	978 (30.3)	5 (7.6)	4 (19.0)	5 (3.0)	0.5	1.2
Source tracing tests	20 (0.6)	2 (3.0)	1 (4.8)	2 (1.2)	10.0	1.0
Post-incident tests	180 (5.6)	10 (15.2)	1 (4.8)	13 (7.7)	5.6	0.3
Check tests	25 (0.8)	1 (1.5)	0 (0)	1 (0.6)	4.0	0.1
LRA Area and Herd Risk Total	**3,226**	**66**	**21**	**84**	**4.2**	**0.5**

Note: Table 3.3.3. test types include: Contiguous tests (VE-CON, VE-CON12), Radial tests (VE-RAD, VE-RAD6, VE-RAD12), Hotspot tests (VE-HS1, VE-HS2), Forward Tracing tests (VE-TR), Backward tracing tests (VE-CT(EM)), Post-incident tests (VE-6M, VE-12M), Check tests (VE-CT(I-I)), AFU tests (VE-TBU).

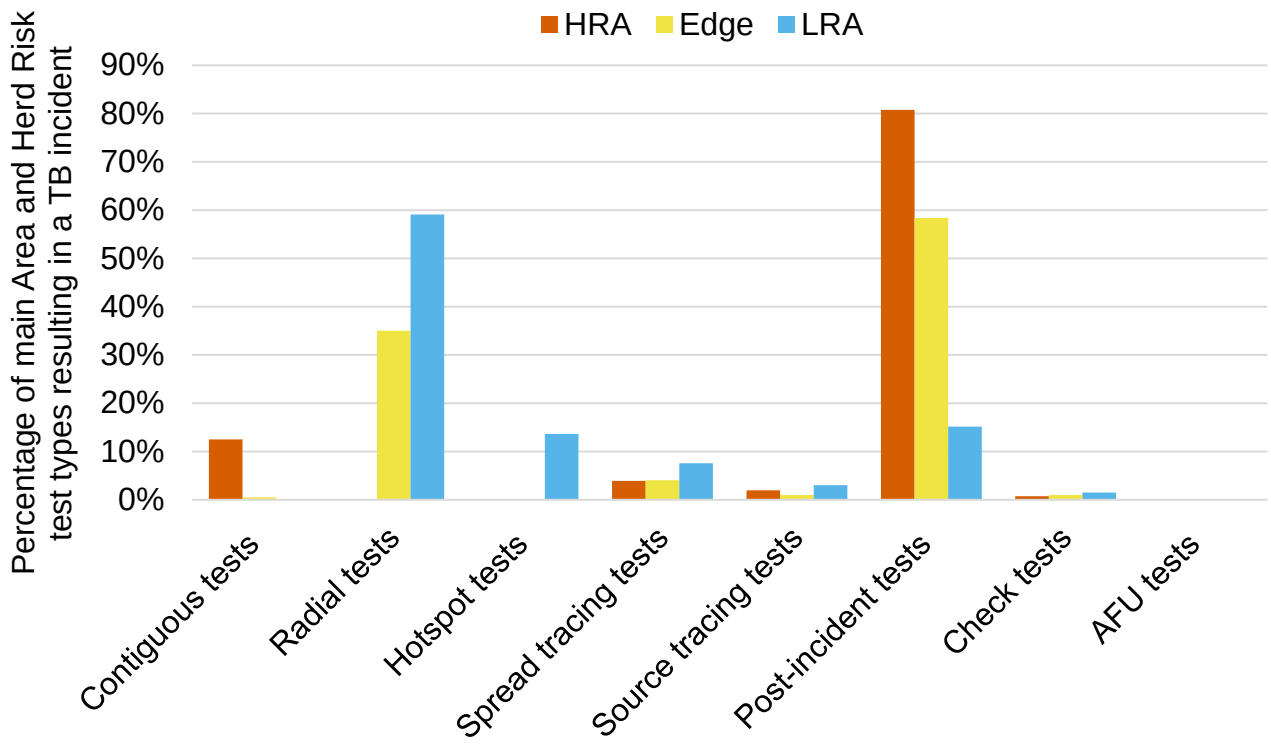


Figure 3.3.3 Percentage of TB incidents by main test types within the Area and Herd Risk surveillance stream by surveillance risk area in 2020

Slaughterhouse Surveillance Stream

Slaughterhouse (SLH) surveillance is provided by compulsory post-mortem inspection (visual inspection of carcases with palpation and incision of lymph nodes) of all cattle slaughtered for human consumption, followed by attempts to isolate *M. bovis* in bacteriological culture from the suspected tuberculous lesions. It is an ongoing, supplementary surveillance stream that may detect infected cattle missed by active live animal surveillance.

The proportion of new TB incidents disclosed by SLH surveillance depends on the background force of infection and also on the frequency and efficacy of live animal surveillance tests that take place in cattle herds. Further analysis of the efficacy of slaughterhouse surveillance and monitoring performance may be found in the Slaughterhouse report. Herds are tuberculin tested at least four times more frequently in the Edge Area and HRA compared to the LRA. Therefore, a higher proportion (but lower number) of TB incidents might be expected to be detected at slaughter in the LRA due to undisclosed infection in the live animal. However, this was not the case in 2019 and 2020. Contrary to the pattern seen in previous years, the LRA no longer had the highest proportion of OTF-W incidents detected by SLH Surveillance (17%) in 2020 compared to the HRA and Edge (20% and 12% respectively). The proportion of *all* TB incidents

disclosed by SLH surveillance was highest in the HRA (13%), followed by the Edge Area (7%) and LRA (6%); likely reflecting the high background force of infection in the HRA.

SLH surveillance predominantly detects OTF-W cases, due to disclosure by the identification of visible lesions at slaughter. Every year, a small number of OTF-S incidents are also reported, that were initially triggered in the slaughterhouse. These are cases where visible lesions detected in the slaughterhouse are subsequently culture negative, but a check test in the source herd identified reactors, which do not themselves have visible lesions.

Since 2010, the proportion of OTF-W TB incidents disclosed through SLH surveillance in the HRA has remained fairly consistent. In the Edge Area and LRA, by contrast, there has been greater fluctuation (Figure 3.3.4).

The proportion of OTF-W TB incidents disclosed through SLH surveillance in the Edge Area fell from 14% in 2019 to 12% in 2020. The Edge Area proportion in 2020 continues to be lower than the HRA and LRA and under half the proportion disclosed in 2011 (29%). The fall in Edge Area cases detected at slaughter since 2011 is most likely due to the increased frequency of routine surveillance in this area.

In the LRA, the proportion of OTF-W incidents detected has been falling consistently since 2016, although it was still higher than the proportions of OTF-W incidents seen in other risk regions in England.

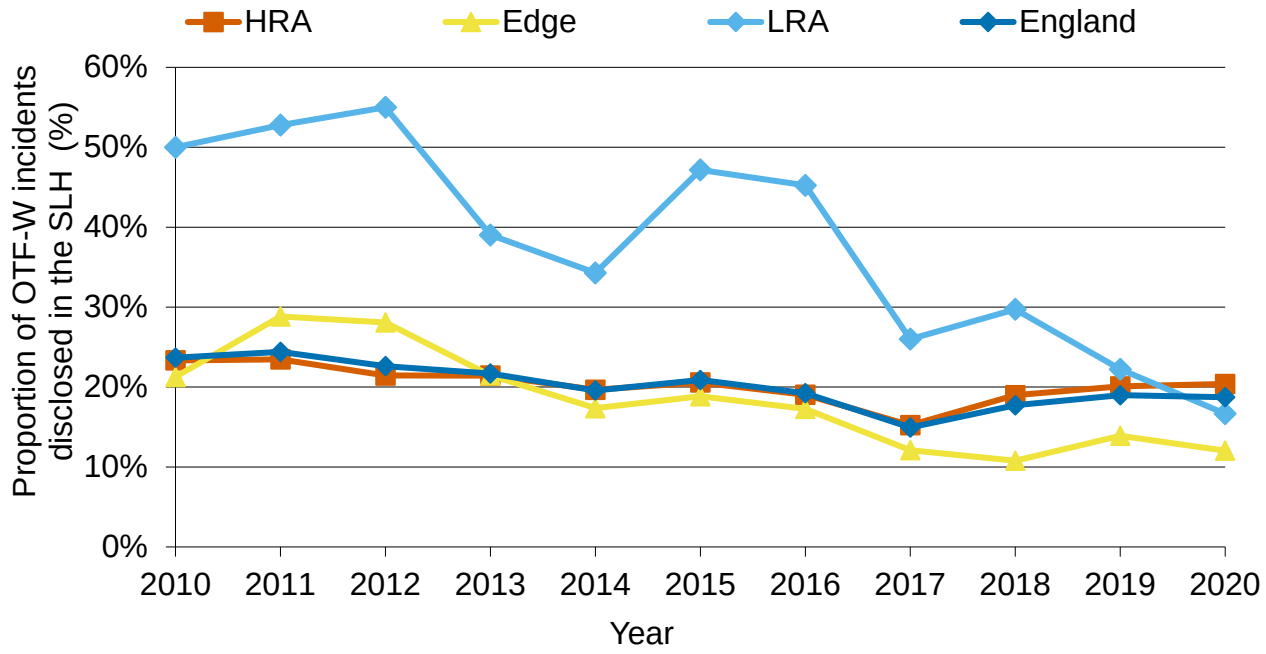


Figure 3.3.4 The proportion of new OTF-W TB incidents that were disclosed by slaughterhouse surveillance from 2010 to 2020, by risk area

Trade & Other Surveillance Stream

Trade surveillance includes international trade tests, private tests, tests at artificial insemination centres and pre- and post-movement testing. Typically, only single animals or a batch of animals are tested and so are referred to as ‘animal’ tests rather than herd tests.

Large numbers of cattle movements take place across the country, but not all cattle require pre-movement testing (PrMT). If an animal has been subject to a government-funded herd test within the required timeframe this qualifies as a PrMT and a further bespoke PrMT funded by the farmer is not required. This means that the total number of animal tests conducted prior to a movement cannot be counted within the surveillance data. Trade & other tests detect the smallest proportion of TB incidents of all the surveillance streams (10%). However, this amounts to a relatively high rate of reactors detected per 1,000 tests (1.4 in the HRA, where most tests in this stream are conducted). In any case, the main purpose of Trade & other tests is to reduce the risk of disease spread, for example into the LRA, with the additional detection of TB-infected herds missed by routine surveillance tests being a consequence of that.

As expected, the majority of Trade & other surveillance cattle tests were conducted in the HRA (61%) compared to 22% in the Edge Area and 16% in the LRA (Table 3.3.1). In the HRA and Edge Area, virtually all Trade & other surveillance stream tests in 2020 were PrMTs (Table 3.3.4), whereas post-movement tests and PrMTs comprised the majority of Trade & other surveillance stream tests in the LRA. In April 2016, a change in policy made post-movement testing of cattle entering the LRA from annual or more frequently tested areas of GB compulsory.

Private tests represented less than 1% of cattle tests in 2020 (slightly less than in 2019) and disclosed no TB incidents. International trade tests (pre-export and post-import tests) and voluntary pre-sale check tests resulted in the disclosure of just two OTF-W incidents, from post-import testing into the LRA (Table 3.3.4).

Table 3.3.4.a Performance of main test types within the Trade & other surveillance stream in the HRA in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Pre-export	7 (<0.1)	0 (0)	0 (0)	0 (0)	0	0
Post-import	50 (0.2)	2 (0.8)	0 (0)	4 (0.9)	4.0	4.2
Post-movement	60 (0.3)	0 (0)	0 (0)	0 (0)	0	0
Pre-movement	20,370 (99.3)	237 (99.2)	154 (100)	437 (99.1)	1.2	1.4
Private	19 (0.1)	0 (0)	0 (0)	0 (0)	0	0
HRA Trade Total	**20,506**	**239**	**154**	**441**	**1.0**	**1.1**

Table 3.3.4.b Performance of main test types within the Trade & other surveillance stream in the Edge Area in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Pre-export	5 (0.1)	0 (0)	0 (0)	0 (0)	0	0
Post-import	36 (0.5)	0 (0)	0 (0)	0 (0)	0	0
Post-movement	45 (0.6)	0 (0)	0 (0)	0 (0)	0	0
Pre-movement	7,344 (98.2)	52 (98.1)	31 (100)	83 (98.8)	0.7	0.7
Private	49 (0.7)	1 (1.9)	0 (0)	1 (1.2)	2.0	2.0
Edge Trade Total	**7,479**	**53**	**31**	**84**	**0.5**	**0.5**

Table 3.3.4c Performance of main test types within the Trade & other surveillance stream in the LRA in 2020

Test type	Test events N (%)	TB incidents N (%)	OTF-W TB incidents N (%)	Reactors N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Pre-export	70 (1.3)	0 (0)	0 (0)	0 (0)	0	0
Post-import	127 (2.3)	3 (12.5)	2 (22.2)	3 (12.0)	2.4	1.3
Post-movement	2,365 (42.9)	19 (79.2)	7 (77.8)	22 (88.0)	0.8	0.5
Pre-movement	2,775 (50.3)	2 (8.3)	0 (0)	0 (0)	0.1	0
Pre-sale check LRA	0 (0)	0 (0)	0 (0)	0 (0)	NA	NA
Private	175 (3.2)	0 (0)	0 (0)	0 (0)	0	0
LRA Trade Total	**5,512**	**24**	**9**	**25**	**1**	**0**

Note: Test types include: Pre-export (VE-EX), Post-import (VE-PII, VE-PIO), Post-movement (VE-POSTMT, POSTMOVNC, VE-POSTMOVOV), Pre-movement (VE-PRMT, VE-AI), Pre-sale check LRA (VE-CT-LRA-SA), Private (VE-PRI).

Pre-Movement Testing (PrMT)

There were over 2.8 million cattle movements within GB in 2020, excluding direct and indirect movements (e.g. via slaughter markets and approved finishing units) to a slaughterhouse. This was over 130,000 more movements than in 2019. Farms in all risk areas move more cattle within their risk area than to and from other risk areas. Furthermore, there is more cattle movement between areas most similar in terms of TB risk (Table 3.3.5). In the HRA and LRA around 80% or more of cattle moved within their area compared to 60% of Edge Area cattle.

Table 3.3.5 Summary of number of cattle movements between risk areas and countries, 2020

Cattle movements in 2020	To HRA	To Edge	To LRA	To Scotland	To Wales	Total
From HRA	660,060	90,611	39,787	1,331	35,876	827,665
From Edge	64,018	209,762	45,613	645	21,937	341,975
From LRA	15,088	44,869	660,861	28,185	7,720	756,723
From Scotland	1,122	4,358	52,735	448,595	1,317	508,127
From Wales	82,441	38,960	27,615	928	280,173	430,117
Total	**822,729**	**388,560**	**826,611**	**479,684**	**347,023**	**2,864,607**

Over 1.1 million cattle movements in 2020 originated in the HRA or Edge Areas. This was similar to the numbers seen in 2019 and 2018.

The proportion of TB incidents disclosed by PrMTs in the HRA was fairly stable between 2010 and 2019 (around 8%), however in 2020 it increased to 10% (Figure 3.3.5). There has been more variability in the Edge Area and LRA over this time period. There was a notable increase in the proportion of TB incidents detected by PrMTs in the Edge Area in 2013. This was due to the introduction of annual testing, which increased the number of herds eligible for this test. The proportion then decreased to 5% 2019 before increasing to 8% in 2020.

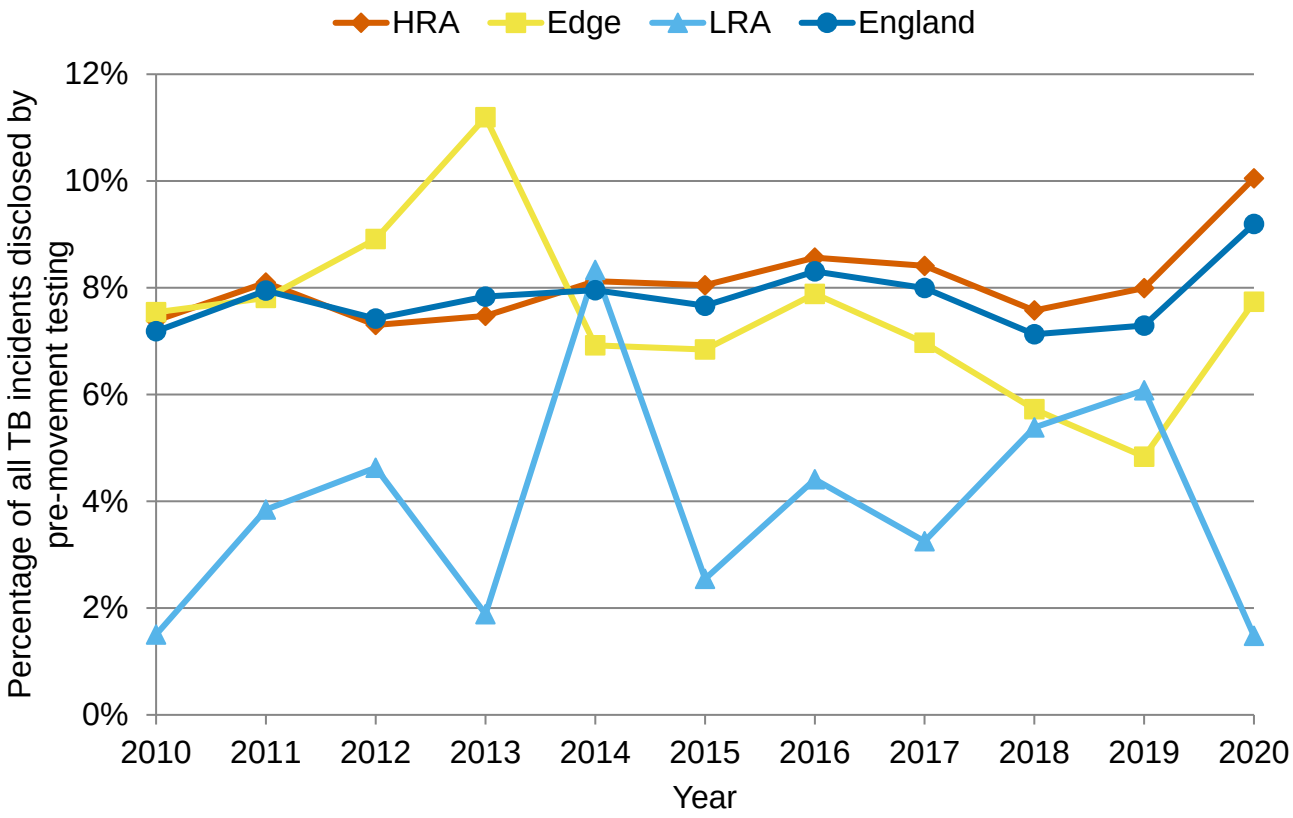


Figure 3.3.5 The proportion of total TB incidents disclosed by pre-movement testing between 2010 and 2020, by risk area. Presented data refer to tests categorised as (bespoke) PrMT, but does not include other tests that can be used as a PrMT.

Inconclusive Reactors (IRs)

Inconclusive reactors (IRs) are cattle that have a differential bovine-avian reaction to the SICCT test that is not strong enough to classify them as reactors. These animals remain isolated from their herd while awaiting the results of a retest in 60 days' time. IRs that do not give a negative result at the retest are deemed to be test reactors and removed, triggering a new incident if their herd was OTF.

As expected, most IR-only herds (herds that had only IRs disclosed and no reactors at the initial test) are detected in the HRA (64%). Similarly, most IRs are identified in the HRA (68%). Between 2019 and 2020, there was a decrease in the number of IR-only herds and IRs disclosed in the HRA, but increases in both the Edge Area and LRA, as seen in previous years (Table 3.3.6).

Table 3.3.6 Summary of number of IR-only herds and IRs disclosed, their percentages and percentage change between 2019 and 2020 by surveillance risk area.

Region	IR-only herds (% of all IR-only herds) (% change 2019-20)	IRs disclosed (% of all IRs disclosed) (% change 2019-20)
HRA	1,518 (64.4%) (-6%)	3,236 (67.9%) (-5%)
Edge Area	552 (23.4%) (5%)	1,015 (21.3%) (5%)
LRA	288 (12.2%) (1%)	518 (10.9%) (1%)

In 2020, 39% of IR-only herds in the HRA went on to have a TB incident within the following 15 months. In the Edge Area the percentage was 32% and 20% in the LRA (Figure 3.3.6).

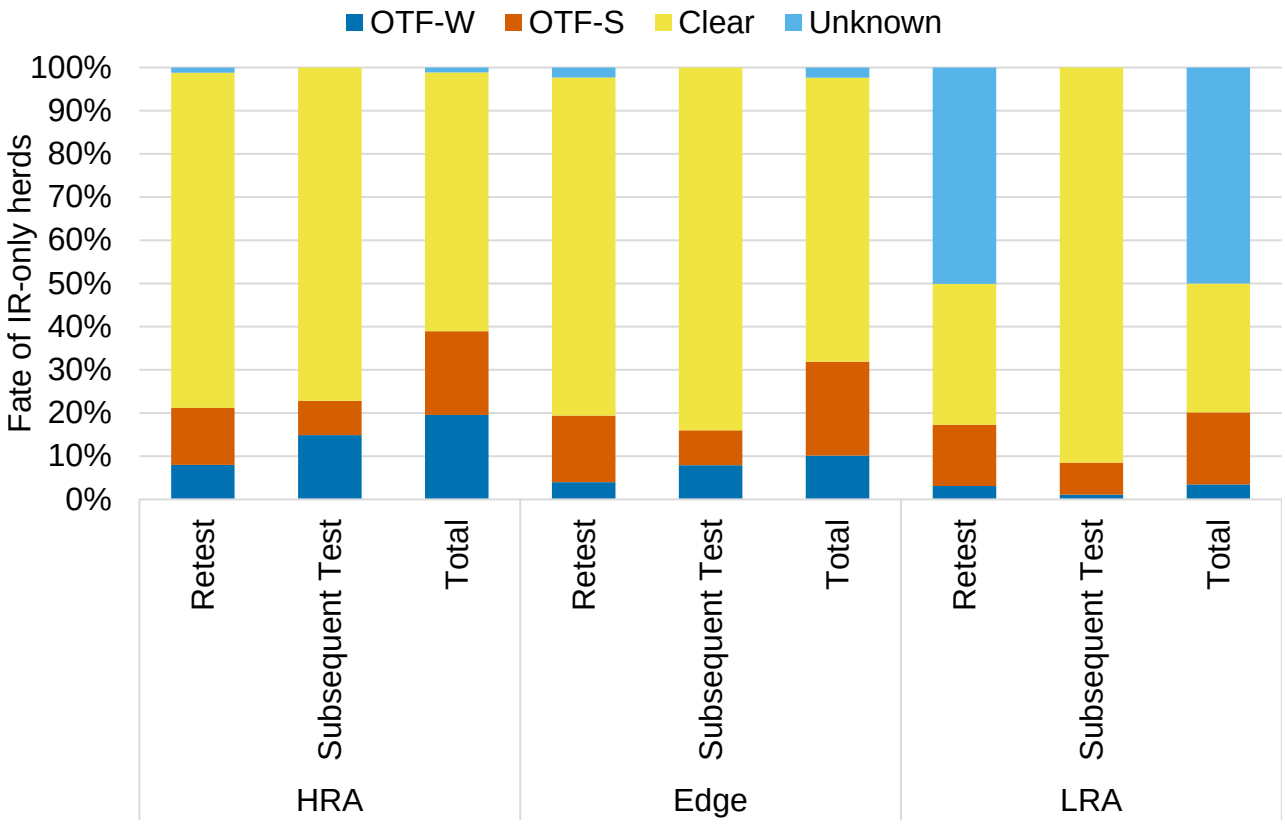


Figure 3.3.6 Fate of IR-only herds, following disclosure in 2020, by risk area. The fate of some herds is recorded as unknown due to reasons such as ceasing trading and not having a retest.

In 2020, in the Edge Area and LRA, nearly all IR-only tests took place in herds with no recent history of an OTF-W incident (88% and 99% respectively). The HRA had the lowest proportion of IR-only herds with no recent history of an OTF-W incident (in the previous three years, 71%). This follows from the higher incidence observed within this region.

Around half of the IRs in IR-only herds where TB infection went on to be detected (OTF-S or OTF-W) were detected by the IR-only herd retests in the HRA (61%) and Edge Area (86%). In the LRA the proportion was 86%.

Figure 3.3.7 suggests that IR-only herds in all risk areas have an increased risk of a TB incident at a subsequent test if they have a history of TB. A multivariable analysis by Brunton et al 2018 shows that the risk posed by IRs in the HRA and Edge Area is substantially reduced by those animals becoming reactors or 2xIRs at the retest 60 days later and being removed from herds. However, IRs that pass the retest can pose a TB risk for around 2.5 years from first disclosure. This indicates that IRs are an important predictor of the presence of infection. Although the retest eliminates most of the risk, the policy to restrict IRs to the herd in which they are disclosed for life reduces the risk further.

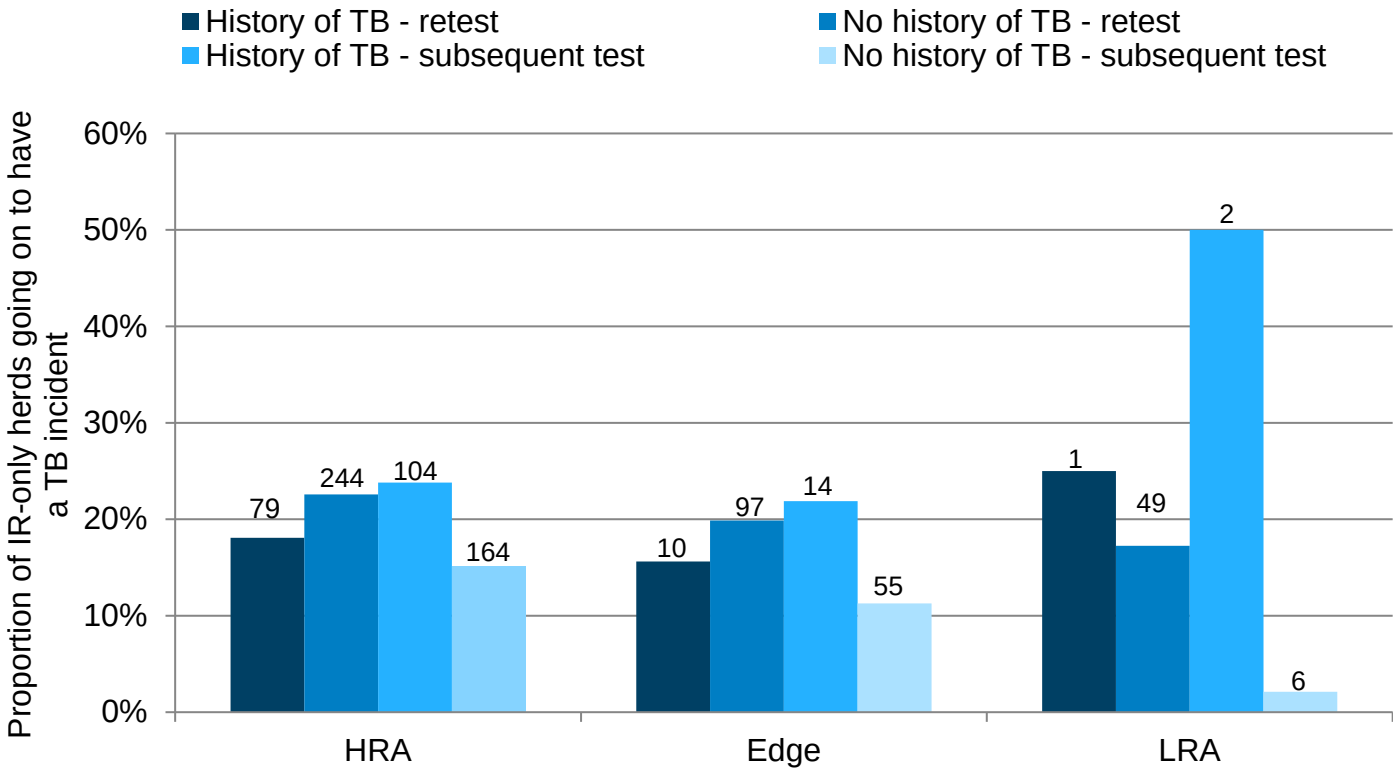


Figure 3.3.7 Proportion of IR-only herds going on to have a TB incident in 2020 at either the IR retest or a subsequent test (within 15 months after IR test), by surveillance risk area and TB history. Totals above each column represent the number of herds with a TB incident.

Interferon gamma tests for detection of additional infected cattle within TB incident herds

The interferon gamma (IFN-γ) blood test is generally used in England as a parallel test in conjunction with the skin test to boost the overall sensitivity of testing in certain TB incident

herds with post-mortem evidence of infection. All herds experiencing fully confirmed (OTF-W) TB incidents in the LRA and Edge Area and in badger control programme (BCP) areas of the HRA that have completed at least two culling seasons, must be subjected to supplementary IFN-γ blood testing, to enhance the detection of infected cattle. Mandatory IFN-γ tests are also used in persistent incidents where herds have been under restriction for more than 18 months, as well as in herds with explosive incidents and those being considered for whole or partial slaughter. Outside these scenarios, the deployment of the IFN-γ blood test in 2020 was discretionary.

Table 3.3.7 Animals (herds) receiving an IFN- γ test in 2020, by risk area and testing reason

Risk Area	Total	Miscellaneous	New OTF-W in BCP areas	OTF-W outside HRA	Persistent OTF-W	Persistent OTF-W in BCP areas
HRA	128,858 (1,121)	5,480 (74)	107,363 (951)	0 (0)	9,738 (62)	6,037 (29)
Edge Area	77,234 (666)	273 (9)	12,341 (68)	64,166 (583)	443 (4)	11 (2)
LRA	3,626 (60)	1 (1)	30 (2)	3,595 (57)	0 (0)	0 (0)
England	**209,718 (1,847)**	**5,754 (84)**	**119,734 (1,021)**	**68,001 (645)**	**10,181 (66)**	**6,048 (31)**

Note: Test types included Chronic breakdown management (VE-IFN_SLHERD), Miscellaneous (VE-IFN, VE-IFN_ANOM, VE-IFN_BOV_OTH, VE-IFN_FLEX, VE-IFN_NSR, VE-IFN_OTH_SP, VE-IFN_PRI), New OTF-W in BCP Areas (VE-IFN_NBCP), OTF-W outside HRA (VE-IFN_LOW_IN), Persistent OTF-W (VE-IFN_PERSI), Persistent OTF-W in BCP Areas (VE-IFN_PBCP). Herds tested are in parentheses. In 2020, no cattle were tested under the Chronic Breakdown Management Policy in England, thus this data was excluded from the table.

A total of 209,718 cattle were IFN-γ tested in England in 2020 and 4.2% (8,882) of those were positive. A total of 1,847 herds were tested and 1,207 had at least one IFN-γ test positive animal disclosed (65%). Both the number of individual animals, and the number of herds receiving IFN-γ tests decreased in 2020 compared to 2019 (244,709 animals and 2,005 herds in 2019).

During the COVID-19 pandemic, some supplementary IFN-γ tests were not performed, especially where the application was discretionary. For example, repeat IFN-γ testing may not have been applied to some herds that would otherwise have received multiple rounds of testing; while in other herds only specific epidemiological groups were tested, rather than the whole herd over six months of age.

Since 2010, the overall IFN-γ test positive rate in animals has varied between 4% and 6%. Historically there have been differences in the positive rate between risk areas, with higher rates in HRA herds (13% in 2015, 8% in 2016 and 11% in 2017). However, in 2020, the rate in the HRA dropped to 5% compared to 3% in the Edge Area and LRA (Figure 3.3.8). This is likely to be due to the sharp increase in compulsory IFN-γ testing in BCP areas, which particularly affects the HRA. This trend is likely to continue whilst BCP areas are

eligible for IFN-γ testing. Previously, many of the IFN-γ tests were applied to persistent and ‘explosive breakdown’ herds where a higher positive rate is expected.

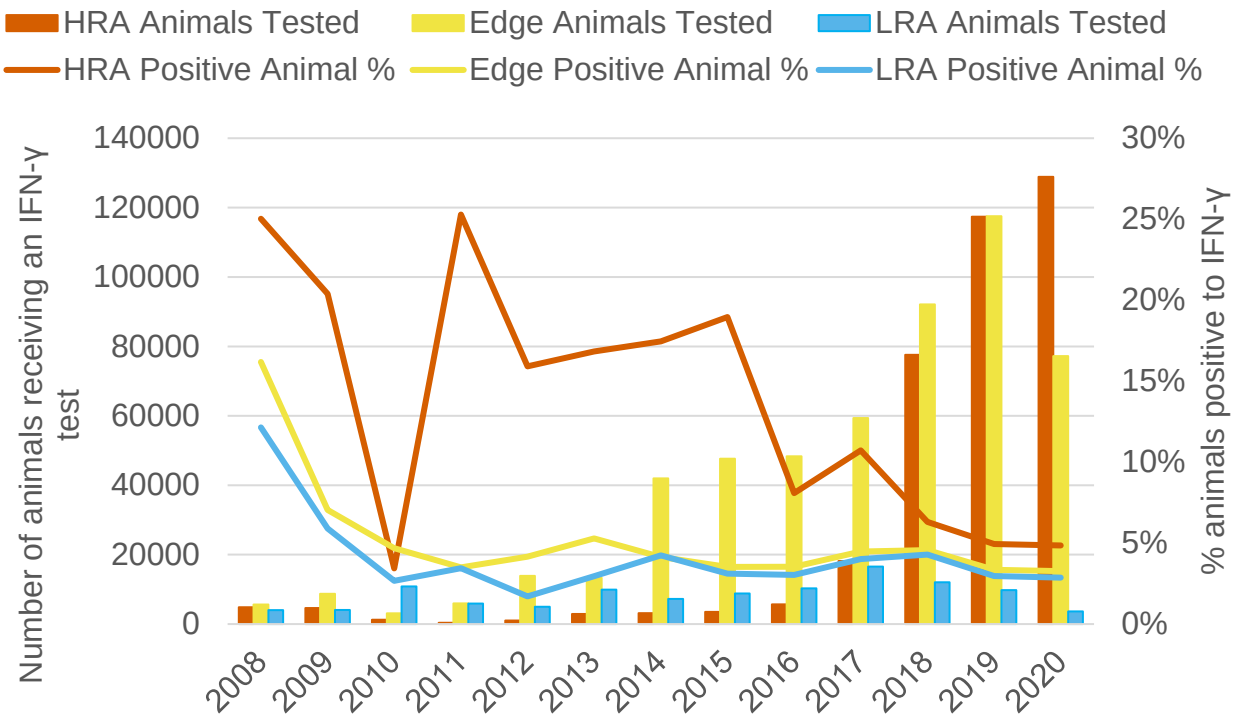


Figure 3.3.8. Number of animals tested and proportions of animals IFN-γ test positive by risk area, 2008 to 2020.

The use of IFN-γ tests at the herd level has evolved over time. Due to a pilot of IFN-γ testing, many herds in 2008 and 2009 had a test (Figure 3.3.9), but the number of animals tested were low (Figure 3.3.8). In 2020, additional IFN-γ testing continued to be deployed subject to veterinary discretion, such as in complex TB incidents. In the Edge Area, the proportion of herds in which reactors were detected using IFN-γ testing has stayed broadly consistent across years at 60-80%. There has been wider variation in the HRA and LRA, possibly due to fewer herds receiving IFN-γ testing in previous years (Figure 3.3.9).

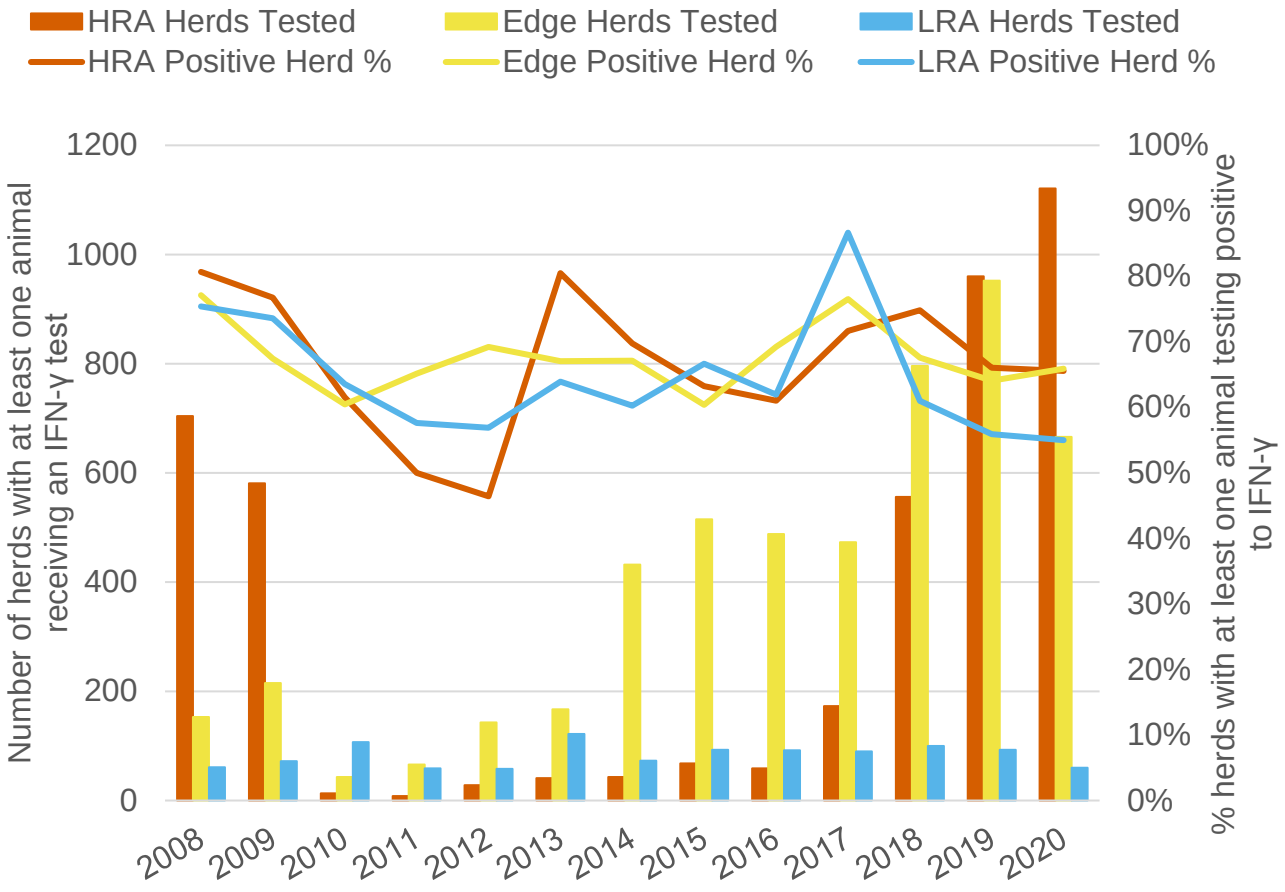


Figure 3.3.9. Number of herds tested and proportions of herds with at least one IFN-γ test positive animal by risk area, 2008 to 2020.

3.4 Impact of disease and control measures: prevalence, duration and persistence

- During 2020, at any point in time, an average of 2,406 herds (4.8% of the cattle herds in England) were under movement restrictions due to a TB incident. In other words, about 95.2% of all the cattle herds in England were Officially TB Free (OTF). This national prevalence level is similar to previous years. The end-of-year point prevalence for England was also 4.8%, with 2,387 out of 49,601 herds under restrictions on 31st December 2020.
- Most herds under movement restrictions were in the HRA. In 2020, the monthly average herd level prevalence in the HRA decreased (9.3%) compared to 2019. Although this parameter has been relatively stable in the past ten years, the herd prevalence in the HRA in 2020 was at the lowest level since 2011. Prevalence in the HRA was highest in the counties of Shropshire (11.7%) and Wiltshire (11.0%).
- Prevalence in the Edge Area has continued to increase since 2003, with a particular rise from 2013 following the introduction of a stricter regime for returning a herd to OTF status after suffering a TB incident. Prevalence in 2020 was highest in the counties of Oxfordshire (12.9%) and Warwickshire (9.3%). Prevalence in the LRA remained very low and stable in 2020, at 0.7%.
- TB infected herds remained under restriction for a median of around six and a half months in the HRA and Edge Area, and just under five and a half months in the LRA. Herds were under movement restrictions for longer periods in larger herds (>200 animals) and in TB incidents with more than one reactor disclosed.
- In the HRA, the number of TB incidents classed as ‘persistent’ (i.e. under movement restrictions for 18 months or longer) that were still ongoing at the end of the year decreased, from 192 at the end of 2019 to 154 at the end of 2020. In the Edge Area the number also decreased from 29 to 20. Only one persistent incident was ongoing in the LRA (in Lincolnshire) at the end of 2020.
- Overall, 221 persistent TB incidents were resolved in England during 2020, 86% of which were located in the HRA.
- In 2020, 28,176 cattle were slaughtered for TB control reasons, with a median of three reactors removed per TB incident. The mean number of reactors removed has fluctuated over time and between risk areas. In 2020, an average of ten reactors were removed per TB incident in both the HRA and in the Edge Area, and three in the LRA. The fluctuation and high numbers of reactors in some incidents will mean the financial impact of TB controls is much greater for some farmers than others.
- Eleven new Badger Control Programme (BCP) areas were licensed in 2020; six in the HRA, four in the Edge Area and one in the LRA. Licences were issued to vaccinate badgers in 320.2 km^2 across England, with 1,094 badgers vaccinated in 2020.

Herd prevalence

Herd prevalence shows the proportion of herds classified as infected with TB at a given point in time. It is measured by counting herds under restriction due to a TB incident at the mid-point of each month, divided by the number of active herds in a geographical area. This measurement depends on both how many herds are newly infected with TB (incidence) and how long restrictions are maintained (incident duration). Stricter controls, in particular the extent of testing needed to provide sufficient evidence to declare a herd OTF, can increase the duration of restrictions. Less stringent controls may lead to a swifter resolution of the TB incident, but risks leaving undetected infection if controls are removed too soon. Prevalence provides an indication of how much impact the epidemic is having on the cattle farming sector.

During 2020, an average of 4.8% of herds in England overall were restricted at any one time, equating to around 2,406 herds. However, this overall figure masks substantial differences between risk areas and counties within those areas, as shown in Figures 3.4.1 and 3.4.2, respectively. Figure 3.4.1 also shows a seasonal cycle, likely related to the time of year when most TB surveillance testing is undertaken. TB testing is planned to fit with the farming calendar when possible. Herd prevalence in the HRA decreased slightly in 2020 compared to 2019, continuing the trend observed since 2018. In the Edge Area, while herd prevalence has increased steadily since 2007 with a marked upward trend since 2013 (when all herds in the area were placed on routine annual testing), it slightly decreased in 2020. The overall increase in prevalence since 2013 reflects both the earlier detection achieved and the more stringent controls deployed. In the LRA, prevalence has remained consistently low for the past ten years.

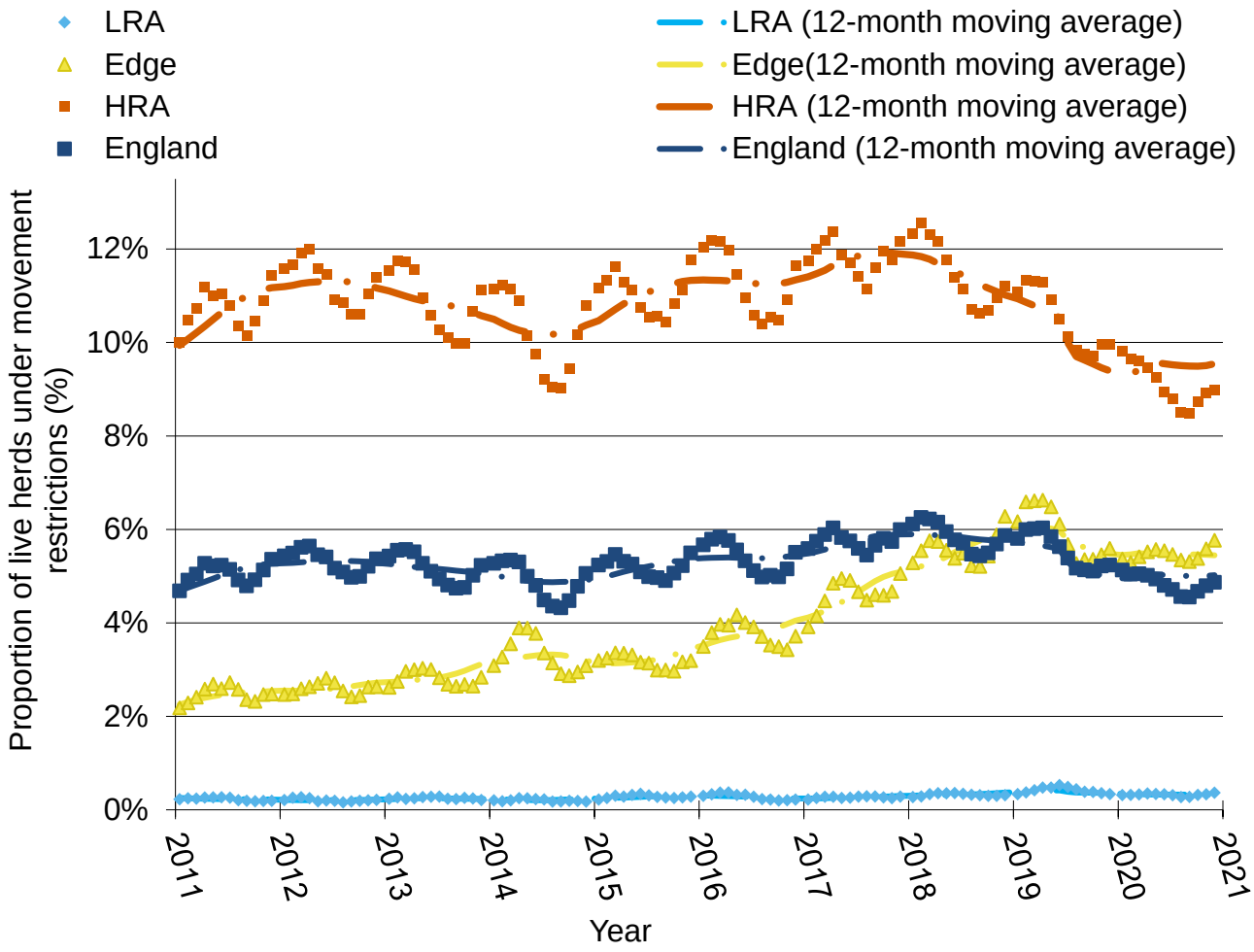


Figure 3.4.1 Proportion of live English herds under TB movement restrictions (prevalence) as a result of any TB incident, by month, between January 2011 and December 2020

- Prevalence in the HRA has generally plateaued since 2011, with a tendency to decrease since 2018.
- In the Edge Area, prevalence has risen over time peaking in 2019 and slightly decreasing in 2020.
- Prevalence has remained consistently low in the LRA.

In 2020, as in previous years, there was wide variation in the herd prevalence of TB between counties (Figure 3.4.2). The highest prevalence was seen in Oxfordshire (13.0%) (Edge Area), followed by Shropshire (11.7%) and Wiltshire (11.0%) (HRA) and the lowest prevalence was in the LRA counties. Further details about prevalence at county level are presented in Section 4. Prevalence levels and trends in individual counties of the Edge Area and LRA are also presented in the Year End Descriptive Epidemiology Reports.

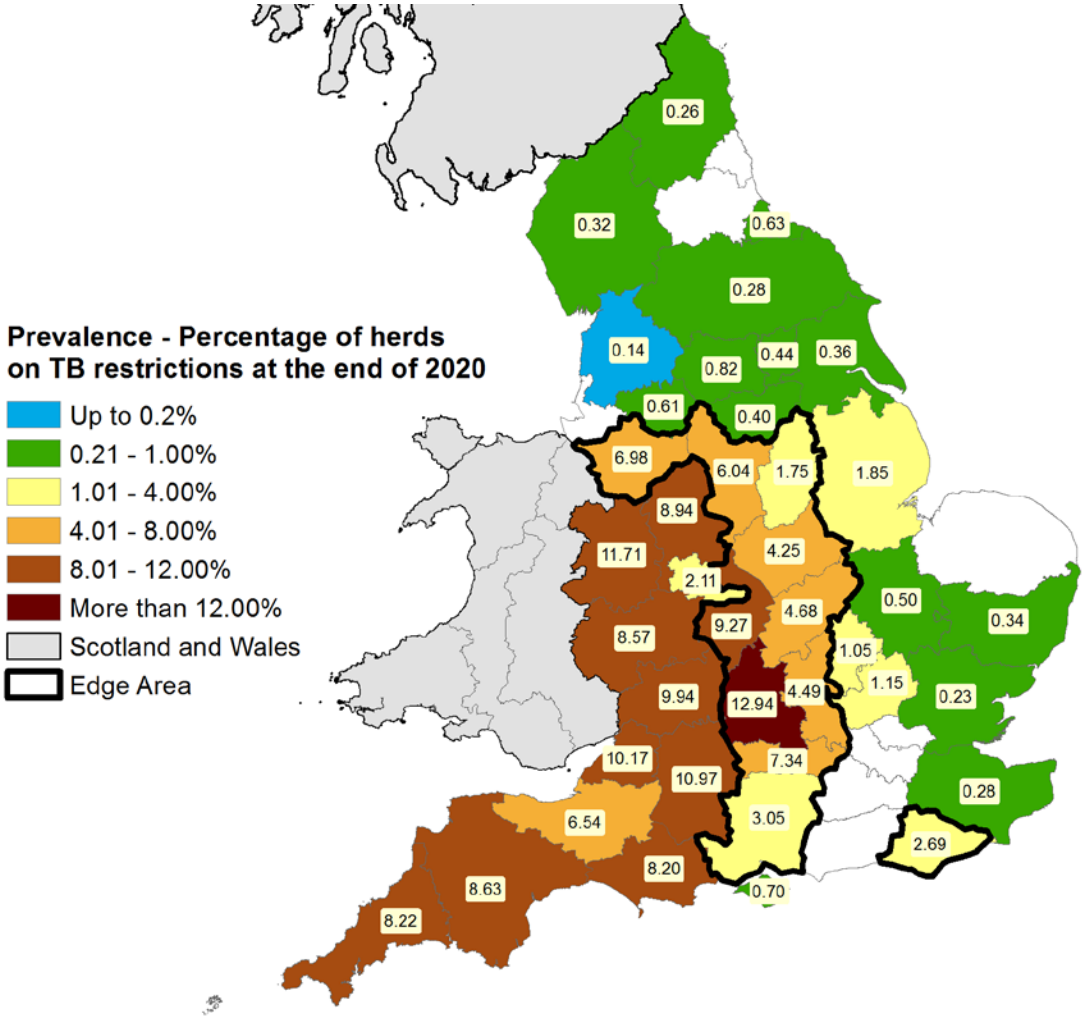


Figure 3.4.2 County prevalence: percentage of herds in each county that were under restrictions due to a TB incident at the end of 2020 (31st December)

- Prevalence is generally greatest in the HRA. However, as in previous years, high levels of prevalence were also found in some Edge Area counties, including Oxfordshire and Warwickshire.

Duration of TB incidents

Herds infected with TB lose their OTF status, and are thus prevented from moving cattle, while incident control measures are in place to limit the risk of spreading TB. Limited exceptions, including direct movements to slaughter, slaughter markets or finishing units approved by APHA (AFUs), are permitted under licence. TB incident duration has an effect on the costs of TB to both farmers and taxpayers because restrictions constrain the management of the herd. Longer incidents are generally associated with more herd tests and more animals removed, and thus greater costs. Shorter periods of restrictions enable

a farmer to get back to business as usual more quickly, so minimising their economic impact. However, this must be balanced against the risk of leaving undetected infection in the herd (and further spread of disease) if restrictions are removed too early.

A total of 3,949 herds in England had movement restrictions lifted in 2020. Of those, 15 were non-grazing AFUs (14 in the HRA and 1 in the Edge Area). Due to differences in the management of TB in AFUs, they have been excluded from the following duration figures.

Herds with a TB incident were under restriction for longer in the HRA and Edge Area, compared to the LRA, with a median duration of approximately six-and-a-half months. The interquartile range (IQR) for herds in the HRA and Edge Area indicates that the herds were under restriction for approximately between just under five-and-a-half and almost ten months (HRA IQR 5.3-9.8, Edge area IQR 5.2-9.1). In the LRA, the median duration of TB incidents was slightly lower than five-and-a-half months (IQR 3.2 – 7.3 months). This reflects the higher proportion of herds with OTF-S cases in the LRA, most of which require only a single short interval test (SIT) with negative results to regain OTF status.

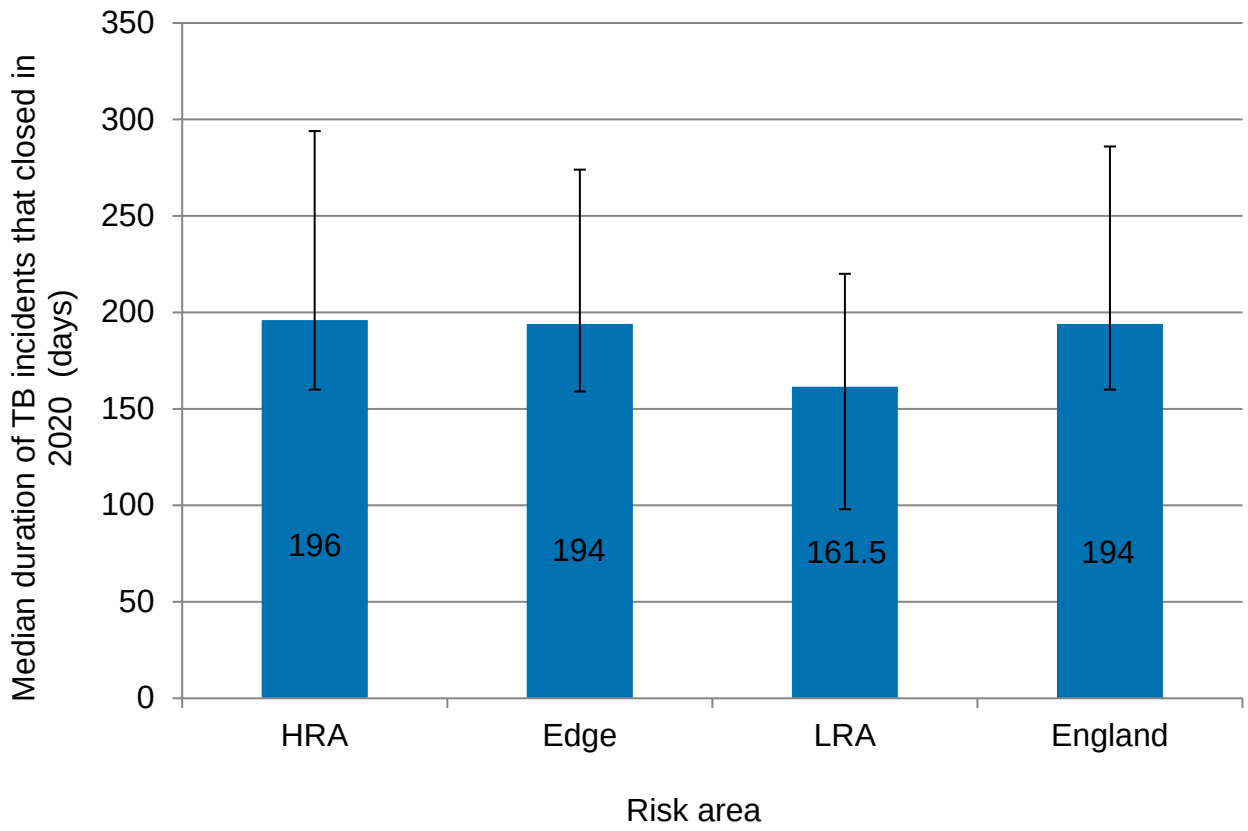


Figure 3.4.3 Median duration and interquartile range of all TB incidents that closed in 2020, by risk area

- Herds were under restriction due to TB for similar lengths of time (median) in the HRA and Edge Area, but the duration was shorter in the LRA. However there is wide county-to-county variation within each risk area.

Factors associated with a significant increase in duration include large herd size and the number of reactors found. The latter can stem from case management processes, such as supplementary IFN-γ blood testing.

The duration of herd movement restrictions was associated with herd size in all risk areas (Figure 3.4.4). In 2020, it took longer for restrictions to be lifted in large herds (more than 200 animals). This can be seen by the increasing proportion of such herds (green shading) in the longer duration categories. A greater proportion of medium and small herds are restricted for shorter periods in the HRA and Edge area. The trend in the LRA is less clear. Between 40% and 47% of incidents in all duration categories were in large herds (over 200 cattle) (Figure 3.4.4).

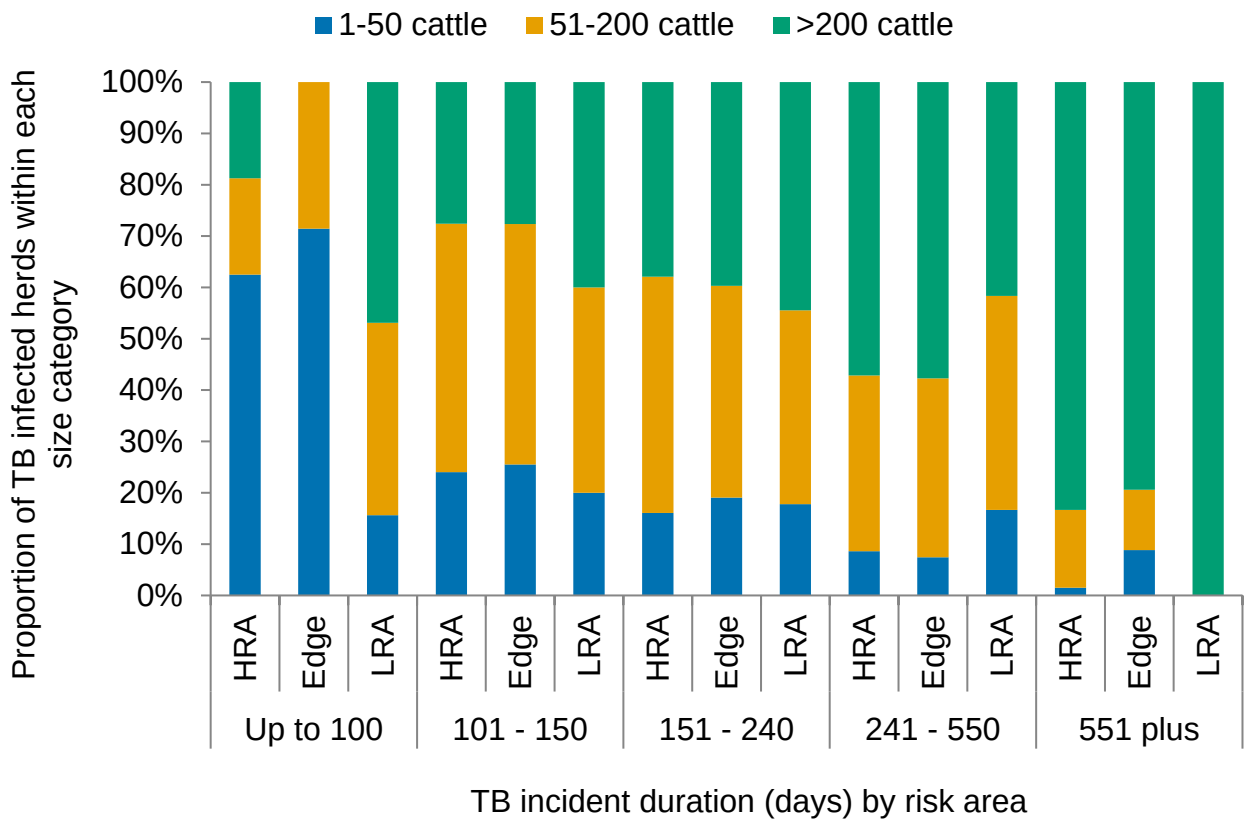


Figure 3.4.4 Comparative duration of TB incidents that closed in 2020, by risk area and herd size

- Smaller herds of up to 50 animals came off movement restrictions more quickly than herds with 51-200 animals, which also resolved more quickly than those with over 200 animals.

A long duration of movement restrictions is the result of challenges in removing infection, or in demonstrating freedom of infection. They may occur due to a number of factors that can interfere with efforts to remove infection, such as:

- The limitations of the test in finding all infected animals (imperfect sensitivity of the skin and interferon-gamma tests), particularly in large herds, due to the presence of animals that fail to react to the test, leading to continued spread within the herd.
- Intense cattle-to-cattle transmission (high within-herd infection prevalence).
- New infection unknowingly introduced with purchased animals (under licence), or new exposure in the environment, including contiguous herd breakdowns or changes in management.
- Repeated re-infection from an unidentified source (e.g. from local wildlife reservoirs of TB, or contiguous herds), possibly driven by management factors, for example the need to use particular fields with known badger activity.
- Uninfected animals showing non-specific reactions to tests (less common).

Figure 3.4.5 shows the number of SITs it took to clear a TB incident, comparing risk area and herd size. Overall in England, 50% of herds (with TB incidents that closed in 2020) took two SITs to clear, and 86% took fewer than five SITs.

In all risk areas, most TB incidents took two SITs to clear. The HRA had herds under restriction for longer, with 15% of herds receiving more than five SITs in 2020. In the Edge Area, 13% of herds received more than five SITs, and in the LRA just three per cent (four herds).

In the HRA, 64% of small herds (1-50 cattle) required two SITs to clear a TB incident, while 32% required three or more. Fewer medium size herds (51-200 cattle) cleared a TB incident with two SITS (56%) and under half required three or more SITs (43%). Most large herds (>200 cattle) required three or more SITs (61%).

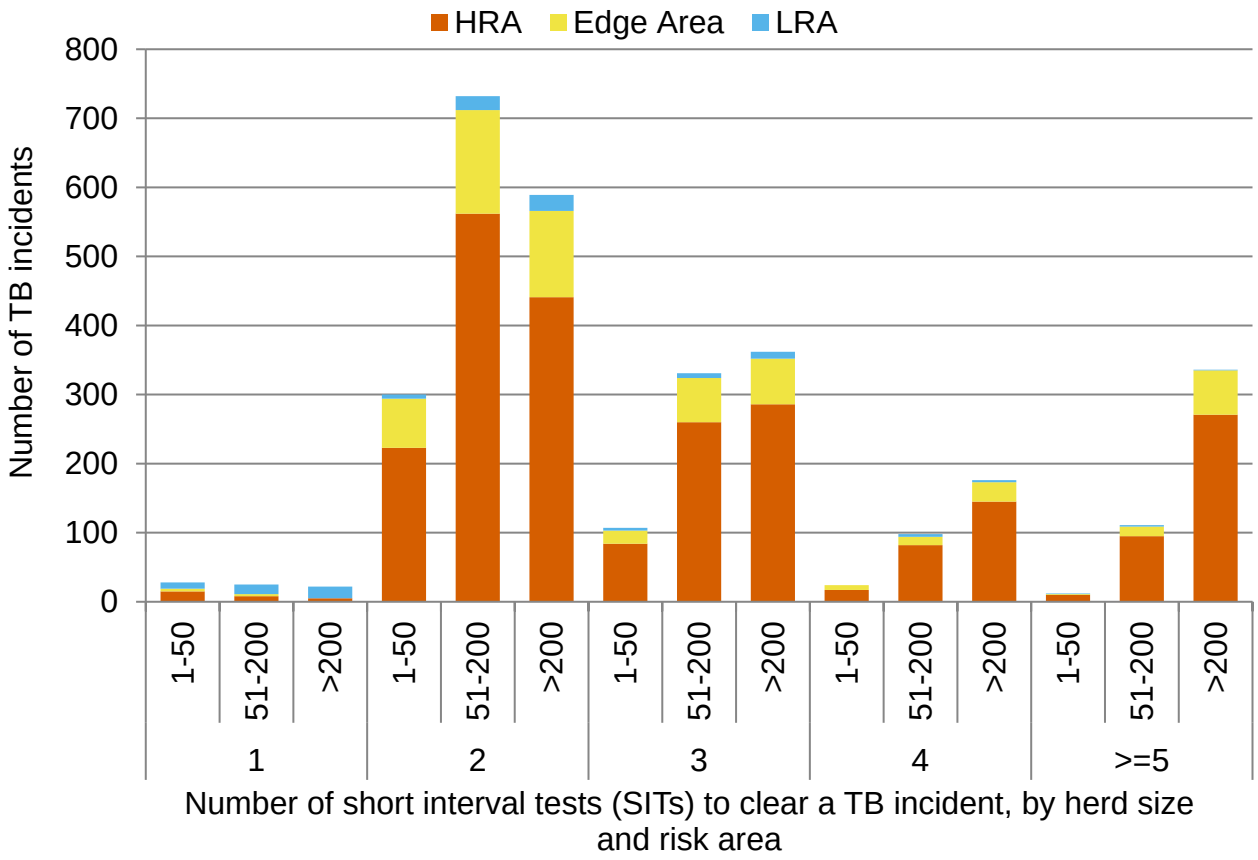


Figure 3.4.5 Number of short interval tests (SITs) to clear a TB incident, by risk area and herd size (for TB incidents ending in 2020)

- In all three risk areas, most herds required two SITs to clear a TB incident.
- In the HRA, large herds (more than 200 cattle) generally required three or more SITs to clear a TB incident.

Changes in duration over time

Since 2010, TB incidents with more than one reactor have consistently been under restriction for longer than those with only one reactor, across all risk areas (Figure 3.4.6). TB incidents with more than one reactor generally have a longer duration of movement restrictions in the HRA, compared to herds in the Edge Area and LRA. For TB incidents with 0-1 reactors, the duration of TB incidents has been similar between the HRA and Edge Area since 2014. The duration of TB incidents for single reactor herds is largely driven by the required number of SITs. In the LRA, this is often only one as many cases are suspect (OTF-S) rather than confirmed (OTF-W), hence the lower duration in the LRA.

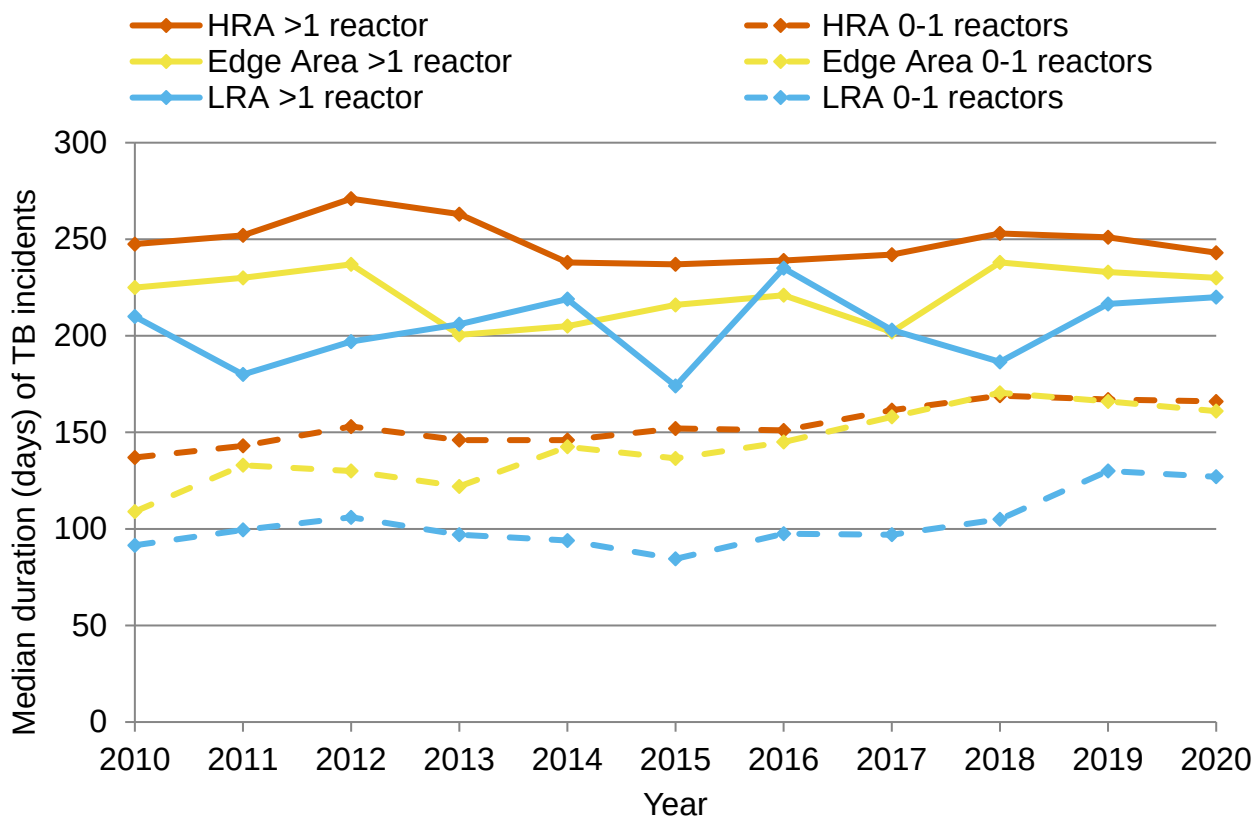


Figure 3.4.6 Median duration of TB incidents that closed in each year, between 2010 and 2020

- TB incidents in the HRA with more than one reactor have consistently been under restriction for longer than incidents in the Edge Area or LRA.
- Since 2013, most single reactor herds in both the HRA and Edge Area have required two SITs to clear a TB incident, leading to a similar duration.

Persistent TB incidents

If a TB infected herd is under movement restrictions for over 550 days (about 18 months), APHA considers the incident to be ‘persistent’. The affected herds are eligible for enhanced management procedures, based on a series of prioritisation criteria. The causes of persistent TB incidents are listed under the paragraph “Duration of TB incidents”.

Figure 3.4.7 shows the number of persistent TB incidents that remained open at the end of each year, since 2011, by risk area. The vast majority (86%) were in the HRA.

The number of persistent incidents still open at the end of 2020 (n=154) was the lowest in the past 10 years. In the Edge Area, the number of persistent incidents has decreased to 20, after a progressive increase from 12 in 2016 to 29 in 2019. In the HRA the number of persistent TB incidents increased from 205 in 2015 to 242 in 2018, however it fell to 192 in

2019 and further decreased to 133 in 2020. Only one persistent incident remained open in the LRA (Lincolnshire) at the end of 2020 (Figure 3.4.7).

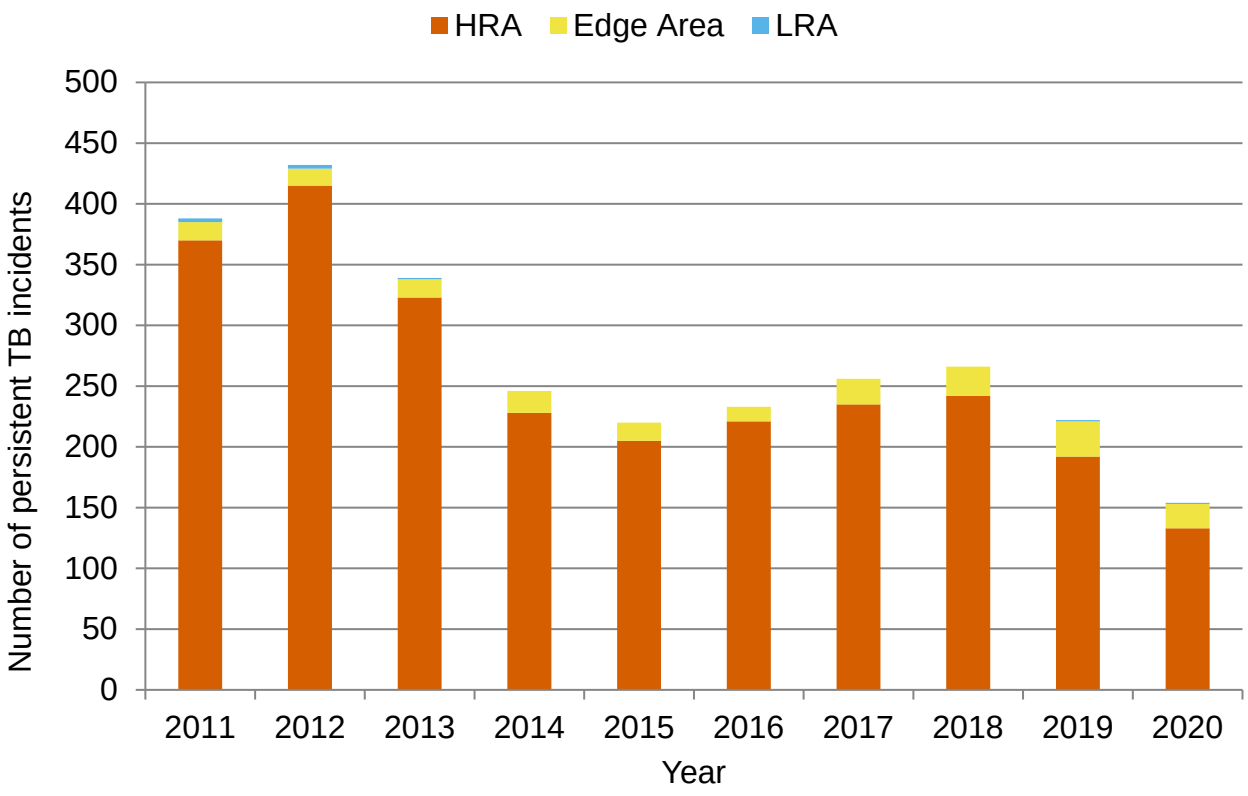


Figure 3.4.7 Number of TB incidents ongoing at the end of each year that had lasted more than 550 days ('persistent' TB incidents).

During 2020, 221 persistent TB incidents were resolved in England overall (185 in the HRA, 35 in the Edge Area and one in the LRA).

Like in previous years, most herds that had prolonged infection with TB were located in the HRA (86%), however there was variation in the burden of persistent incidents between counties (Figure 3.4.8).

Within each county, the highest proportion of persistent TB incidents open in the HRA at the end of 2020 were located in Cornwall (10.7%), Devon (10.6%) and Dorset (10.1%). In the Edge Area, Berkshire had the highest proportion of persistent incidents (26.7%), followed by Buckinghamshire (15.0%) and Oxfordshire (10.5%). Figure 3.4.8 shows that, as in 2019, the burden of persistent incidents disproportionately affected counties in the south and east of the HRA and central Edge Area.

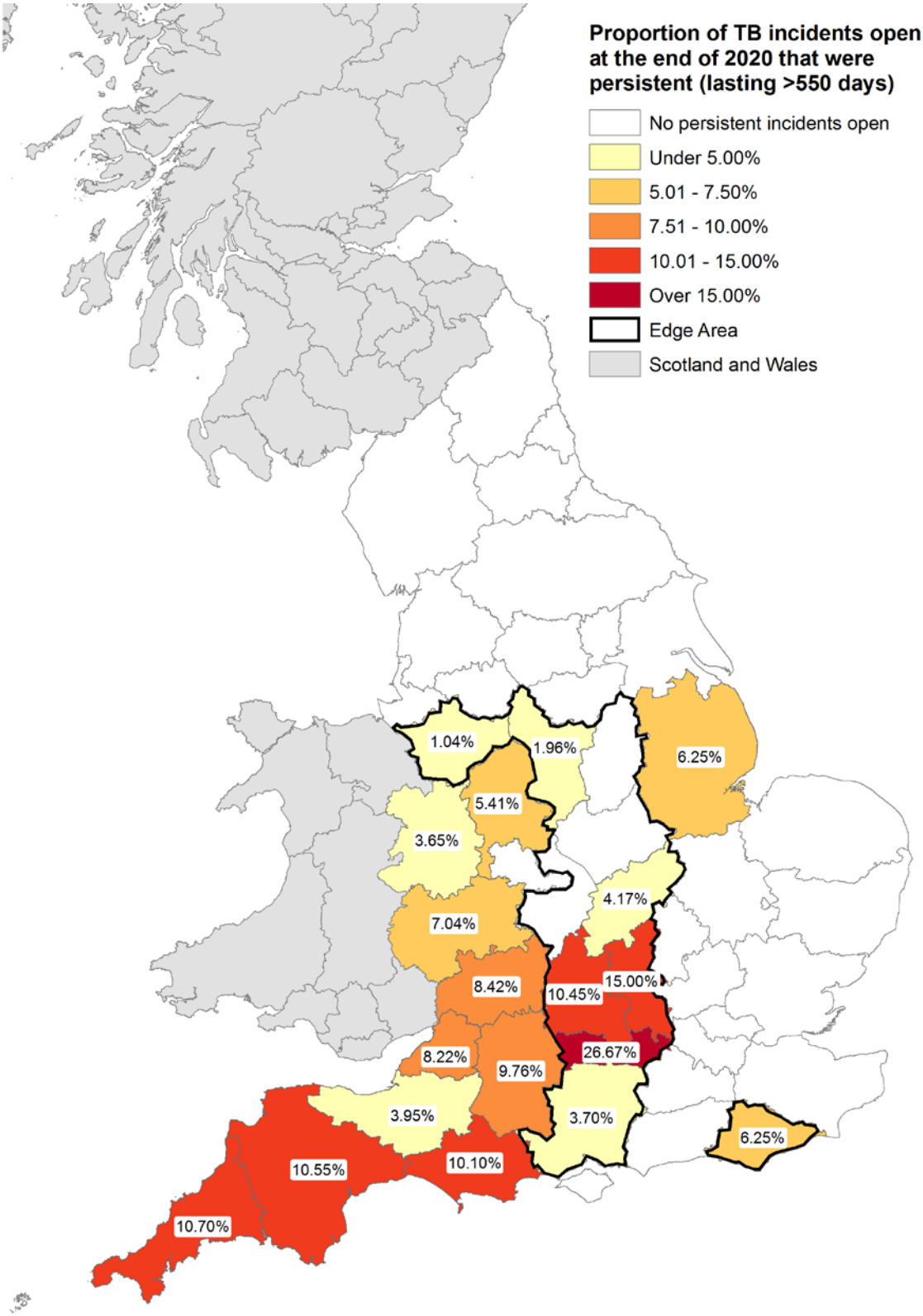


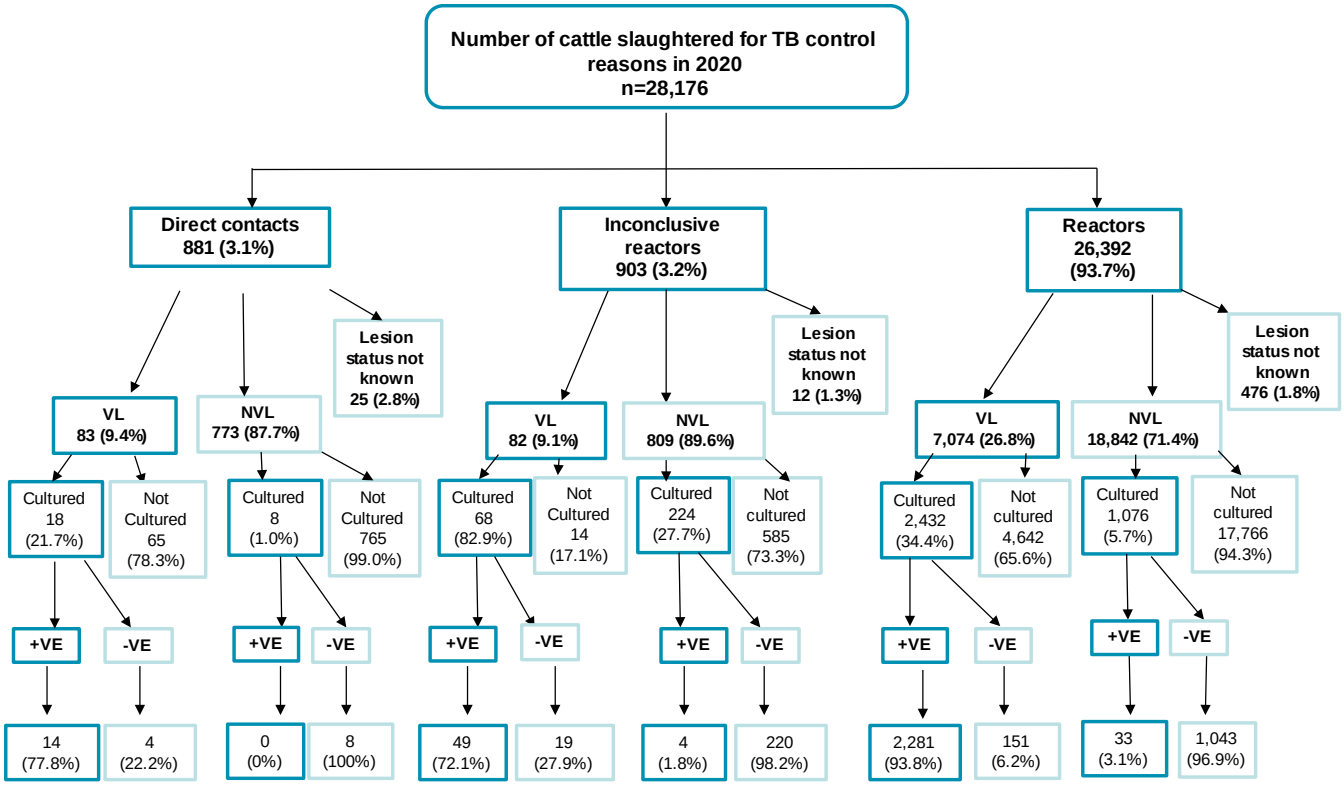
Figure 3.4.8 Proportion of all TB incidents in each county, open at the end of 2020, that had lasted more than 550 days (persistent incidents)

Number of animals removed from TB incident herds

Cattle that test positive for TB must be isolated from the herd and are rapidly removed. In 2020, a total of 28,176 cattle were slaughtered for TB disease control purposes in England, with the vast majority of them being skin and/or interferon-gamma test reactors (93.7%). The remaining 6.3% were removed as inconclusive reactors (IRs) before re-testing, either voluntarily by the keeper, or by APHA as direct contacts (Figure 3.4.9a).

Virtually all cattle slaughtered for disease control purposes have a post mortem examination, but not every TB-affected animal is sampled for laboratory culture and isolation of *M. bovis*. Confirmation of TB infection means the detection of typical lesions at post mortem (PM) examination (visibly-lesioned or VL sample) in a slaughtered test reactor, or identification of *M. bovis* in culture.

In line with previous years, 93% of samples from VL cattle (reactors, IRs and DCs) yielded a positive culture result, whereas only 2.8% of non-visibly-lesioned (NVL) samples did so (Figure 3.4.9a).



KEY: VL = visible lesions; NVL = non -visible lesions; +VE = *M. bovis* positive; -VE = *M. bovis* negative

Figure 3.4.9a Diagram showing the number of cattle that were slaughtered for TB control reasons in 2020 and the number in which infection with *M. bovis* was confirmed

The results of the SICCT skin test can be read at standard (ST) or severe (SEV) interpretation, depending on the circumstances in which the test is being performed. Severe interpretation is used for most short interval tests carried out in TB incident herds. It is designed to identify more positive animals, thus reducing the risk of leaving undisclosed infection in the herd.

Most test reactors were removed under the standard-interpretation of the skin test (13,554 animals, 52%), while 17% (4,413 animals) were severe-interpretation reactors and 32% (8,829 animals) were IFN-γ test positives. IFN-γ tests are compulsory in OTF-W incidents in the Edge Area, LRA and within the HRA where badger control has been in operation for at least two years. Over a quarter of all cattle slaughtered for TB control reasons in the HRA were IFN-γ test positive animals (28%). In the Edge Area and LRA, IFN-γ test positive animals accounted for 44% and 30% of all the cattle slaughtered, respectively (Figure 3.4.9b), as opposed to 2019 where they accounted for over half of all cattle slaughtered.

Slaughtered cattle that went on to be confirmed at post mortem (VL reactors or *M. bovis* positive animals) originated as standard-interpretation reactors in 77% of cases.

In England overall, 40% of standard-interpretation reactors were confirmed by visible lesions and/or *M. bovis* culture positive results. For severe-interpretation reactors and IFN-γ test positive animals, the proportion confirmed as *M. bovis* positive was 13%. The proportion for IFN-γ test positive animals increased compared to 2019 (9%). As expected, these percentages varied by TB risk area (highest in the HRA and lowest in the LRA) (Figure 3.4.9b).

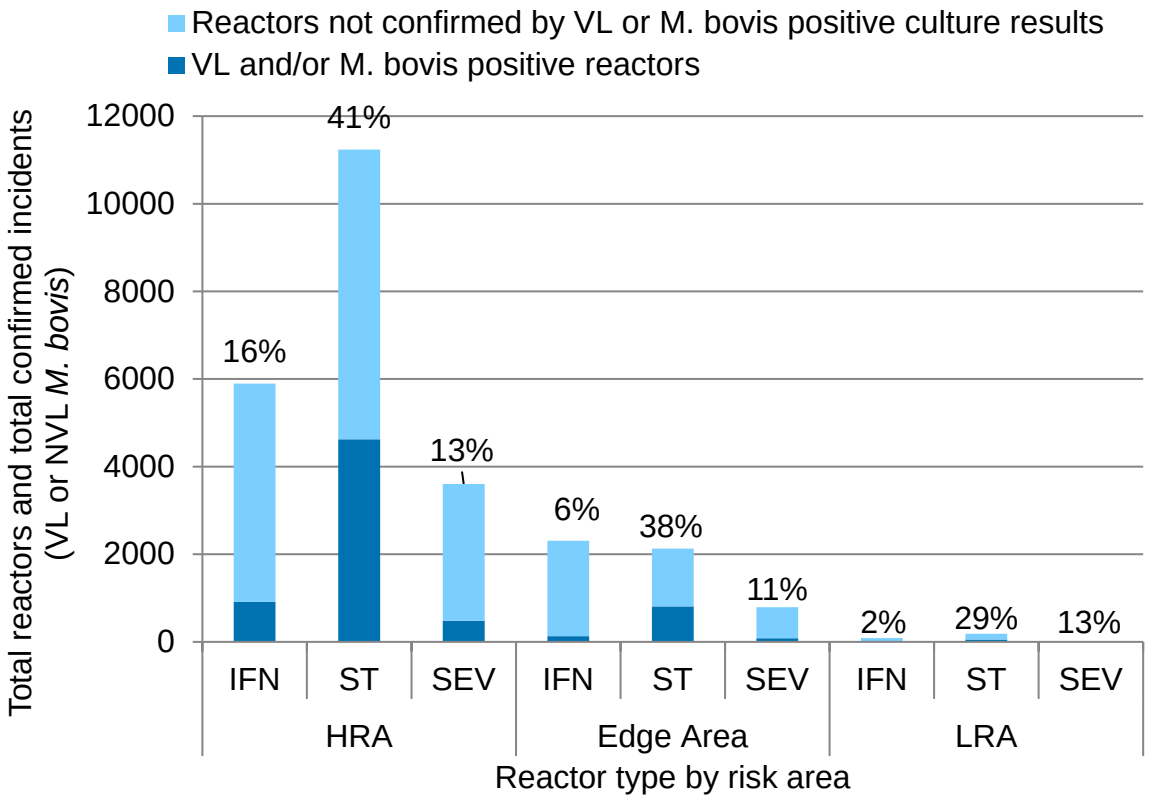


Figure 3.4.9b Number of reactors and total animals removed in 2020 with post-mortem evidence of *M. bovis* infection (VL reactors and/or culture-positive animals), by reactor type (IFN-γ test positives, standard and severe interpretation reactors to the skin test) and risk area. Stacked bars labelled with the percentage of reactors that were confirmed by VL and/or culture results.

In 2020, there was a 10% decrease in the number of cattle removed from herds across England compared to 2019. The majority of the 28,176 cattle removed from herds were reactors taken from the HRA (n=20,863, 79%), which has been the pattern over the last ten years (Figure 3.4.10). However substantial numbers were also taken as 1xIRs or DCs (877 in the HRA) and 2xIR or 3xIRs (503 in the HRA). After a steep increase in the number of reactors removed from herds in the Edge Area, jumping from 2,609 in 2013 to 7,029 in 2019, the number of reactors decreased by 25% in 2020, to 5,242. Increases seen since 2013 were due to more stringent controls in the Edge Area.

Two consecutive skin herd tests with negative results at severe interpretation are required before restrictions can be lifted from any incident herd in the HRA (since April 2016) and the Edge Area (since 2013). This means that some IRs disclosed at standard interpretation may be removed as reactors when severe reinterpretation is applied. This increases the number of reactors, reducing the risk of leaving residual infection in the herd. Furthermore, compulsory application of the IFN-γ test in all OTF-W incidents in the Edge Area was rolled out from 2014.

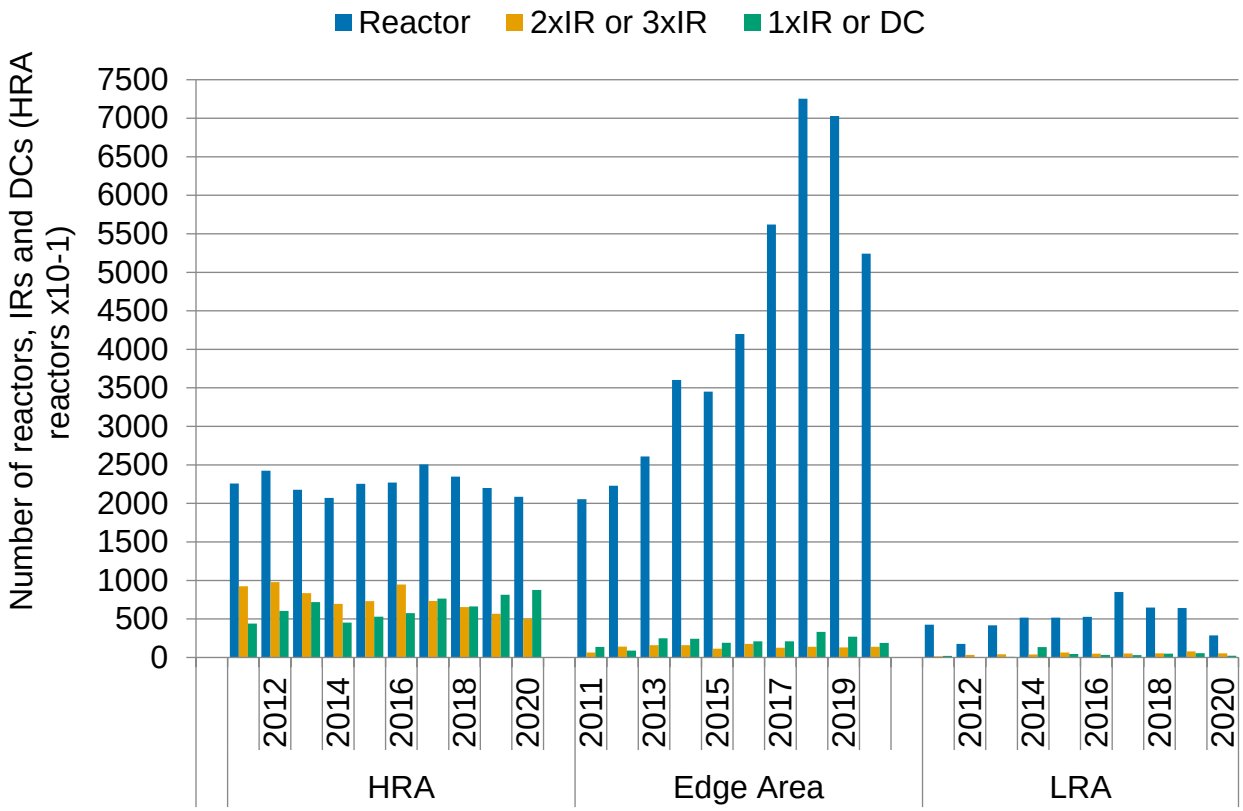


Figure 3.4.10 Number of reactors, inconclusive reactors and direct contacts removed from herds between 2011 and 2020, by risk area. Note - HRA reactors presented as a tenth of their true value.

- Most cattle removed over the past ten years are reactors taken from the HRA, with substantial numbers also removed as DCs or IRs.
- The number of cattle removed as reactors in the Edge Area has increased substantially since 2013, when more stringent controls were introduced.

In 2020, the *median* number of reactors removed per incident was three, as was reported in 2019. The *mean* number of test reactors removed (including IFN-γ test positive animals) in the HRA per TB incident was around six from 2009 to 2014. It has since increased to almost 10, by the end of 2020. Figure 3.4.11a shows the moving average (mean) number of reactors removed in each risk area. There has been greater fluctuation in the Edge Area, which showed a peak in 2015 and has since risen to over 10 since 2018, but slightly decreasing towards the end of 2020. This was most likely due to the increased use of IFN-γ tests in recent years, decreased in 2020 due to the COVID-19 pandemic. There are very few incidents in the LRA, so the mean shows greater variability.

Of the TB incidents that closed in 2020, 278 had no reactors (Figure 3.4.11b). These were either incidents initiated by a slaughterhouse case, or by two or more inconclusive reactors, where subsequent testing in the herd revealed no further reactors. Sixty-six percent of TB incidents in England had two or more reactors, largely driven by the Edge

Area and the HRA (68% and 67% respectively). In the LRA, the proportion was 34% (Figure 3.4.11b).

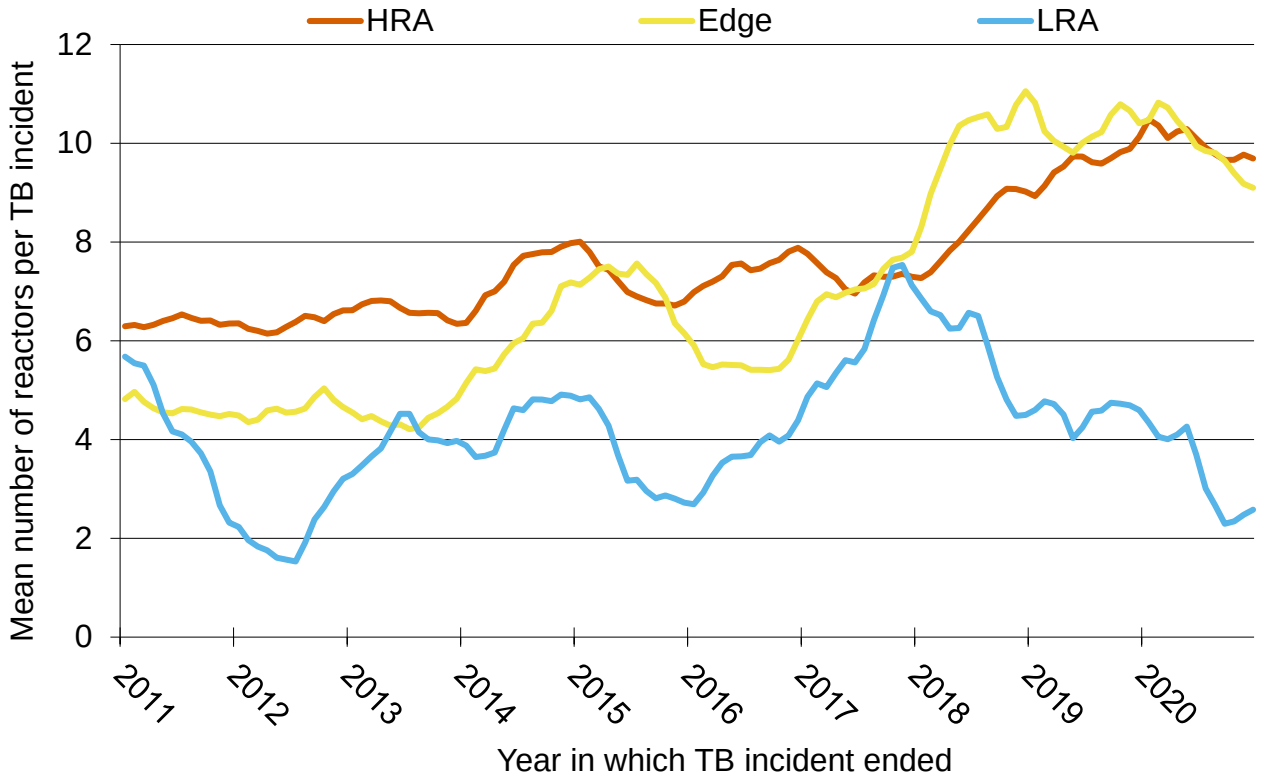


Figure 3.4.11a Rolling mean total number of test reactors taken per TB incident that closed between January 2011 and December 2020, by risk area (12-month moving average)

- The mean total number of test reactors removed in the HRA per TB incident was around six from 2009 to 2014 and has since risen to close to 10 reactors in 2020.
- There has been greater fluctuation in the Edge Area, which showed a peak in 2015, before increasing to over 10 in 2018 and 2019, but falling to just over 9 by the end of 2020.
- There are few incidents in the LRA, so the mean shows greater variability.

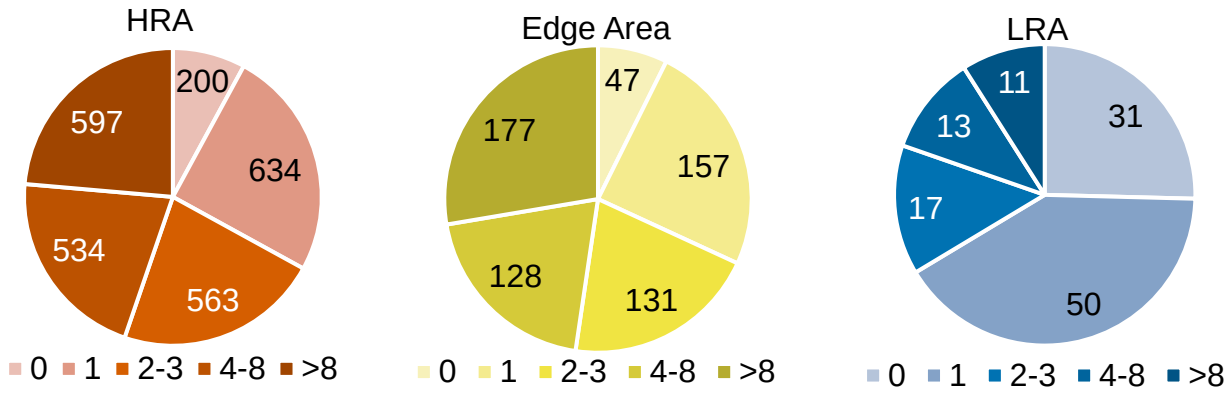


Figure 3.4.11b Number of reactors per TB incident that closed in 2020, by risk area. The frequency of TB incidents for each category of reactor numbers is specified in each pie

- In the HRA, incidents are spread fairly evenly between all reactor categories, with the exception of 0 reactors, which has fewer incidents.
- In the Edge Area, incidents with more than eight reactors were most common.
- In the LRA, incidents with just one reactor were most common.

TB control in wildlife

Although the bovine TB bacterium (*Mycobacterium bovis*) can potentially infect any warm-blooded mammal, the main wildlife reservoir in England is the European badger (*Meles meles*) (Clifton-Hadley, 1993). Badger culling for TB control purposes has been implemented in England since 2013, under licence from Natural England in badger control programme (BCP) areas. TB in badgers is also controlled through the licensed use of injectable BCG vaccine. Licenced badger culling and badger vaccination activities undertaken in 2020 are summarised below.

Licensed badger culling

In 2020, 11 new intensive badger culling areas were licensed in England; six in the HRA, four in the Edge Area and one in the LRA. In total, 44 intensive badger control areas were in operation during 2020, as well as 10 additional areas where Supplementary Badger Control was undertaken (having already completed four annual culling seasons).

Badger removal results from 2020 indicate that all 44 BCP areas undergoing intensive culling achieved the minimum number of badger removals required, with good spatial coverage of the licenced areas. Further information can be found in the Summary of badger control monitoring during 2020.

Licensed badger vaccination

In 2020, 1,094 badgers were vaccinated against bovine TB in England, an increase from 890 badgers in 2019. Licences to vaccinate badgers were in operation in almost every HRA and Edge Area county; excluding the West Midlands, Buckinghamshire and Northamptonshire. Licences were also issued in the LRA counties of Cumbria and Greater Manchester. Together, these licences covered a total of 320.2 km^2 across England. More details can be found in the Summary of badger vaccination in 2020.

4. The TB epidemic in England's risk areas

4.1 Epidemiology of TB in the High Risk Area

- Within the HRA, there was a 3.7% reduction in TB herd incidence in 2020 compared to 2019 (16.2 TB incidents per 100 herd years at risk in 2020, 16.9 in 2019). This change was not significant (p=0.184)
- The total number of TB incidents in 2020 (2,358) also decreased by 5.7% compared to 2019 (2,501). This was not a significant reduction (p=0.403).
- In 2020, TB incidence per 100 herd-years at risk decreased in five HRA counties, compared to a reduction in almost all HRA counties in the previous year. A marked increase was seen in Shropshire in 2020, however other non-decreasing counties either had a stable or slight increase in incidence rate. Shropshire and Staffordshire had the highest incidence of 21 and 19 incidents per 100 herd-years at risk, respectively. The lowest incidence rates were observed in Dorset, Somerset and the West Midlands (as seen in 2019).
- The overall average monthly prevalence for the HRA decreased from 10.5% in 2019 to 9.1% in 2020, however this decrease was not statistically significant (p= p=0.140). As with incidence, prevalence rates varied between counties. The highest end of year herd prevalence rates in 2020 were seen in Shropshire and Wiltshire, with 12% and 11% of herds restricted due to a TB incident at the end of the year, respectively. The lowest prevalence rate was seen in the West Midlands (2%).
- Devon had the highest population of herds in the HRA and accounted for around 23% of all new TB incidents in 2020.
- The duration of TB herd incidents was close to 200 days for all HRA counties in 2020. Counties experiencing the longest TB incidents on average (for incidents that ended in 2020) included Dorset (median duration 213 days), followed by Wiltshire (208 days) and Avon (204).
- Most persistent TB incidents still ongoing at the end of 2020 (duration >550 days), were in Devon and Cornwall, which had the highest proportion of ongoing persistent incidents still open at the end of 2020 (10.6% and 10.7%, respectively).
- The HRA (n=128,858) accounted for 61% of all IFN-γ tests carried out in England in 2020, a large increase from 48% in 2019. Of these IFN-γ tests, 30% (n=38,464) were carried out in Devon alone.

Geographical coverage of the HRA

The HRA extends from the western areas of the Midlands to the south and west of England (excluding the Isles of Scilly) (Figure 4.1.1). In January 2018, the boundary of the HRA was redefined to exclude five counties that were previously divided between the HRA and Edge areas. All these counties (Cheshire, Derbyshire, East Sussex, Oxfordshire and Warwickshire) were moved fully into the Edge Area, reducing the size of the HRA. Data reported in this chapter is for the 12 counties that constituted the HRA from 2018 onwards, unless otherwise stated. TB trends over time compare TB incidents in the post-2018 HRA counties only, and do not include incidents from part-counties that are now Edge Area.

Defra's overall objective for the HRA is to gradually reduce TB incidence following a period of stabilisation.

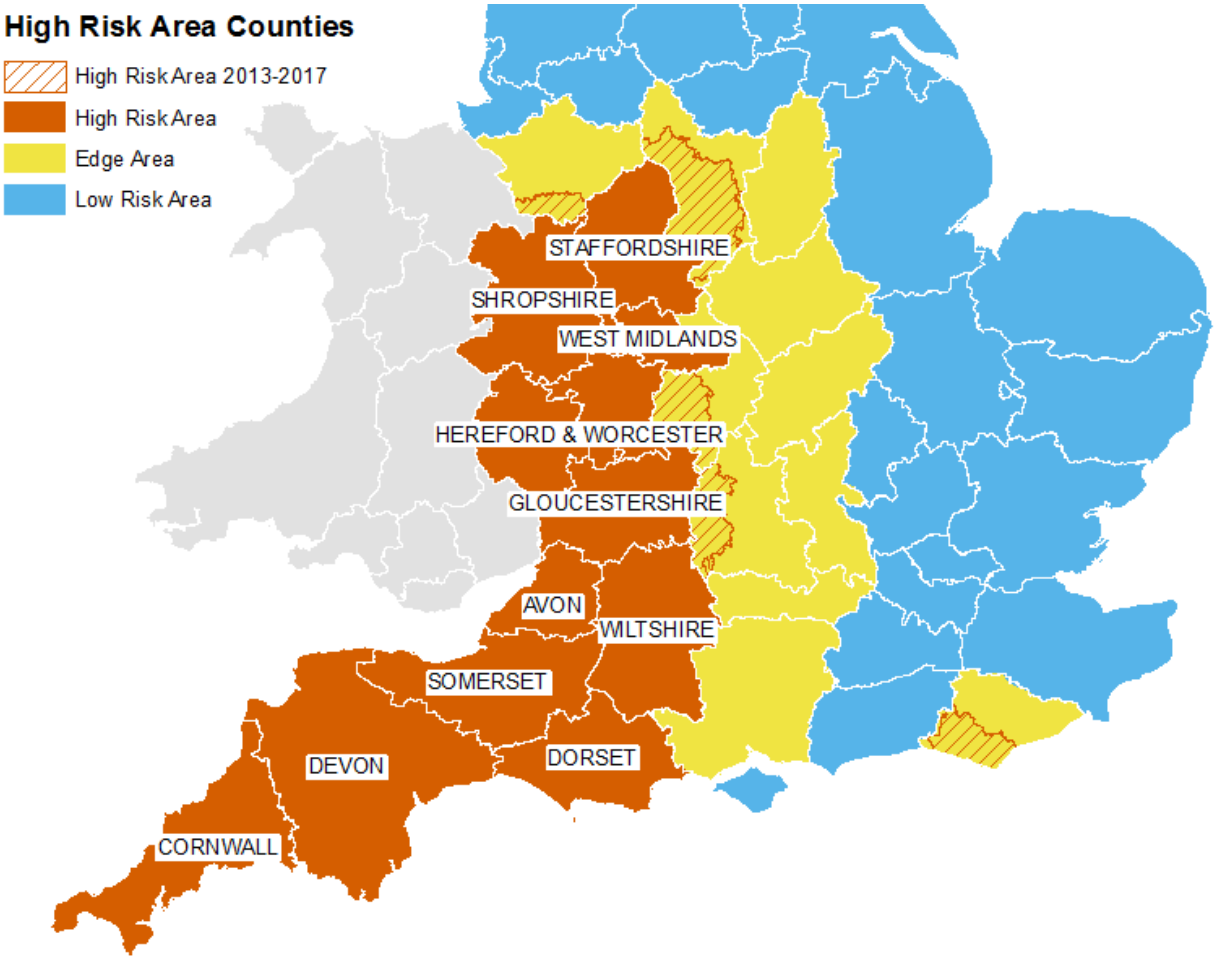


Figure 4.1.1 HRA county map, showing the former HRA sections of five counties with 'split' status between 2013 and 2017

In this chapter, TB incidents are mostly reported with no distinction between status (culture confirmed (OTF-W) or strongly suspected (OTF-S)). This is due to the high positive

predictive value of the skin test in the HRA, which indicates that over 90% of all skin test reactors are truly infected (see Explanatory Supplement for further details).

The herd incidence rate in the HRA in 2020 was 16.2 TB incidents per 100 herd years at risk (100HYR). The incidence rate decreased by 3.7% compared to 2019 (16.9 incidents per 100HYR), however this was not a significant reduction (p value =0.184) (Table 4.1.1).

Table 4.1.1 Table of headline figures for the High Risk Area for TB in England

Year	Total number of new TB infected herds (TB incidents)	Incidence rate	Median duration of TB incident (days) (interquartile range)	Prevalence (average monthly)
2020	2,358	16.2	196 (160 to 294)	9.1
2019	2,501	16.9	205 (166 to 306)	10.5
Change (%)	-5.7	-3.7	+1.5-4.4	-13.2
Statistical significance	(p=0.403)	(p= 0.184)	(p=0.069)	(p=0.140)

Table 4.1.1 Note: The change in total number of incidents was compared using a chi-squared test. The incidence rate is defined as new TB infected herds per 100 herd-years at risk (100HYR). The difference between 100HYR incidence in 2019 and 2020 was compared using the incidence rate ratio. The median duration of TB incidents (days) was compared using the K-sample equality-of-medians test. Average monthly prevalence between 2019 and 2020 was compared using a z-test.

Number of new TB infected herds

The annual number of new TB infected herds is important in terms of disease control resource planning and the number of farm businesses impacted. The number of new TB incidents decreased in eight of the ten HRA counties in 2020 compared to 2019. When considering the trend in new TB incidents over a five-year period (2016 to 2020), a significant decreasing trend was observed for Cornwall (p=0.003), Devon (p<0.001), Dorset (p=0.007), Gloucestershire (p=0.049), Somerset (p=0.004) and Wiltshire (p=0.042). For Staffordshire and Hereford & Worcester, the number of new TB incidents has decreased for three consecutive years, but the five-year trend was not significant (Figure 4.1.2). The greatest reduction in new TB incidents between 2016 and 2020 was seen in Cornwall and Devon (36% and 34% reduction, respectively). Almost a quarter (23%) of all HRA TB incidents were detected in Devon in 2020. The number of new TB incidents increased in Shropshire, from 242 in 2019 to 300 in 2020 (Figure 4.1.2).

Figure 4.1.3 shows the proportion of new TB incidents that were OTF-W (confirmed by the detection of lesions and/or culture positive) in each county. In 2020, the highest proportion of OTF-W incidents were disclosed in Shropshire (72%) Staffordshire (71%) and

Gloucestershire (70%) (Figure 4.1.3). In 2019 Hereford & Worcester had the joint highest proportion of OTF-W incidents, at 75%, however this proportion fell to 65% in 2020. In Devon, Cornwall, Gloucestershire and Avon the proportion of OTF-W incidents has been decreasing for three or more consecutive years. Other HRA counties have had a stable or increasing proportion of OTF-W incidents over the past five years (Figure 4.1.3).

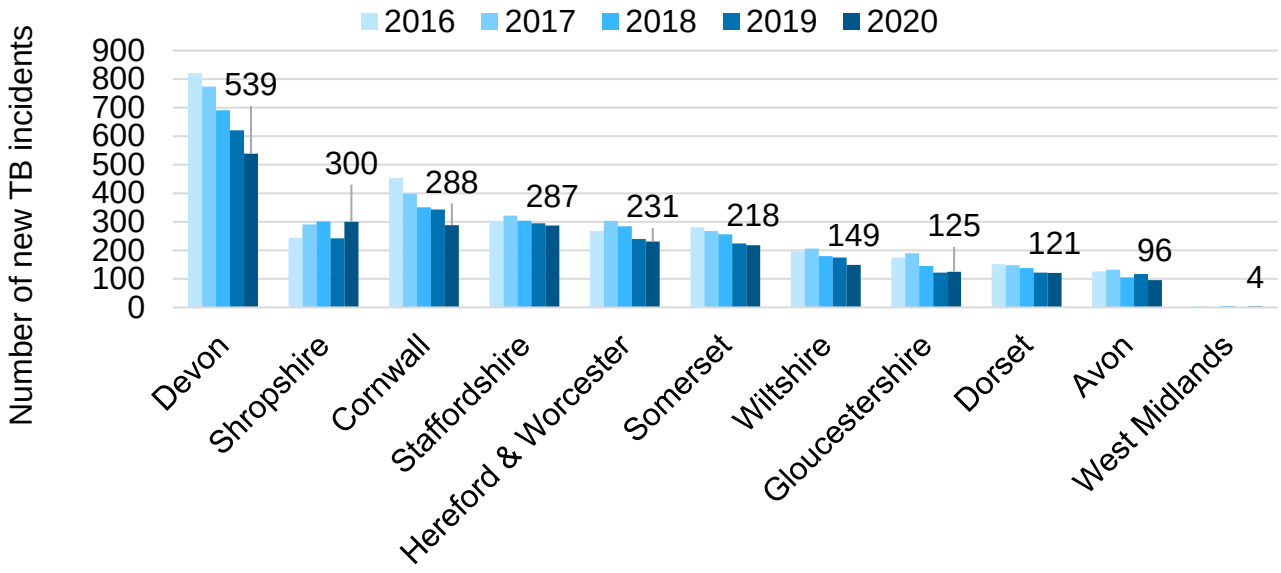


Figure 4.1.2 Annual total number of new TB incidents (OTF-W and OTF-S) by HRA county 2016 to 2020. Counties ranked by total TB incidents. Number of incidents in 2020 labelled on chart.

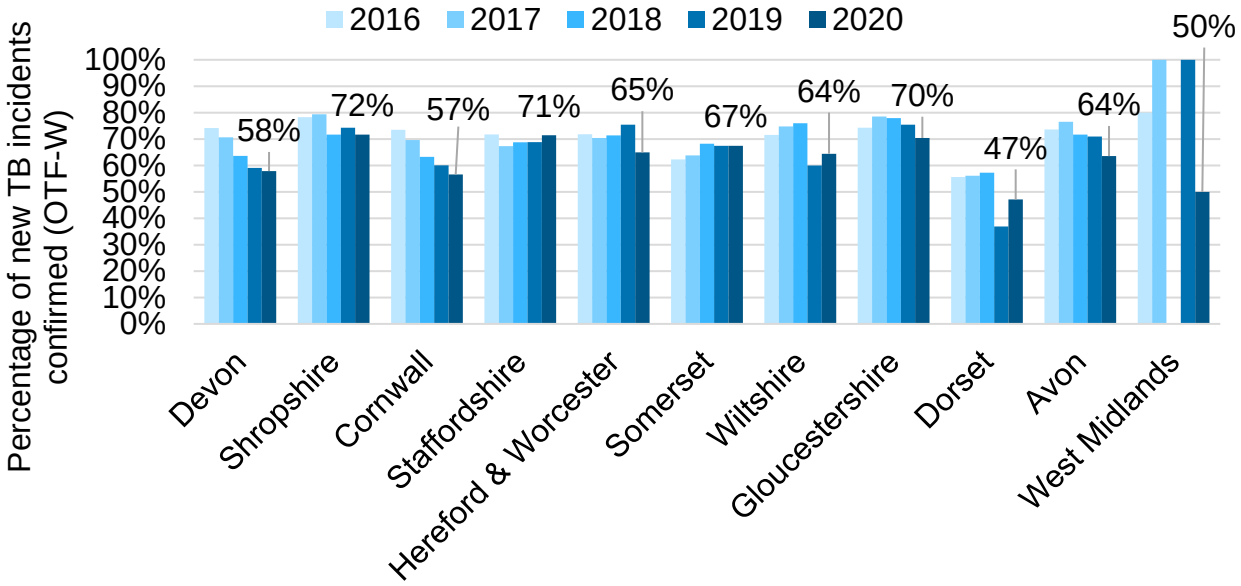


Figure 4.1.3 The percentage of new TB incidents confirmed (OTF-W) in HRA counties, 2016 to 2020. Counties ranked by total TB incidents in 2020. Percentage of OTF-W in 2020 labelled on chart.

County level TB incidence rate

The preferred measure of disease occurrence is incidence per 100 HYR, which reflects the rate at which new TB incidents are occurring in the population of herds at risk. Figure 4.1.4 ranks counties in the HRA by their incidence rate since 2015.

TB incidence decreased from 2019 to 2020 in five of the eleven HRA counties. The highest incidence in 2020 was observed in Shropshire and Staffordshire (20.9 and 19.1 TB incidents per 100 HYR, respectively). TB incidence increased in both Shropshire and Staffordshire in 2020, compared to 2019. In Shropshire, 2020 incidence increased by 24% compared to 2019, a significant inter-year change (p=0.0132). This was also the highest level of incidence reported for Shropshire over the 2015 to 2020 period. In Staffordshire, incidence has been more stable in recent years, and the rate in 2020 (19.1) was lower than that reported in 2017 and 2018 (20.0 and 19.4 TB incidents per 100 HYR, respectively) (Figure 4.1.4).

Cornwall and Wiltshire both had a 14% reduction in incidence in 2020 compared to 2019, however these changes were not statistically significant (p>0.05). A significant inter-year decrease (-12%) was observed in Devon only, from 18.1 to 15.9 incidents per 100 HYR (p=0.029) (Figure 4.1.4).

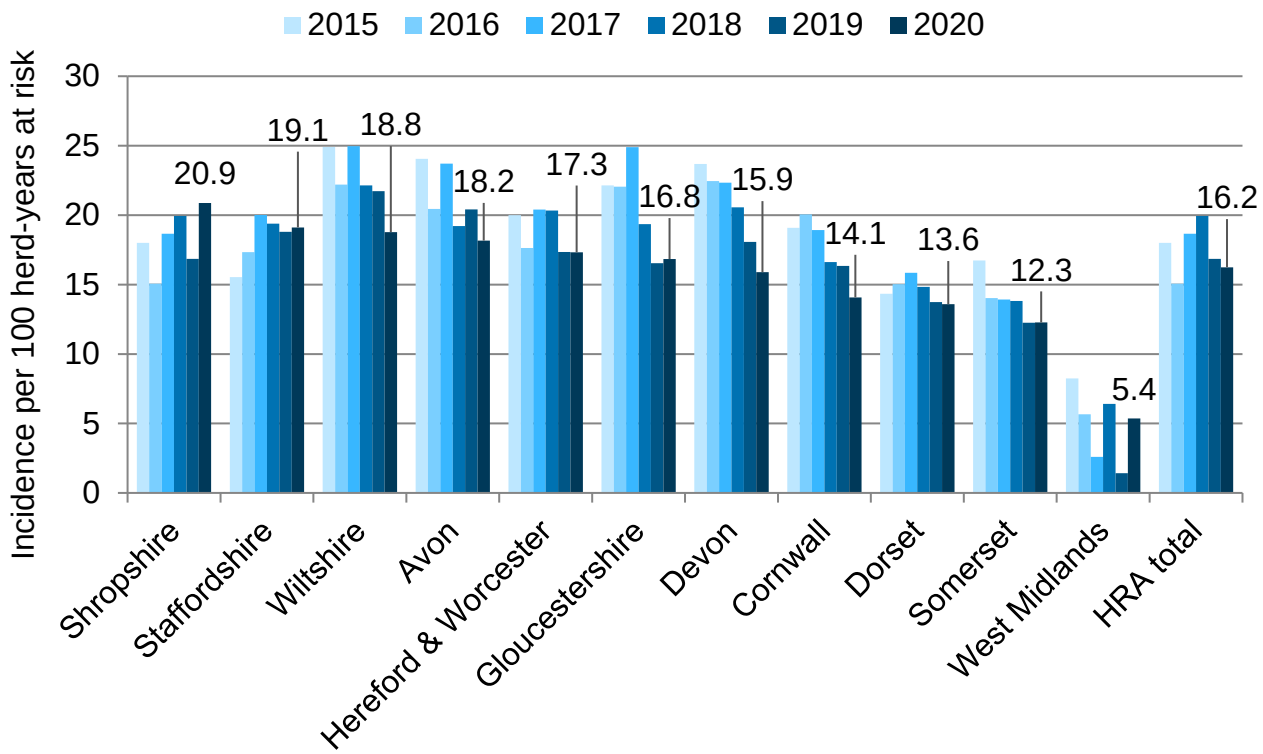


Figure 4.1.4 Incidence rate (per 100 herd-years at risk) from 2015-2020, by HRA county. Counties ranked by incidence in 2020.

- The incidence rate continued to fall in Cornwall, Wiltshire, Devon and Dorset in 2020, compared to 2019. A decrease was also observed in Avon, which had increased in 2019 compared to 2018.
- Shropshire, Staffordshire, Gloucestershire and the West Midlands all had increased incidence in 2020, compared to 2019, however in Staffordshire and Gloucestershire the increases were very small, and for West Midlands the number of incidents is very low (4 in 2020).
- Incidence was stable in Somerset and Hereford & Worcester in 2020, compared to 2019.

County level end-of-year prevalence

End of year herd prevalence figures for 2020 are provided in Figure 4.1.5. Prevalence reflects the proportion of herds that are restricted due to TB at a given point in time, reported here at the 31st December in each year. Prevalence reflects variation in incidence, the duration of TB incidents, and the timing of the start of the incident. Further notes on the methodology of incidence and prevalence measures are described in the Explanatory Supplement.

End of year herd prevalence declined in 2020 for the third year running in the HRA overall (8.9%). This decrease from 2019 to 2020 occurred in seven of the eleven HRA counties. Shropshire, Gloucestershire, Dorset and the West Midlands. As with incidence, Shropshire had the highest prevalence in 2020 (12%). The lowest prevalence in 2020 was seen in Somerset (7%) and the West Midlands (2%) (Figure 4.1.5).

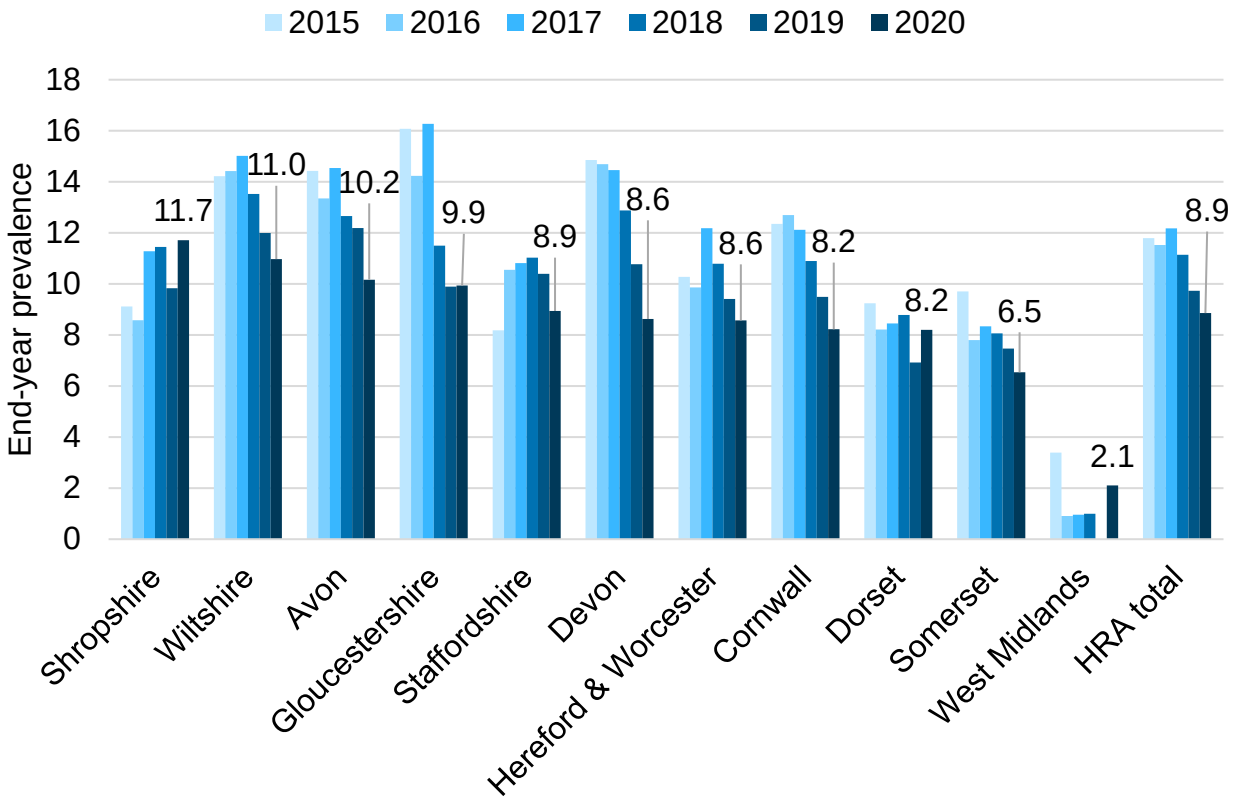


Figure 4.1.5 End of year prevalence from 2015-2020, by HRA county. Counties ranked by decreasing order of prevalence in 2020

Demographics and influence on TB

The risk of TB infection has consistently been shown to increase with the number of cattle in a herd and other factors, like the level of fragmentation of the farm land (Broughan et al., 2016). The total number of cattle is a crude demographic measure, as the cattle distribution and management within herds can influence the risk of disease. Generally, the more cattle within a county, the more TB incidents, but there are exceptions (Figure 4.1.6, also see 3.2.1a and b, Chapter 3.2 Characteristics of herds found infected with TB).

Devon had 23% of all HRA TB incidents in 2020, as well as 23% of herds and 25% of all HRA cattle. In 2020 Devon was followed by Shropshire, with 13% of all HRA TB incidents, but only 10% of herds and 10% of cattle (Figure 4.1.6).

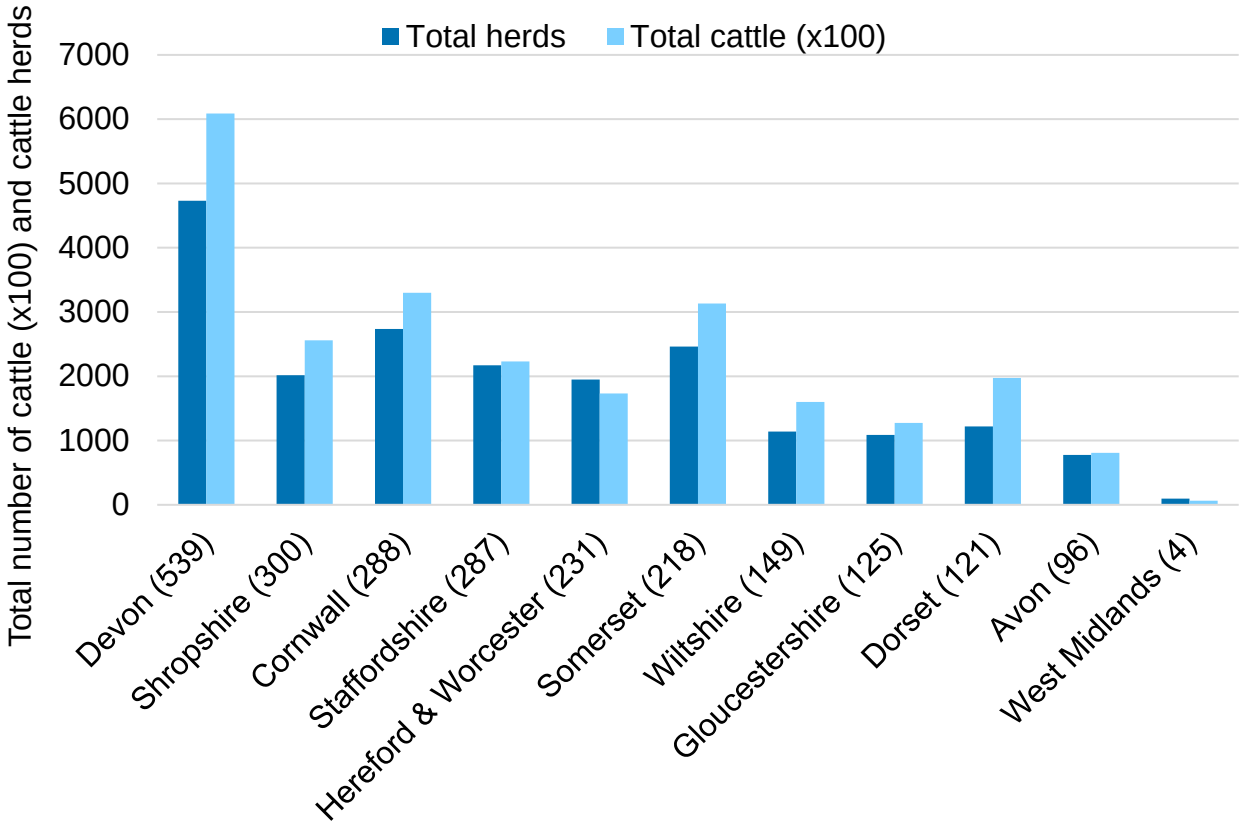


Figure 4.1.6 Total Number of cattle (x100) and herds in HRA counties in 2020. Counties ranked by new TB incident totals (in parenthesis next to county name).

- As expected, counties with larger numbers of cattle and herds, tended to have a greater number of TB incidents.
- Shropshire had more TB incidents than would be expected when considering the number of herds and cattle in the county. Somerset and Dorset appear to have fewer TB incidents than may have been expected.

Figure 4.1.7 shows the relative numbers of herds, and proportions of large herds in the different counties of the HRA in 2020, ranked by the proportion of large herds (>300 cattle). The proportion of large herds in 2019 is very similar to 2020. Although analyses confirm that larger herds are more at risk of disease, the presence of more large herds alone cannot explain the higher incidence rate in the HRA. Some HRA counties with a high proportion of large herds have a relatively low incidence rate; for example, Dorset, has the highest proportion of large and very large herds, but is ranked 8th for incidence per 100 HYR in the HRA).

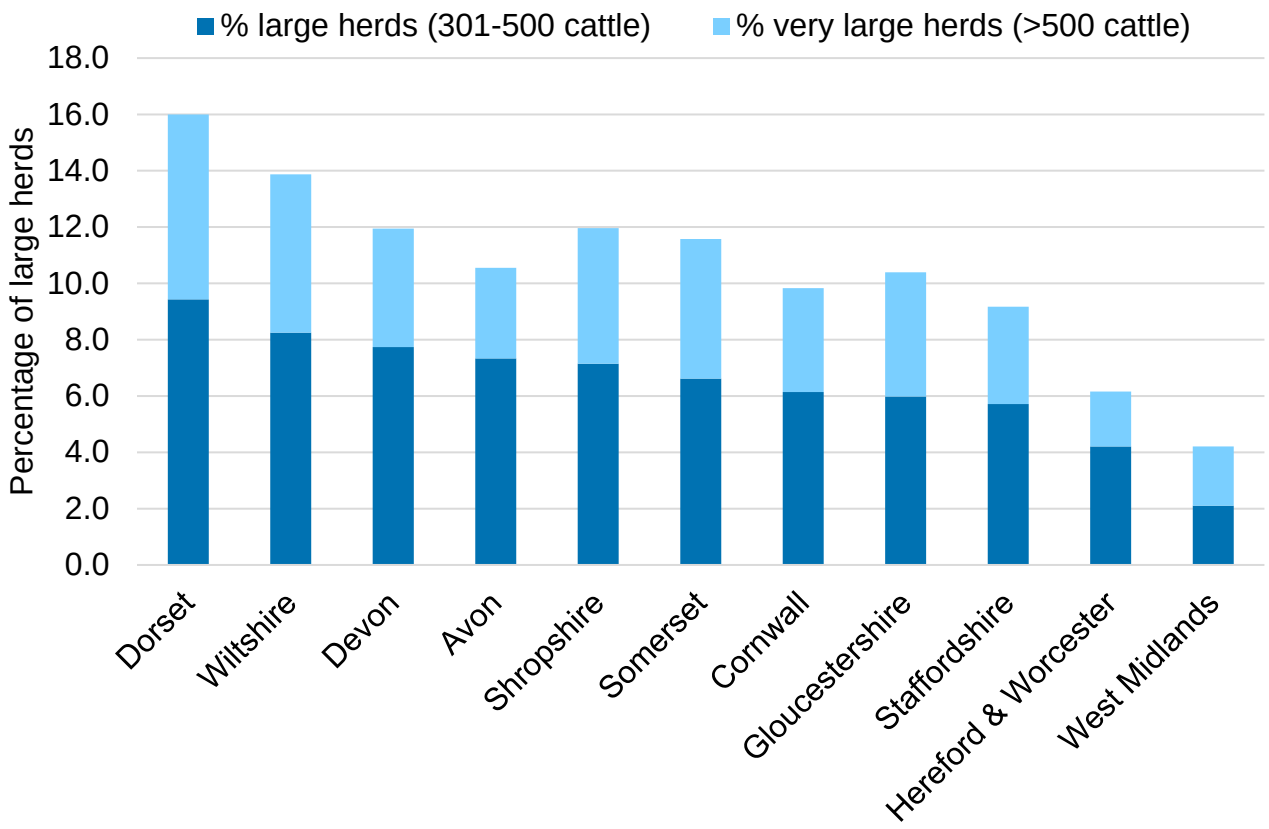


Figure 4.1.7 Percentage of large herds, by HRA county. Counties ranked by herds with 301-500 animals

- Dorset had the highest proportion of herds with greater than 300 cattle (16%) followed by Wiltshire (14%).
- Hereford and Worcester (6%, 120 herds) and West Midlands (4%, 4 herds) had the lowest proportion of herds with over 300 animals.

TB incident duration and persistence

A total of 2,528 TB incidents ended in the HRA in 2020. Figure 4.1.8a shows the median duration of all TB incidents, and OTF-W incidents only, by HRA county. Fourteen of the 2,528 TB incidents that closed in the HRA in 2020 were in finishing units (AFUs). These have been excluded from the median duration calculations presented in Figure 4.1.8a due to differences in management practices for these incidents. In 2020, median duration was close to 200 days for all counties in the HRA. The longest median duration for all TB incidents was Dorset (213 days), followed by Wiltshire (208 days), Avon (204) and Gloucestershire (200.5) (Figure 4.1.8a).

The median duration of confirmed (OTF-W) incidents was longer compared to the median for all TB incidents, across all HRA counties (Figure 4.1.8a). This is likely to be a result of

compulsory interferon-gamma (IFN-γ) testing for OTF-W herds in some parts of the HRA, which can delay a return to OTF status.

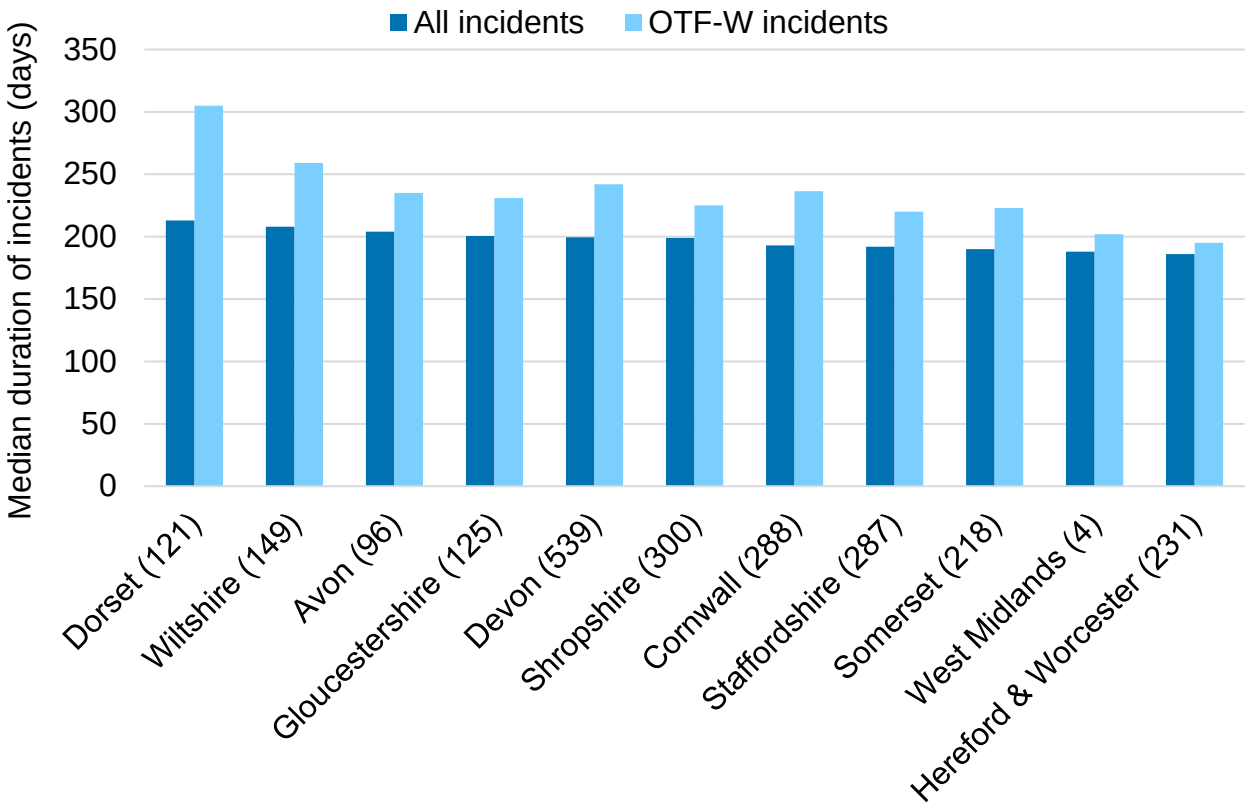


Figure 4.1.8a Median duration (days) of incidents that ended in 2020, for all incidents and OTF-W incidents, by HRA county. Counties ranked by the duration of all TB incidents (number of incidents in parenthesis)

- In all counties, duration of herds under movement restrictions was higher in confirmed (OTF-W) incidents compared to total TB incidents.
- Median duration was highest in Dorset (213 days for all TB incidents)

Figure 4.1.8b shows the median duration of all TB incidents (including finishing units) that closed in each year from 2016 to 2020. For many counties, duration has been fluctuating close to 200 days over the time period. The difference in median duration between counties was not significant in 2020 (p=0.591; K sample equality-of-medians test). Dorset was the only county to rank in the top three for median duration every year since 2016. This may be due to the high proportion of large and very large herds in the county (>300 animals) (Figure 4.1.7). Shropshire, Staffordshire and Somerset all had an increase in median duration of more than 30 days over three or four consecutive years; Staffordshire and Somerset, 2016 to 2019 and Shropshire, 2016 to 2020 (Figure 4.1.8b).

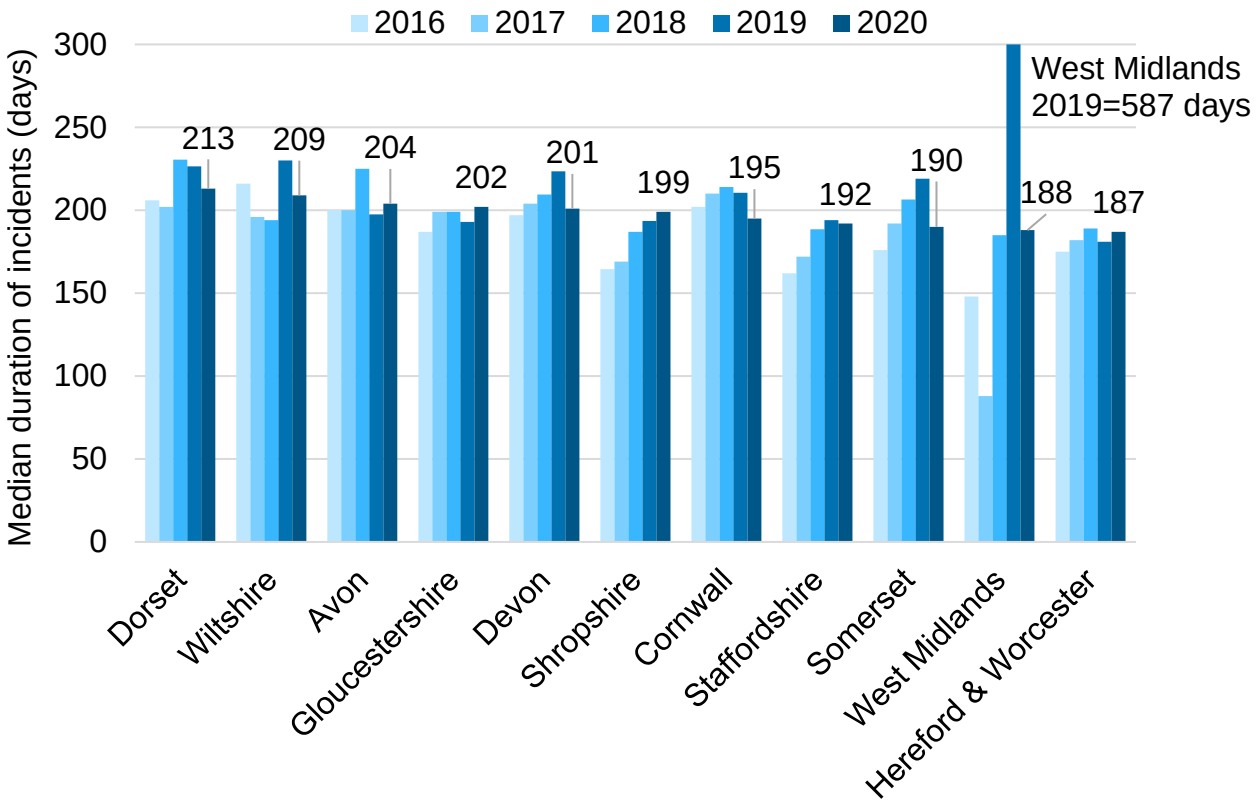


Figure 4.1.8b Median duration (days) of all incidents that ended in each year between 2016 and 2020, by HRA county. Counties ranked by 2020 duration

Recurrence of TB infection

In 2020, 57% of TB incidents in the HRA occurred in herds that had experienced at least one TB incident in the previous three years. This recurrence rate was higher than in the other risk areas in England (Edge Area - 41% and LRA - 13%). Within the HRA, recurrence was highest in Wiltshire (64%) and Avon (63%), and lowest in Shropshire (52%) and the West Midlands (0%, none of four TB incidents) (Figure 4.1.9).

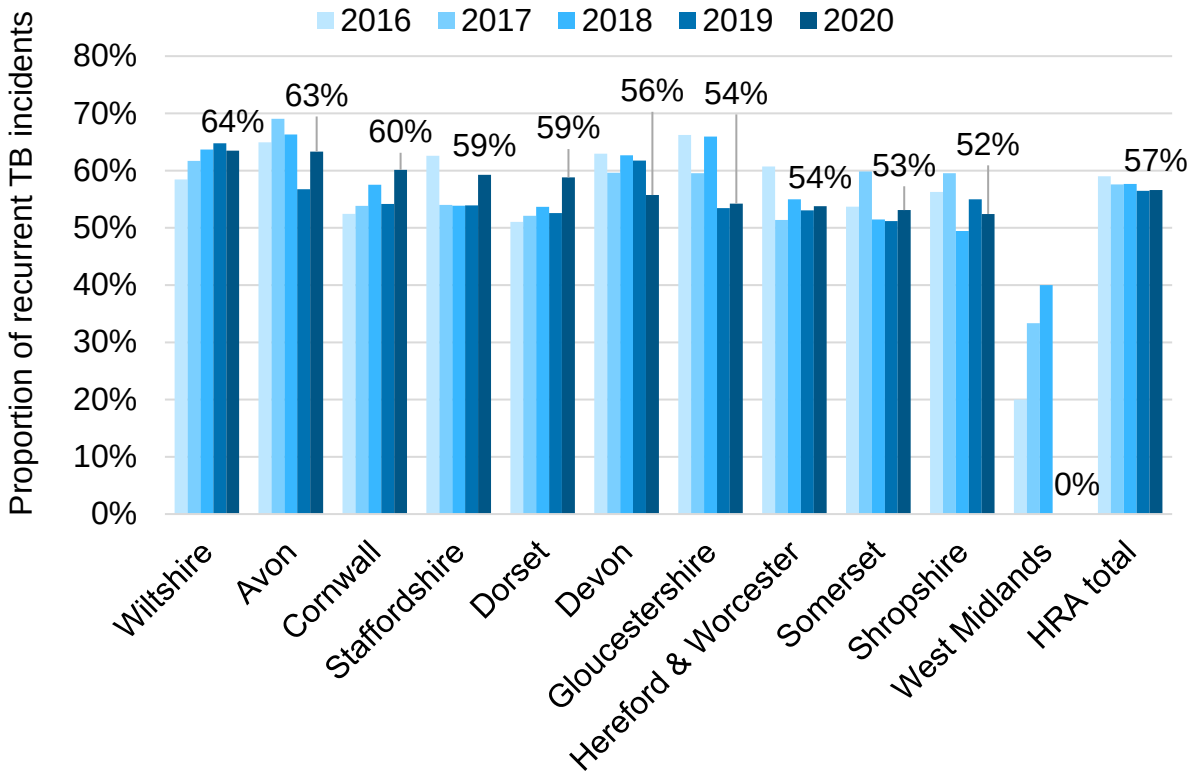


Figure 4.1.9 Annual proportion of TB incidents in herds that had experienced any TB incident in the previous three years, by HRA county (2016 to 2020). Counties ranked by decreasing recurrence in 2020.

The high positive predictive value of the skin test in the HRA together with the need to intensify the efforts to tackle disease in this area and reduce recurrence, justifies the application of two successive short interval tests (SITs) at severe interpretation at the beginning of any new incident in the HRA irrespective of post-mortem results. This, along with the increased use of the IFN-γ blood test in the HRA since April 2017, should help reduce recurrence due to recrudescence and may also reduce the severity of incidents. Other measures implemented in the HRA may also contribute to reducing recurrence, for example encouraging good biosecurity and badger control as both target recurrence due to reinfection from wildlife.

Incidents lasting for more than 550 days are deemed to be persistent and affected herds are eligible for enhanced management procedures (Figure 4.1.10). During 2020, 185 persistent incidents were resolved in the HRA, however 133 were still ongoing at the end of the year.

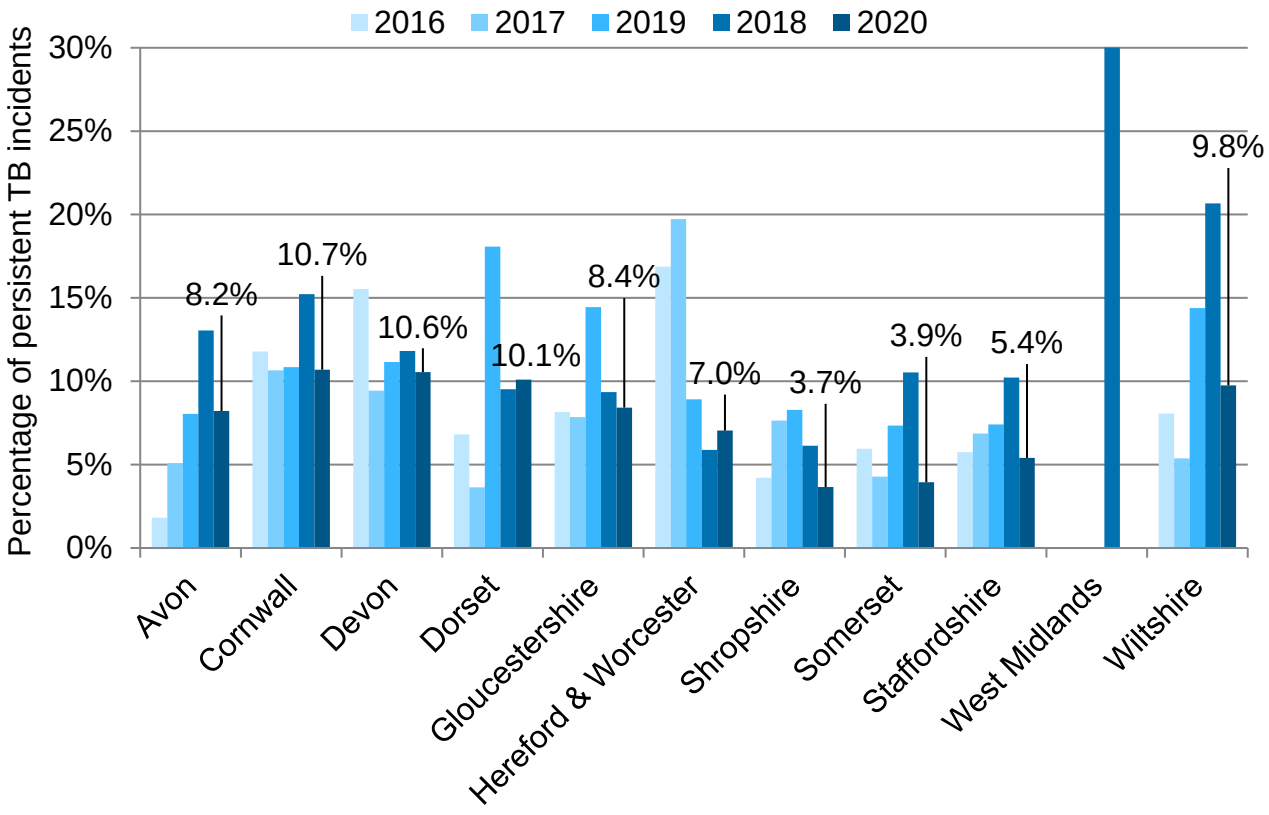


Figure 4.1.10 Percentage of persistent TB incidents (duration over 550 days) that were still ongoing at the end of 2020 in the HRA

- The proportion of persistent incidents was highest in Cornwall, Devon and Dorset.

TB surveillance and incident detection

A detailed description of the test types included in each of the four TB surveillance streams explored in this chapter can be found in Chapter 3.3 Finding Infected herds. Figure 4.1.11 shows the proportion of TB infected herds disclosed by each surveillance stream and county. In the HRA overall, the highest proportion of TB incidents were disclosed by Area & Herd Risk tests (45%). This was the leading disclosing surveillance type in most counties, however in Hereford and Worcester, Shropshire, Somerset and the West Midlands more incidents were detected through routine testing.

Overall, routine annual surveillance tests disclosed the second highest proportion of TB incidents in the HRA (34%), with the highest proportion of incidents disclosed in West Midlands (2 out of 4 TB incidents, 50%), followed by Hereford and Worcester (44%). Trade & other surveillance tests led to the fewest detections of TB in the HRA in 2020 (8%), with Wiltshire finding the highest proportion of incidents (16%) (Figure 4.1.11).

Overall, backward tracing herd tests were the most efficient tests at detecting incidents within the HRA in 2020 (22 incidents per 100 herd tests). This was second to post-incident

tests, carried out at approximately six and 18 months after restoration of an OTF herd status, which disclosed 18 TB incidents per 100 herds tested in 2020 (Table 3.3.3.a, Chapter 3.3 Finding Infected herds).

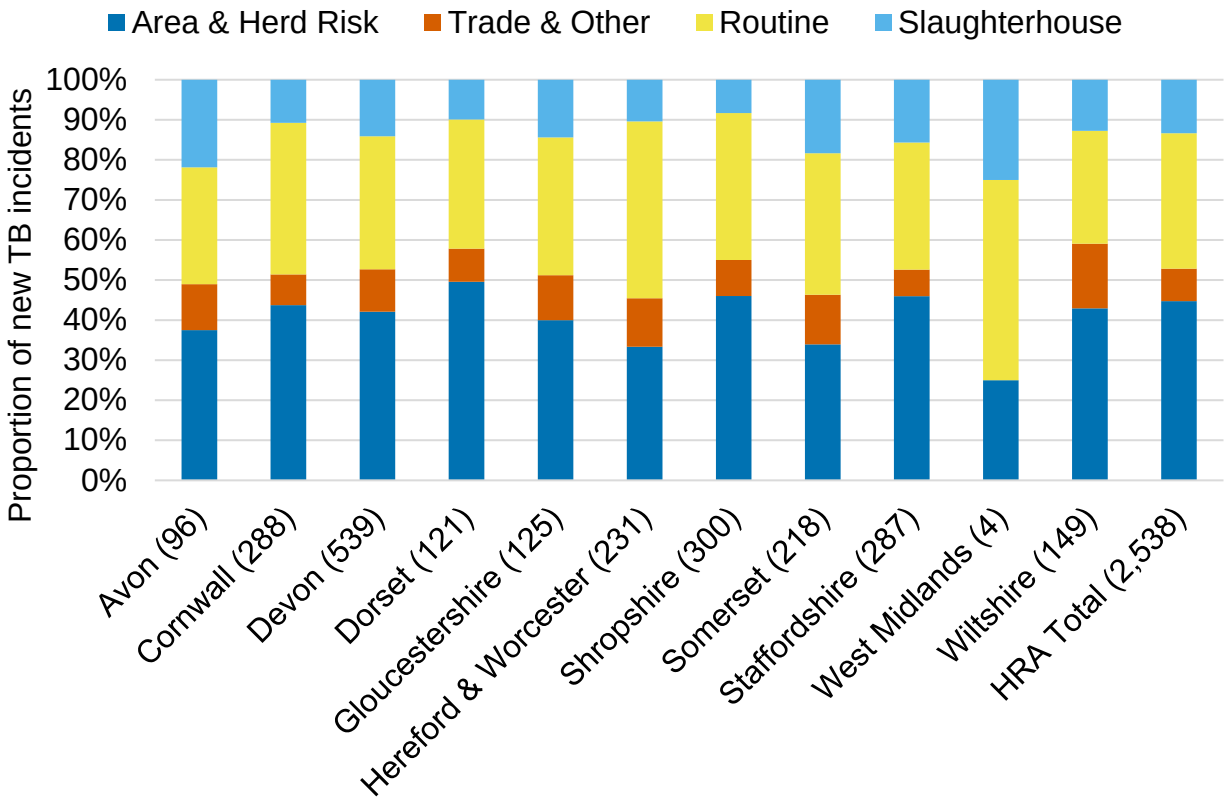


Figure 4.1.11 Proportion of TB infected herds in 2020 in each surveillance stream, by HRA county

In the HRA overall, 13% of all TB incidents and 20% of OTF-W incidents were disclosed through routine post-mortem meat inspection of cattle in slaughterhouses in 2020, as was seen in 2019. Variation between counties can be seen in Figure 4.1.12. Avon (31%) and Somerset (27%) had the highest proportion of OTF-W incidents disclosed by SLH surveillance in 2020. The lowest rates of OTF-W detection by SLH surveillance were reported in Shropshire (11%) and Hereford and Worcester (15%).

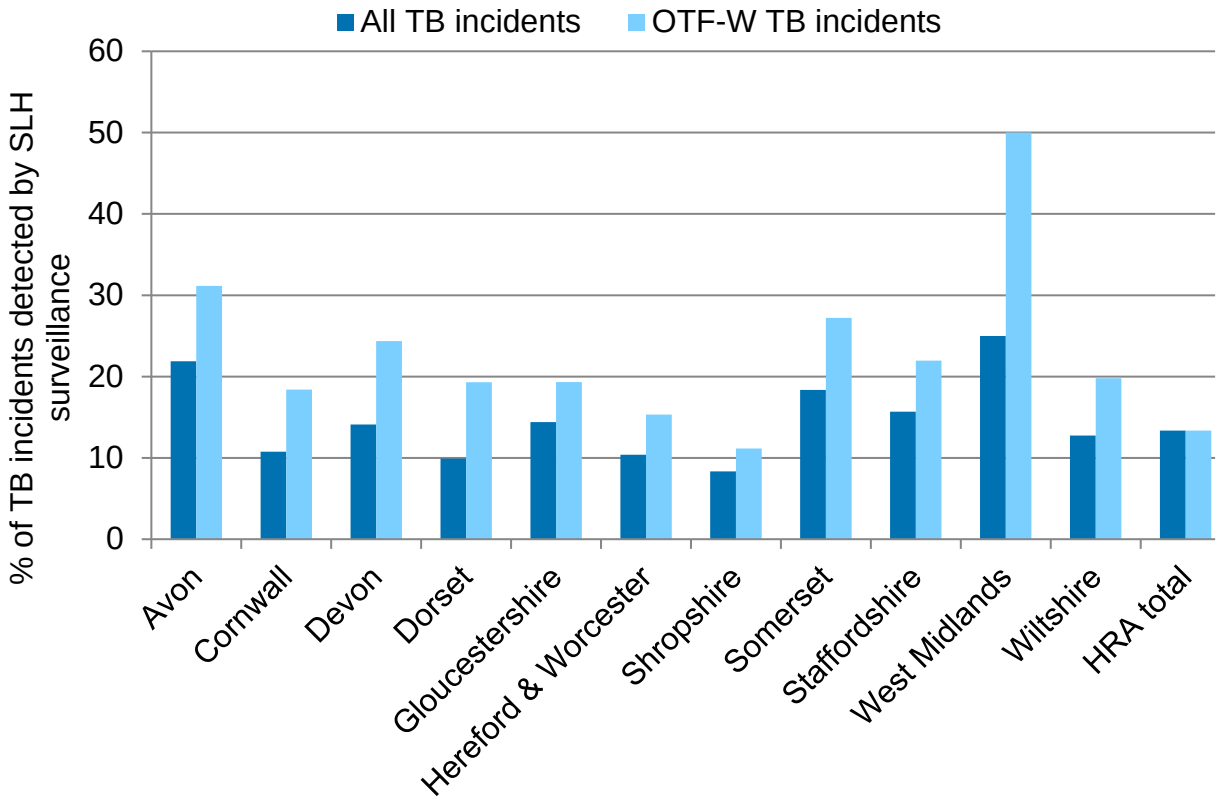


Figure 4.1.12 Percentage of TB incidents disclosed by slaughterhouse surveillance (post mortem meat inspection) in 2020, for all TB incidents and OTF-W incidents, by HRA county

Number of reactors removed

Overall, 20,863 cattle were slaughtered for TB control purposes in the HRA in 2020. These comprised 14,843 skin test (SICCT) reactors, 5,895 IFN-γ blood test positive animals and 125 antibody test positives. The total number of animals removed, and the proportion that were detected by IFN-γ testing, varied by county. Most cattle were removed from herds in Devon (5,376 animals), where 40% of reactors were detected by IFN-γ testing. As in previous years, the county with the highest proportion of reactors detected by IFN-γ testing was Dorset (48%) followed by Devon (40%) and Somerset (38%) (Figure 4.1.13). No IFN-γ test positives were detected in the West Midlands in 2020.

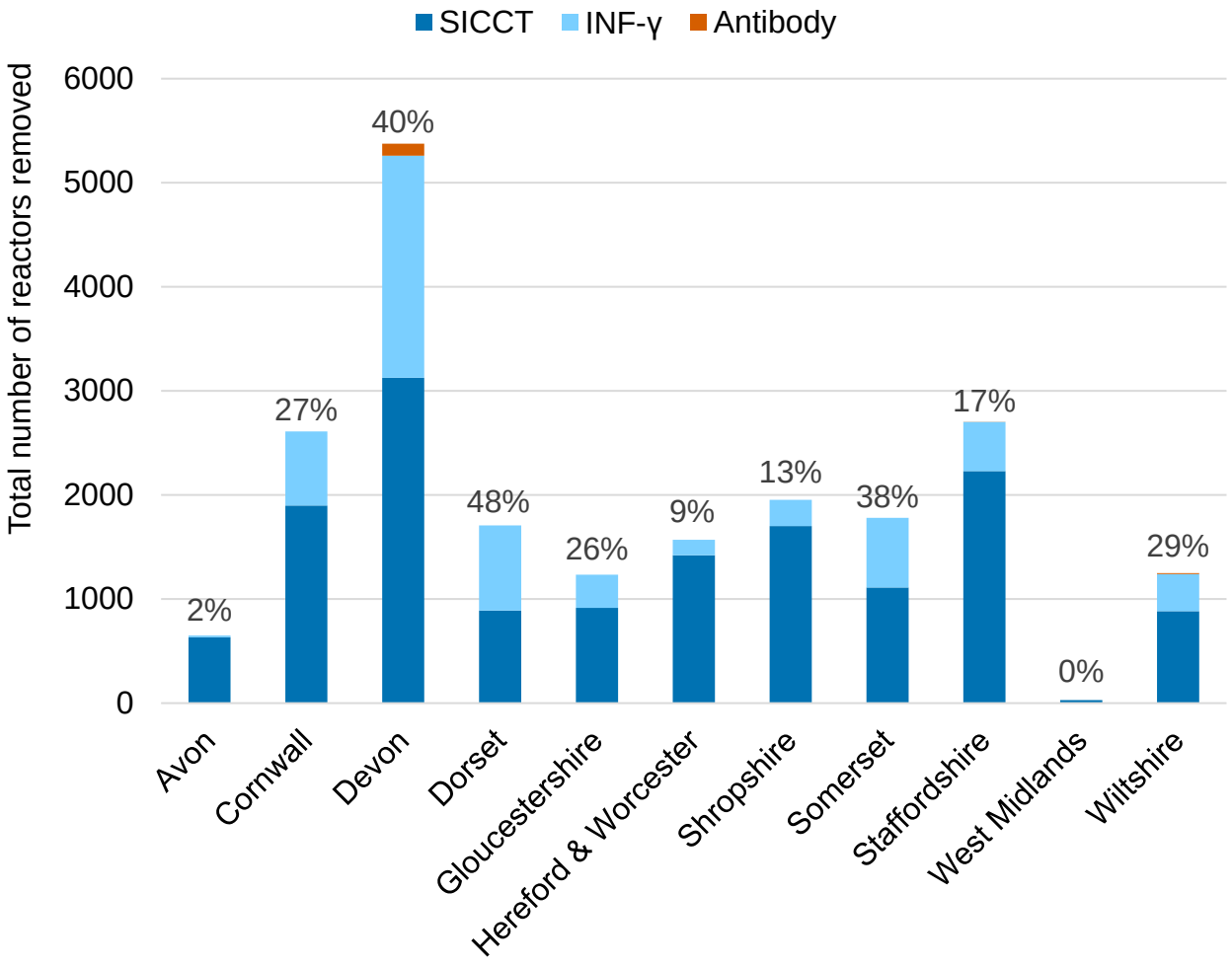


Figure 4.1.13 Number of reactors removed in 2020 due to SICCT, IFN-γ and antibody testing, by HRA county. Proportion of reactors removed due to IFN-γ testing above bars.

Use of the IFN-γ test in the HRA

The IFN-γ blood test supplements the SICCT skin test during certain OTF-W TB incidents in the HRA. Supplementary testing is used to maximise the detection of infected cattle and minimise the risk of residual cattle infection when OTF herd status is restored.

The application of IFN-γ testing is mandatory for OTF-W TB incidents that occur in BCP areas which have completed two or more successful culling seasons. In 2020, this applied to parts of Cornwall, Devon, Dorset, Gloucestershire, Herefordshire, Somerset, Staffordshire and Wiltshire. For more information on TB control in wildlife see chapter 3.4. Mandatory IFN-γ tests are also used in the enhanced management of persistent incidents where infected herds have been under restriction for more than 18 months. Furthermore, herds with explosive or chronic incidents, which are being considered for whole or partial slaughter, receive mandatory IFN-γ tests. Additional deployment of the IFN-γ blood test was discretionary in the HRA. This included the application of a flexible extended version

of IFN-γ in cases, where co-infection with *Mycobacterium avium* subspecies *paratuberculosis* (Johne's disease) infection was suspected to interfere with the detection of *M. bovis*-infected animals.

The total number of IFN-γ tests carried out in the HRA has increased rapidly in recent years. In 2016 just under 6,000 tests were performed. In 2017 this rose to 19,000 IFN-γ tests, increasing four fold to 80,000 in 2018. In 2020, 128,858 animals received an IFN-γ test in the HRA, with 5% identified as positive overall. Although this is a 10% increase on the number of HRA IFN-γ tests performed in 2019 (117,381), the rise is smaller than expected based on the number of eligible herds. During the COVID-19 pandemic some supplementary IFN-γ tests were not performed, especially where the application was discretionary. For example, repeat IFN-γ testing may not have been applied to some herds that would otherwise have received multiple rounds of testing; while in other herds only specific epidemiological groups were tested, rather than the whole herd over six months of age.

As in previous years, the proportion of animals testing positive to the IFN-γ test varied by HRA county: from 3% in Shropshire, to 7% in Avon and Devon. The biggest changes in the number of tests performed in 2020 compared to 2019 were seen in Staffordshire and Shropshire (7.0 and 2.7 fold increase, respectively). A decrease in the number of tests performed was seen in Devon, Dorset, Wiltshire, Hereford & Worcester and Avon (Figure 4.1.14).

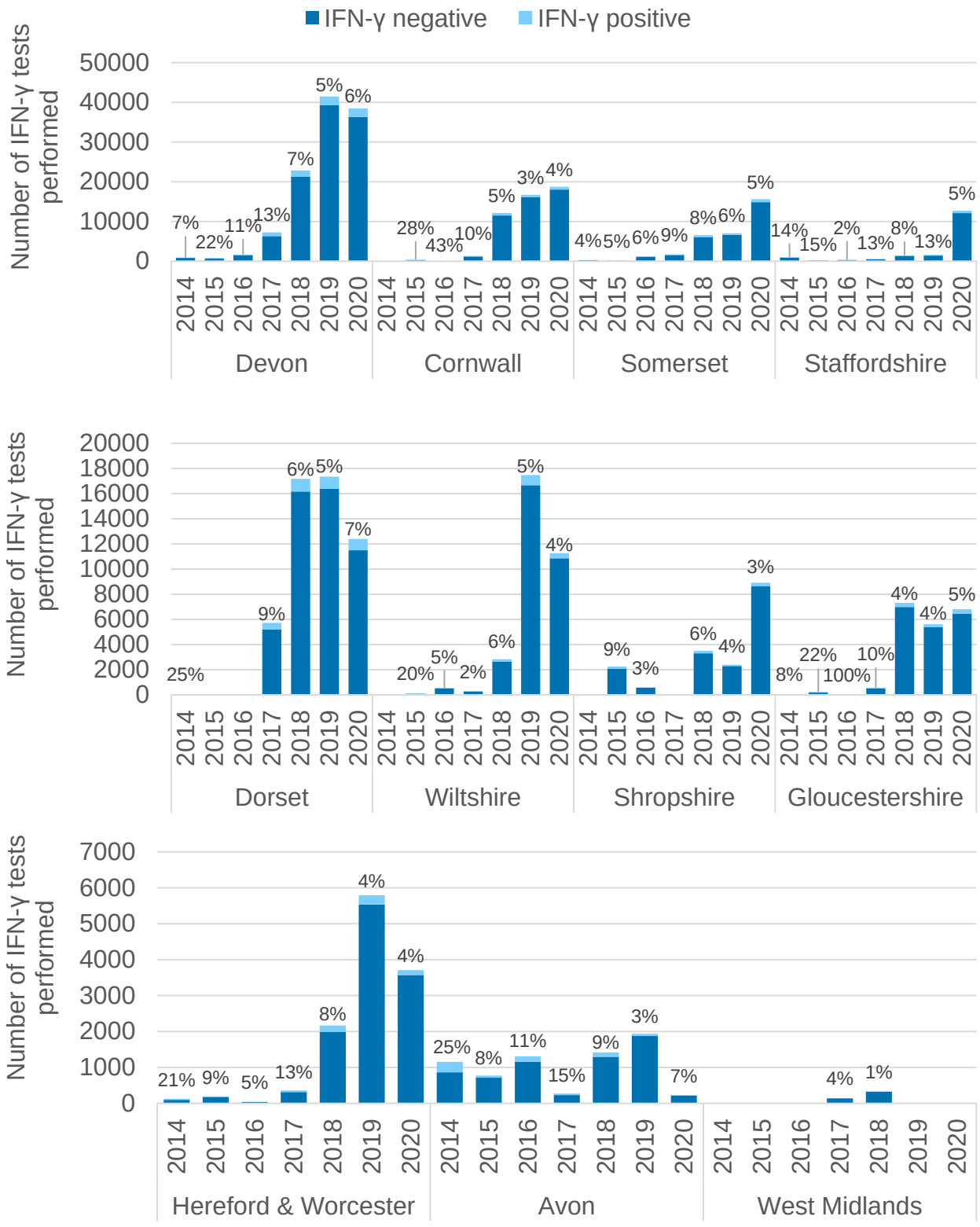


Figure 4.1.14 Number of IFN-γ tests performed in HRA counties, 2014-2020. The percentage of tests with a positive result are labelled on the chart. Note y axis scale is different between charts.

Source of infection

In the HRA, one third of all new TB incidents are randomly selected for an in-depth veterinary investigation to attempt to identify the most likely source of TB infection within the herd. Up to three potential sources may be identified during the investigation, and these are weighted by the veterinarian's certainty about the source based on the available evidence. More details on the methodology for identifying and weighting sources of infection can be found in Chapter 3.2 Characteristics of herds found infected with TB and the Explanatory Supplement.

In 2020, 1,094 new TB incidents were selected for an investigation in the HRA. Badgers were identified as the predominant source of infection, accounting for 56% of the source in the HRA, when weighted by the certainty calculation. Badgers were the most strongly identified source in every HRA county, ranging from 79% of the weighted source in the West Midlands (2 investigations) and 73% in Cornwall (137 investigations), to 47% in Devon (272 investigations) and 43% in Wiltshire (59 investigations).

4.2 Epidemiology of TB in the Edge Area

- This chapter summarises key findings from the Edge Area Year End Descriptive Epidemiology Reports.
- Six-monthly routine herd surveillance testing was in operation in the endemic portion of the Edge Area in 2020. In the remainder of the Edge Area, compulsory radial testing for herds located within 3km of any OTF-W cattle herd complemented annual routine testing.
- The number of new TB incidents disclosed in the Edge Area in 2020 (n=672) increased by 5.0% compared to 2019 (n=641). Decreases were seen in seven of 11 Edge Area counties, with increases in Derbyshire, Leicestershire, East Sussex and Northamptonshire. In 2020, the greatest number of incidents were detected in Cheshire (n=160), the least in Nottinghamshire (n=13).
- Overall, there was a slight non-significant increase in TB incidence per 100 herd years at risk (HYR) in the Edge Area in 2020 compared to 2019 (10.1 TB incidents per 100 HYR in 2020, 9.9 in 2019, p=0.685). Additionally, incidence per 100 unrestricted herds tested increased in 2020 compared to 2019.
- The end-of-year herd prevalence increased in 2020 (5.7%) compared to 2019 (5.3%) for the Edge Area overall. This increase was seen in most of the counties, with the exception of Oxfordshire, Warwickshire, Berkshire and Cheshire.
- The duration of TB incidents varied between counties. On average, the longest TB incidents (that ended in 2020) were in Oxfordshire, Warwickshire and Berkshire, lasting around eight months on average.
- Over forty percent (41%) of new TB incidents in the Edge Area in 2020 occurred in herds that had experienced at least one TB incident in the previous three years. Recurrence was highest in Oxfordshire (55%), Warwickshire (52%) and Cheshire (52%).
- The sources of infection for herds with TB incidents was highly variable between counties. Badgers were identified as the primary weighted source of TB infection in eight Edge Area counties, most prominently in Cheshire (64.3%), Derbyshire (57.4%), Northamptonshire (55.7%), Oxfordshire (53.3%) and Berkshire (49.6%). Cattle movements were identified as the primary weighted source in Buckinghamshire (51%) and Hampshire (36.5%).
- New areas of endemic infection and new clusters are emerging in several counties in the Edge Area.

Geographical coverage of the Edge Area

The Edge Area forms a buffer separating the HRA of England to the south and west from the LRA of England to the north and east (Figure 4.2.1). In 2018, the Edge Area was expanded westward to fully include five counties that were previously split between the HRA and Edge Area (Cheshire, Derbyshire, East Sussex, Oxfordshire and Warwickshire). Data reported in this chapter is for the 11 full counties that made up the Edge Area from 2018 onwards. TB trends over time compare TB incidents in the fully post-2018 Edge Area counties.

Six-monthly routine herd surveillance testing remained in operation in 2020 in the endemic portion of the Edge Area adjoining the HRA after being introduced in January 2018 (Figure 4.2.1). In the remainder of the Edge Area, compulsory radial testing for herds located within 3km of any OTF-W cattle herd complemented routine annual testing.

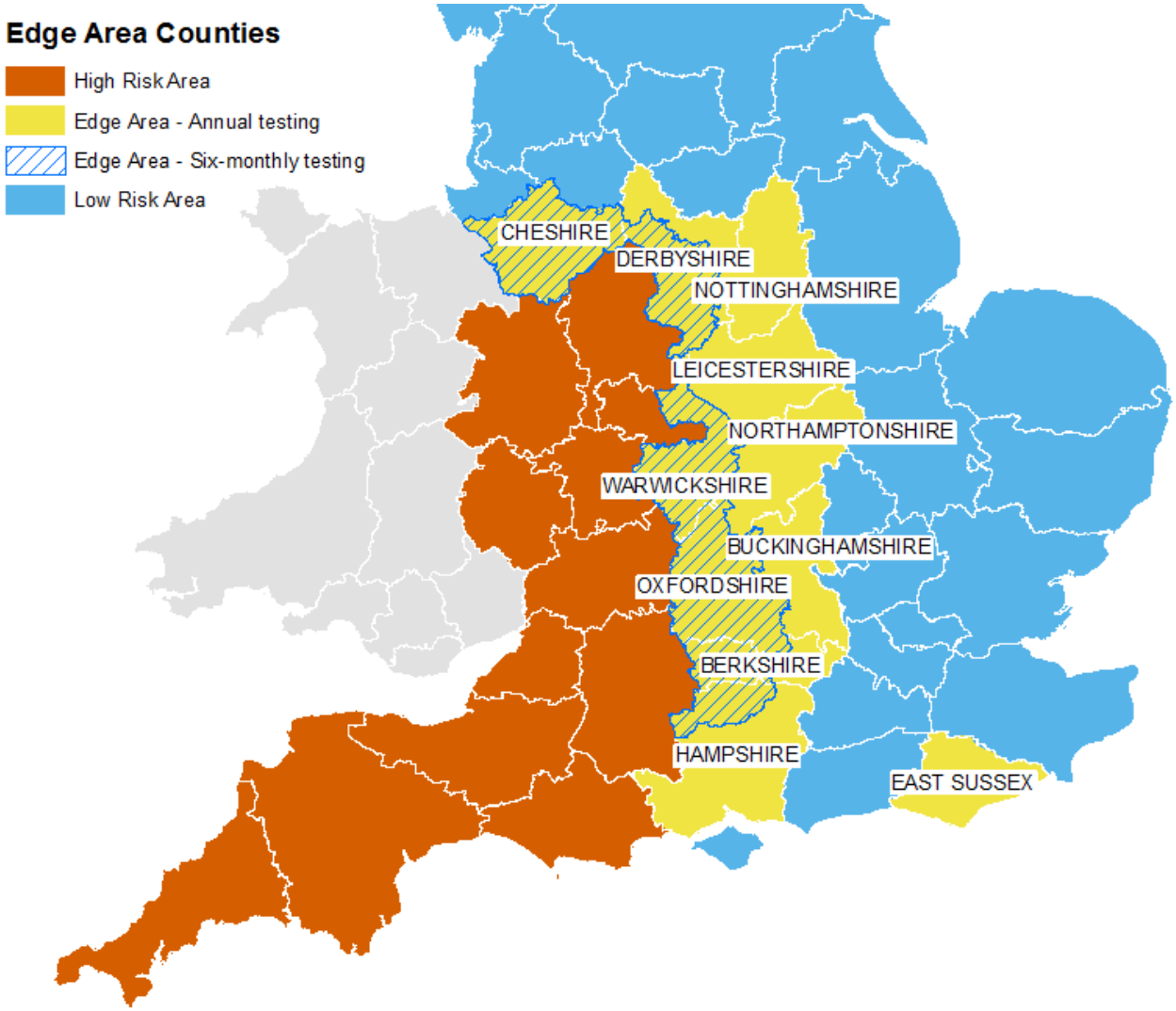


Figure 4.2.1 Edge Area county map, showing the areas under six-monthly routine herd testing

County level number of new TB incidents

The number of new TB incidents increased in the Edge Area overall in 2020 (n=672) compared to 2019 (n=641). This was mainly driven by a large absolute rise in the number of new incidents in Derbyshire (from 114 in 2019 to 147 in 2020). After a decrease in the number of new TB incidents in Derbyshire between 2018 (n=717) and 2019, the increase in 2020 is in line with the trend observed since 2015 (n=526). The number of new TB incidents decreased in most counties in 2020 compared to 2019, except for Derbyshire, Leicestershire, East Sussex and Northamptonshire (Figure 4.2.2).

The number of new incidents was highly variable between counties. The highest number of new incidents were disclosed in Cheshire, Derbyshire, Oxfordshire, Leicestershire and Warwickshire. Historically counties adjacent to the HRA disclosed the highest number of new incidents, whereas this was not the case in 2020. Notably, East Sussex presented an almost 50% increase in incidents (average of 23 incidents in the past four years to 41 incidents in 2020).

Apart from Leicestershire and East Sussex, these are all Edge Area counties where six-monthly routine herd testing is carried out, either in part, or the whole of the counties (Figure 4.2.1). In 2020, the lowest number of new TB incidents were disclosed in Nottinghamshire (Figure 4.2.2).

The percentage of new TB incidents that were OTF-W (confirmed by the detection of lesions and/or culture positive) in each county between 2016 and 2020 is shown in Figure 4.2.3. In 2020, the percentage of OTF-W incidents was highest in Warwickshire (70%) and lowest in East Sussex (29%). The percentage OTF-W has decreased over three consecutive years in Oxfordshire, from 72% in 2017 to 61% in 2020. In Leicestershire, Buckinghamshire and Berkshire the percentage of OTF-W has increased over two consecutive years, 2018 to 2020. A large decrease was seen in 2020 compared to 2019 for Cheshire and Derbyshire (67% and 71% in 2019 respectively, to 53% in 2020 for both counties, Figure 4.2.3).

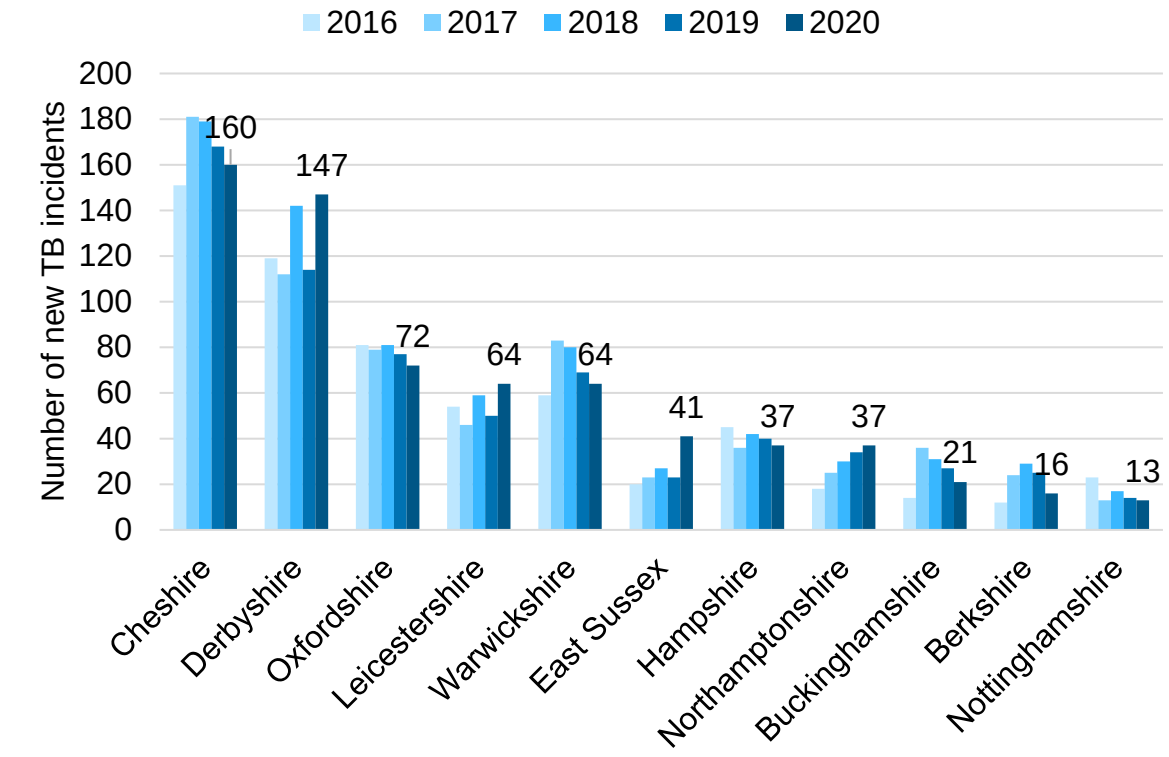


Figure 4.2.2 Annual total number of new TB incidents (OTF-W and OTF-S) by Edge Area county 2016 to 2020. 2020 incidents labelled on chart.

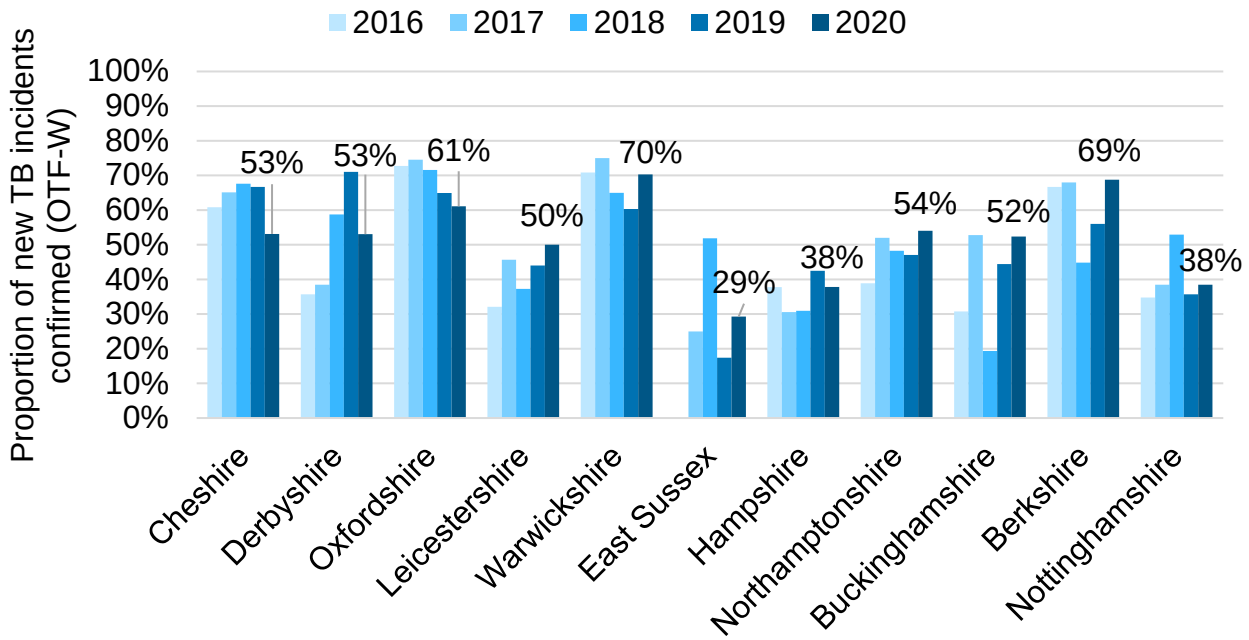


Figure 4.2.3 The percentage of new TB incidents confirmed (OTF-W) in Edge Area counties, 2016 to 2020. Counties ranked by total new TB incidents in 2020. Percentage of OTF-W in 2020 labelled on chart.

County-level TB incidence rate

There was a slight, statistically non-significant increase in the TB herd incidence rate in the Edge Area as a whole in 2020 compared to 2019 (10.1 TB incidents per 100 HYR in 2020, up from 9.9 in in 2019, p=0.68).

At the county level, incidence per 100 HYR increased in four counties, and decreased in seven. East Sussex was the only Edge Area county with a significant increase in incidence per 100 HYR between 2019 (4.56) and 2020 (8.08) (p=0.026), although it remained below the incidence for the Edge Area as a whole. The majority of incidents were located in the former HRA part of the country where TB is endemic and there is a higher density of cattle, and 66% of the OTF-S incidents were disclosed by an inconclusive result to a retest of an inconclusive reactor, which is unusually high.

As in previous years, there was wide variation in the burden of TB across the Edge Area in 2020. Incidence ranged from 19.7 herds per 100 HYR in Oxfordshire, down to just 3.2 in Nottinghamshire (Figure 4.2.4). Measures of incidence presented here include all incidents (OTF-W and OTF-S). They may differ from those published in the Year End Descriptive Epidemiology reports, which exclude TB incidents in non-grazing Approved Finishing Units.

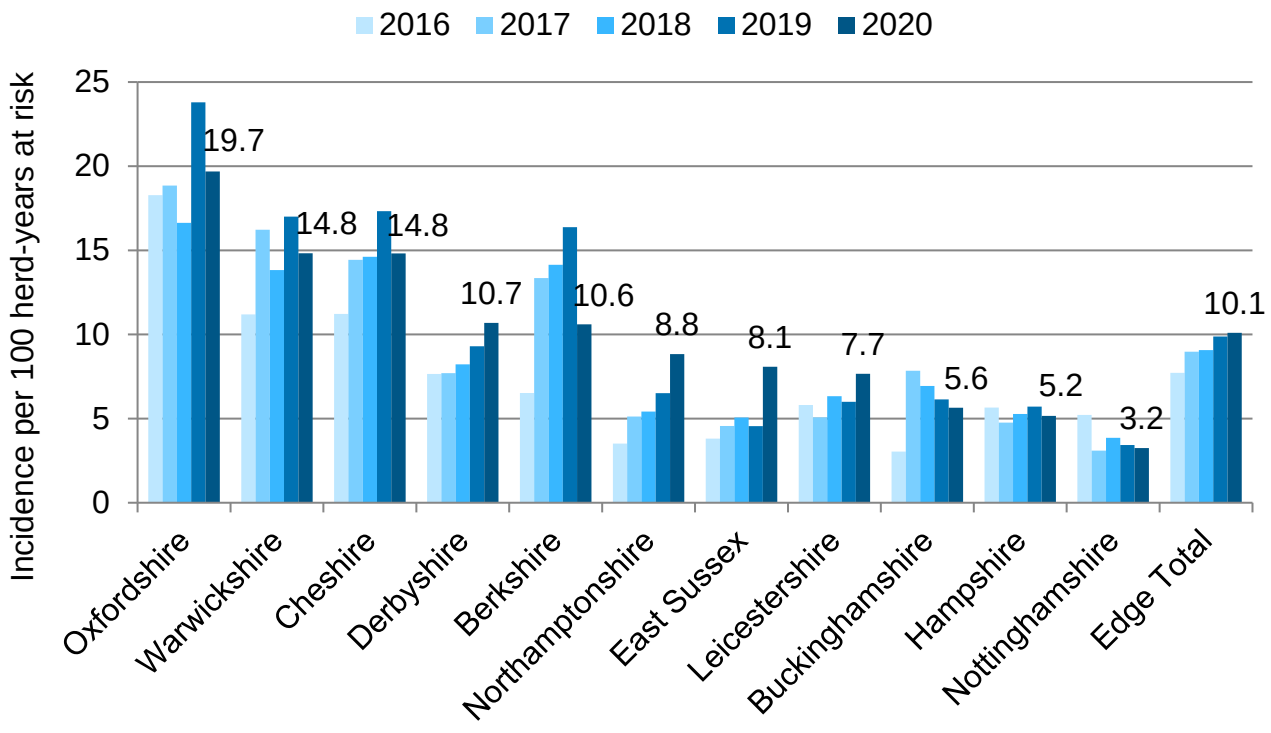


Figure 4.2.4 Incidence rate (per 100 herd-years at risk) from 2016-2020, by Edge Area county. Counties ranked by incidence in 2020.

- The incidence rate increased in 2020 compare to 2019 in Derbyshire and Leicestershire (with six-monthly testing), and East Sussex and Northamptonshire.

Oxfordshire, Cheshire, Warwickshire, Berkshire, Derbyshire and Hampshire were all subject to enhanced six-monthly testing in 2020. When areas change surveillance frequency, the number of herd-years at risk (denominator) can be artificially inflated (with increased surveillance frequency) or deflated (with reduced surveillance frequency). In 2018, when six-monthly testing was introduced to selected Edge Area counties (excluding Cheshire), incidence per 100 herd-years at risk declined. In 2019, when earned recognition allowed eligible herds to revert to annual testing, incidence per 100 herd years at risk climbed back up again. In 2020, the surveillance frequency was stable and any effects on the incidence per 100 herd years at risk statistic was minimal.

A simpler measure of incidence, new cases per 100 unrestricted (OTF) herds tested, is provided in Figure 4.2.5. Incidence per 100 unrestricted herds tested is less susceptible to changes in surveillance testing frequency. It is not intended to be a long-term substitute for the incidence per 100 HYR, but is useful to provide clarity when surveillance intervals change, and can be used to compare incidence trends over the 2016 to 2020 time period.

In the Edge Area overall, incidence per 100 unrestricted herds tested has fluctuated in the past five years, but showed an overall increasing trend, from 7.4 in 2016 to 9.2 in 2020. Incidence per 100 unrestricted herds tested decreased or remained the same in most of the counties in 2020 compared to 2019, except for Derbyshire, East Sussex, Leicestershire and Northamptonshire (Figure 4.2.5). In Northamptonshire, incidence per 100 unrestricted herds has increased annually for the past five years, consistent with the trend in new TB incidents and incidence per 100 HYR (Figures 4.2.2 and 4.2.4). In East Sussex, incidence per 100 unrestricted herds increased sharply between 2019 and 2020 (from 4.2 to 7.8).

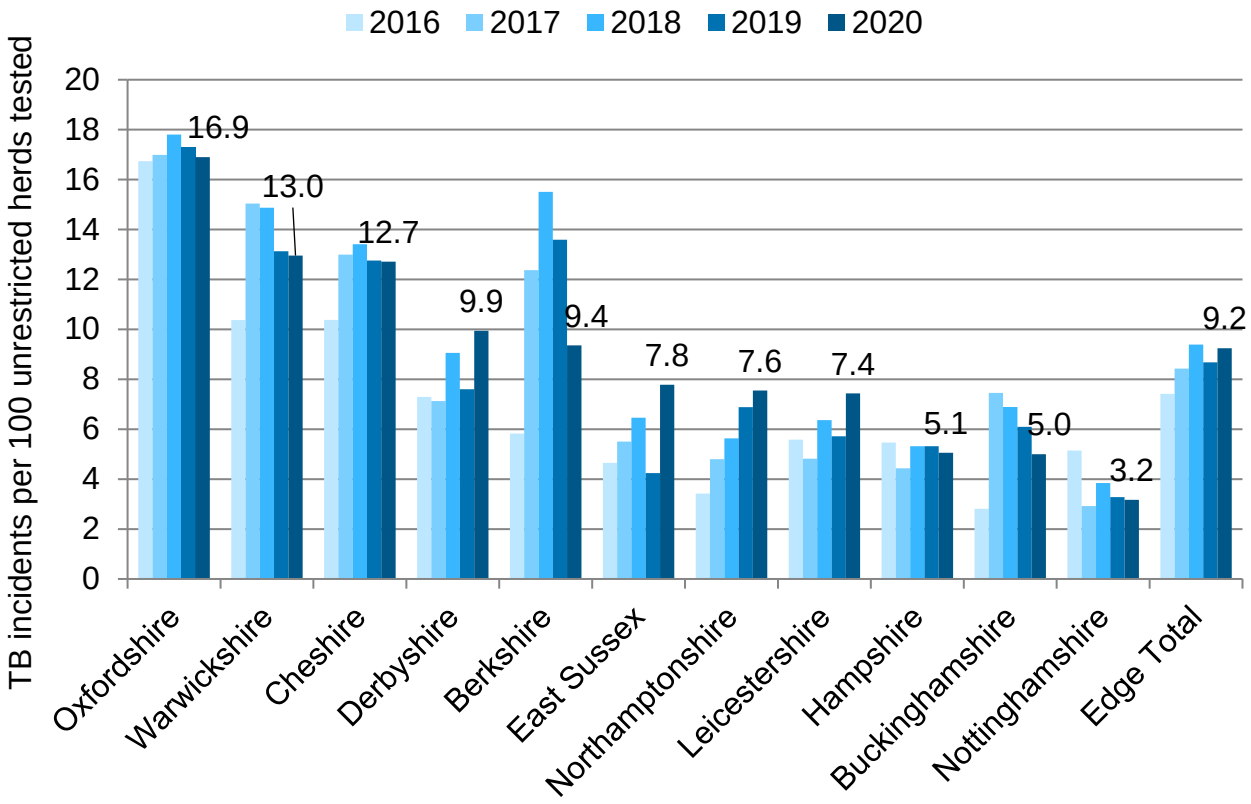


Figure 4.2.5 New TB incidents per 100 unrestricted herds tested from 2016-2020, by Edge Area county. Counties ranked by 2020 incidence value.

- The number of new incidents per 100 unrestricted herds tested has increased every year since 2016 in Northamptonshire.
- The number of new incidents per 100 unrestricted herds tested generally decreased in most of other Edge Area counties in 2020 compared to 2019, except for Derbyshire, East Sussex, Leicestershire and Northamptonshire.
- East Sussex presented a 45% increase in number of new incidents per 100 unrestricted herds tested compared to 2019.

County-level end-of-year prevalence

The end-of-year herd prevalence (proportion of herds under movement restrictions on 31st December due to an ongoing TB incident) increased in the Edge Area in 2020 compared to 2019 (5.7% and 5.3% respectively, Figure 4.2.6). This increase was observed in most Edge Area counties in 2020 compared to 2019, except for Warwickshire, Berkshire and Cheshire. Oxfordshire had the highest prevalence at the end of 2020 (12.9%), and prevalence was lowest in Nottinghamshire (1.7%). As with incidence, prevalence figures presented here include all OTF-W and OTF-S incidents irrespective of the herd type. Prevalence figures in the Year End Descriptive Epidemiology reports for Edge Area

counties may differ slightly as they exclude TB incidents in Approved Finishing Units with no grazing.

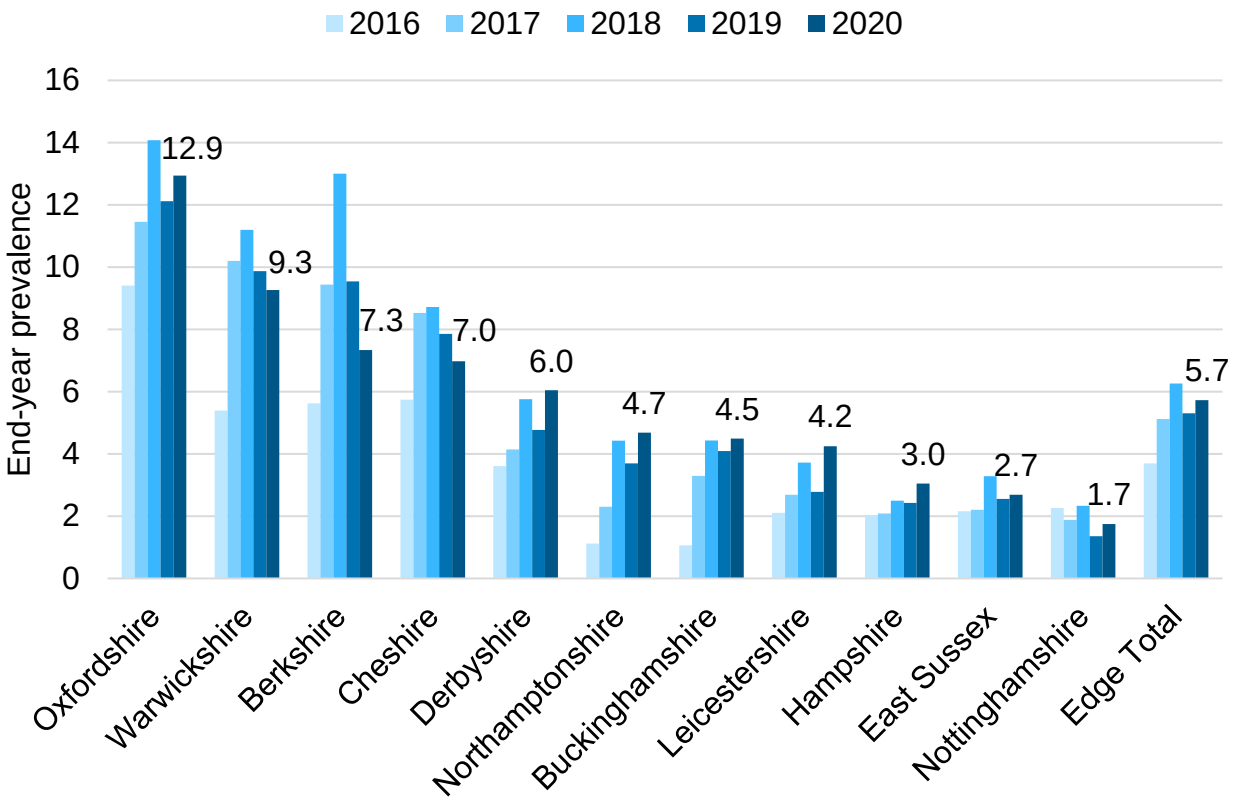


Figure 4.2.6 End of year prevalence from 2016-2020, by Edge Area county ranked by decreasing order of prevalence in 2020

- End-of-year prevalence increased in most of the counties in 2020 compared to 2019, except for Warwickshire, Berkshire and Cheshire.
- The overall end-of-year prevalence in the Edge area had a small increase in 2020 compared to 2019.

TB incident duration and persistence

A total of 672 TB incidents closed in the Edge Area during 2020. The median duration for incidents that closed was 194 days (Interquartile Range (IQR) 159 to 274 days). At the county level, the longest median duration was observed in Oxfordshire, followed by Warwickshire and Berkshire. Counties with the shortest median durations were Hampshire, Buckinghamshire, Nottinghamshire and Northamptonshire (Figure 4.2.7).

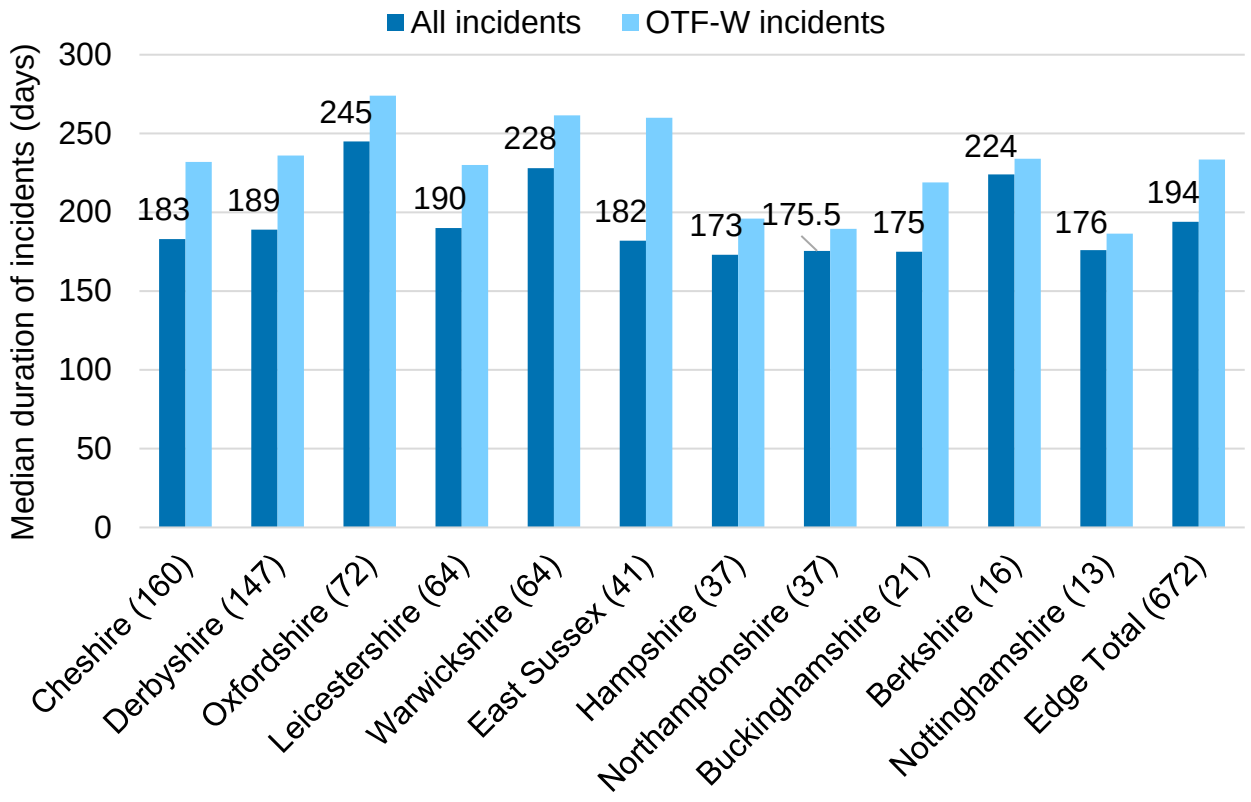


Figure 4.2.7 Median duration (days) of TB herd incidents that ended in 2020, by Edge Area county ranked by number of incidents (in parentheses)

- Median duration was highest in Oxfordshire for all TB incidents (245 days) and for OTF-W incidents (274 days).

Recurrence of TB incidents

In the Edge Area in 2020, 41% of new TB incidents occurred in herds that had experienced at least one TB incident in the previous three years. Recurrence was highest in the Edge Area counties of Oxfordshire, Warwickshire and Cheshire (Figure 4.2.8). Recurrence in these three counties is higher than the proportion reported in seven of the ten HRA counties (Figure 4.1.8, Chapter 4.1 Epidemiology of TB in the High Risk Area).

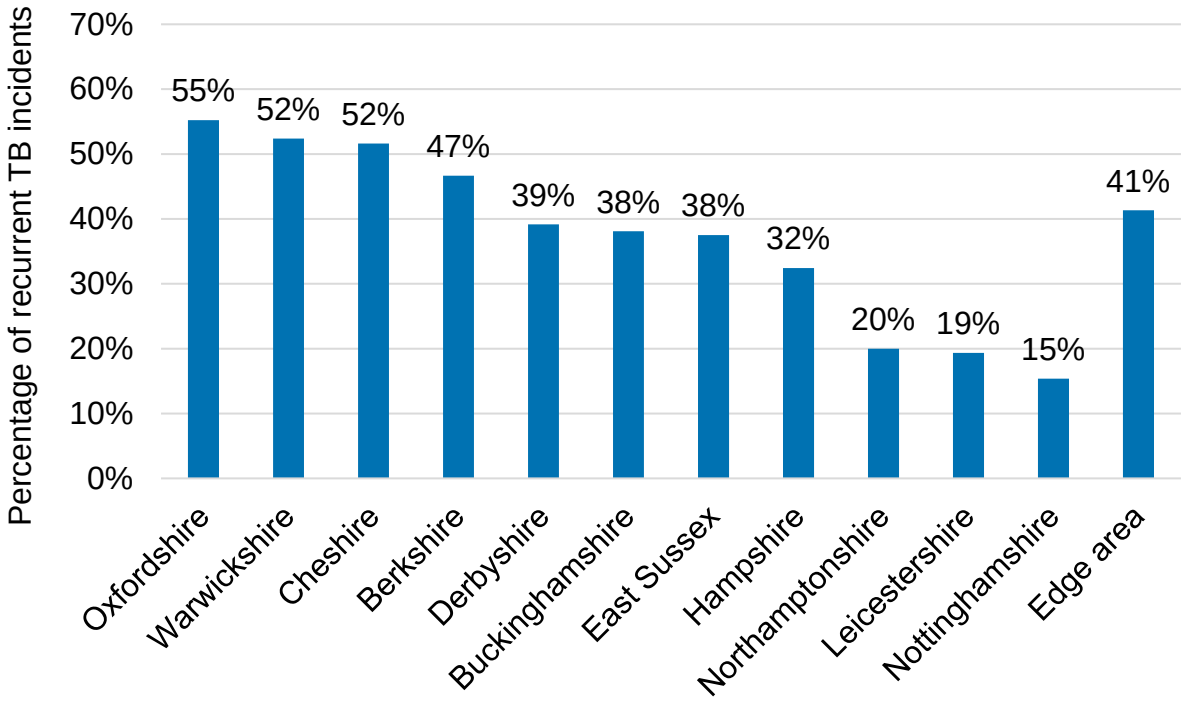


Figure 4.2.8 Proportion of TB incidents in 2020 in herds that had experienced any TB incident in the previous three years, by Edge Area county

Source of infection

For herds with new TB incidents in the Edge Area, the predominant source of infection varied between counties. In 2019, incidents bordering the HRA were more frequently ascribed to badgers and those closer to the LRA were more commonly linked to cattle movements, while this pattern was no longer applicable in 2020 (Figure 3.2.11, Chapter 3.2 Characteristics of herds found infected with TB). Badgers were identified as the primary weighted source of TB infection in eight Edge Area counties, most prominently in Cheshire (64.3%), Derbyshire (57.4%), Northamptonshire (55.7%), Oxfordshire (53.3%), Berkshire (49.6%) and Warwickshire (43.6%). Cattle movements were identified as the primary weighted source in Buckinghamshire (51%) and Hampshire (36.5%) (Table 3.2.1, Chapter 3.2 Characteristics of herds found infected with TB). Other/unknown sources also played a big role in the Edge Area (14.1%) and had the largest weighted contribution in Nottinghamshire (61.6%).

New areas of endemic infection and new clusters emerging

Edge Area counties are strategically located along the endemic front of TB and as such, areas of spread and retraction often occur within them. Figure 3.1.6 (spread and retraction of endemic TB areas in 2020, Chapter 3.1) provides a visual depiction of changes to the endemic area in 2020. Areas of developing significance are also discussed in the Edge

Area Year End Descriptive Epidemiology Reports, which provide a greater depth of discussion at the local level. Some of the highlighted areas of significance include:

- Cheshire and Oxfordshire: Whole Genome Sequencing has identified over 10 clusters in Cheshire and several in Oxfordshire. Each cluster contained *M. bovis* isolates that were closely genetically related within local geographical areas, but these clusters are not always clearly geographically defined and may overlap with one another.
- Hampshire: The 10:u cluster continued to be centred around the north Hampshire/Berkshire border in the formerly HRA portion of county. Another cluster of geographically close 11:a cases were detected in central-western Hampshire in 2020. These incidents were identified as being related to cattle purchases with no opportunity for cattle to cattle transmission.
- Northamptonshire: whole genome sequencing has helped identify that the area running along the border with Warwickshire and Oxfordshire has now likely become endemic for *M. bovis*. Other clusters in this county include one near Cambridgeshire and one along the Leicestershire border, both with risk pathways for incidents attributed to badgers.
- Buckinghamshire: a new strain of *M. bovis* 130:7-5-5-4*-3-3.1 was found for the first time in Buckinghamshire. A small island of expansion seen in mid Buckinghamshire was most likely to be associated with cattle purchases.

Areas of improvement

- Cheshire: the ratio of OTF-W to OTF-S incidents has improved markedly since 2019 indicating a likely lower burden of infection reflected in reduced reactor and IFN-γ numbers.
- Hampshire: the genotype 10:a cluster in the north west of the county and the genotype 10:u cluster west of Winchester did not yield any new incidents in 2020.

4.3 Epidemiology of TB in the Low Risk Area

- The following bullet points summarise key findings from the LRA TB Epidemiology reports for 2020.
- Overall, the herd incidence rate in the LRA remained very low and stable (1.1 incidents per 100 herd-years at risk). The number of new incidents decreased in 2020 compared to 2019 (135 incidents and 148, respectively). Of those 135 new herd incidents in 2020, 42 (31%) had reactors with visible lesions of TB and/or culture-positive animals (OTF-W) (Figure 4.3.1). Notable increases were seen in Lincolnshire (22 new TB incidents in 2020, 15 in 2019), West Yorkshire (11 in 2020, 3 in 2019) and Kent (9 in 2020, 3 in 2019). Notable decreases were seen in Essex (6 in 2019, 1 in 2020), South Yorkshire (10 in 2019 to 3 in 2020), West Sussex (13 in 2019 to 5 in 2020), Cumbria (29 in 2019 to 23 in 2020) and Lancashire (13 in 2019 to 8 in 2020) (Figure 4.3.2).
- There was a higher degree of uncertainty around the source of TB in cases detected in the LRA compared to the HRA and Edge Area. In part, this is related to the smaller proportion of OTF-W incidents in the LRA, where genotyping and Whole Genome Sequencing (WGS) of *M. bovis* isolates from culture-positive animals can provide key evidence as to the likely source of infection.
- Movement of cattle with undetected infection into the LRA remained the most common source of TB for new incidents in 2020. This was closely followed by incidents of undetermined source, which was expected due to the low proportion of OTF-W incidents detected. Badgers were identified as 8.7% of the weighted sources of infection, a slight decrease compared to 2019 (10%). There were frequent movements of cattle from higher risk areas onto finishing units inside the LRA. Compulsory post-movement testing for such animals goes some way to mitigating the risks associated with sourcing cattle from outside the LRA.
- In the LRA, hotspot procedures are initiated around OTF-W incidents of undetermined origin. Within a potential hotspot area, cattle herds located within 3km of the index herd undergo enhanced testing, and a concurrent survey of found-dead badgers and wild deer is implemented. If *M. bovis* infection is confirmed by the wildlife survey, the potential hotspot becomes a confirmed hotspot (HS).
    - A third year of badger culling and second year of badger vaccination was undertaken in HS21 (East Cumbria) in 2020. As in 2019, the endemic strain 17:z was not cultured in any cattle herds located in HS21.
    - Wildlife surveillance undertaken in HS23 (south west Lincolnshire) during 2019 revealed two badgers with *M. bovis* positive culture results in 2020. HS23 became the second confirmed hotspot area in the LRA and had seven TB incidents (3 OTF-W and 4 OTF-S) in 2020.

- The radial testing programme in HS24 (West Sussex) was completed in 2020 and the area will revert to four yearly testing in 2021.
- Wildlife surveillance continued in 2020 in potential hotspot areas HS25 (Norfolk), HS26 (south Cumbria) and HS27 (North Yorkshire), but no culture-positive wildlife submissions were detected to date.
- A new potential hotspot was initiated in October 2020 in east Lincolnshire (HS28). The hotspot was created following a cluster of incidents potentially due to local spread of infection, but there have been no confirmed *M. bovis* infections in wildlife so far.

- As well as cattle movements, spread of infection from endemic TB sections of the Edge Area poses a risk to the LRA. Parts of the LRA identified as being at particular risk for this reason included:
  - Greater Manchester: incidence in the neighbouring Edge Area county of Cheshire is high and there are concerns there could be disease spill over into the area around Stockport.
  - Lincolnshire: a potential hotspot area (HS23) was initiated in 2018 and confirmed in 2020, close to the border of Leicestershire where TB appears to be endemic.
- Other areas that will require close monitoring include:
  - West Yorkshire: the region saw an overall increase in cases in 2020, close to potential hotspot HS27 in North Yorkshire and the Lancashire border. Two of the three OTF-W have unclear origin and detected further reactors after radial testing, posing concern about lateral spread of infection. This area is under close monitoring for further incidents.

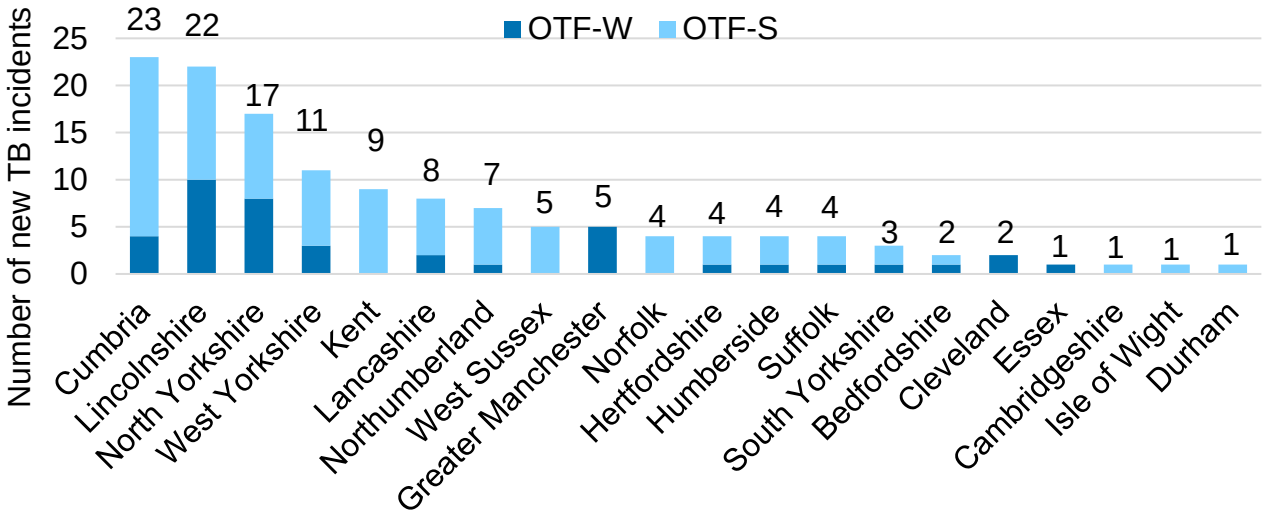
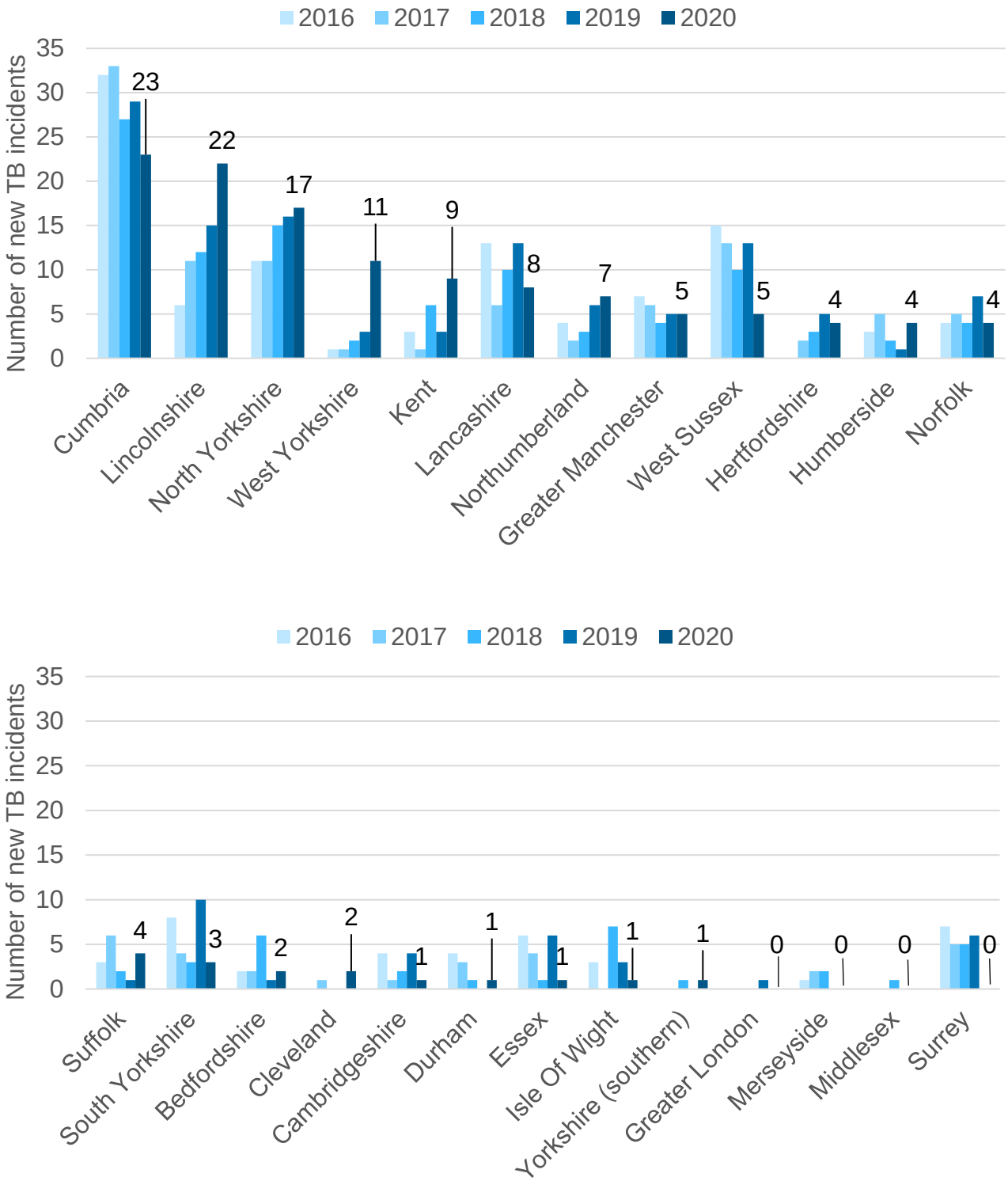


Figure 4.3.1 Total number of new TB incidents (OTF-W and OTF-S) by LRA county in 2020. Total incidents labelled on chart.



Not shown: Two LRA counties that did not report any new TB incidents between 2015 and 2020 (Isles of Scilly and Tyne & Wear).

Figure 4.3.2 Annual total number of new TB incidents (OTF-W and OTF-S) by LRA county 2015 to 2020. Number of 2020 incidents labelled on chart.