Animal & Plant Health Agency

Bovine tuberculosis in England in 2023

Epidemiological analysis of the 2023 data and historical trends

November 2024

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APHA is an Executive Agency of the Department for Environment, Food and Rural Affairs and also works on behalf of the Scottish Government, Welsh Government and Food Standards Agency to safeguard animal and plant health for the benefit of people, the environment and the economy.

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1. Executive summary

1. Bovine TB is a chronic infectious and contagious disease caused by the bacterium *Mycobacterium bovis*. In England, it is subject to a statutory eradication programme based on the government's strategy, published in April 2014 and then independently reviewed in 2018, which aims to achieve officially TB free (OTF) status for the whole country by 2038. Within the strategy, England is divided into three bovine TB "risk areas" as determined by the level of disease.
2. Eradication of bovine TB requires control of infection in both cattle and the main wildlife reservoir, the European badger (*Meles meles*). In cattle, this includes:
    - Systematic active surveillance through both routine and targeted, ad hoc tuberculin skin testing of herds. The frequency of routine skin testing varies across England according to risk area, which is described in Chapter 2 - Preface.
    - Mandatory tuberculin skin testing of cattle moved between herds (pre- and post-movement TB testing)
    - Routine (passive) slaughterhouse surveillance.
    - Additional measures aiming to reduce the risk of disease persistence and enable herds to regain OTF status,, movement restrictions and more sensitive testing of infected cattle herds. More detail is described in Chapter 2 – Preface.
3. *M. bovis* infection in the badger population is controlled through licensed badger culling and vaccination.
4. New TB incidents:
    - In 2023, the number of new TB incidents recorded across England decreased by 17% compared to 2022.
    - The High Risk Area (HRA), spanning the west and south-west, accounted for more than three quarters (76%) of these incidents (Table 1.1). New incident numbers in the HRA fell by 19% on 2022.
    - The Edge Area, which lies between the HRA and LRA and has a split testing policy, contained 18% of new TB incidents in 2023, two-thirds of which were observed in the six-monthly testing portion (Table 1.1). New incident numbers in the Edge Area fell by 9% on 2022.
    - As in previous years, the Low Risk Area (LRA) in the north, east and south-east had very few TB incidents in 2023, representing around 6% of new TB incidents occurring in England. Of these, only approximately one third were TB lesion- or culture/PCR test-positive (OTF status withdrawn (OTF-W)) incidents (Table 1.1).

5. TB herd incidence rate: Trends in the TB incidence rate (number of new TB incidents per 100 herd years at risk; HYR) are discussed in detail in Chapter 3.1.
    - In 2023, there was a significant fall in incidence rate compared to 2022, which reached the lowest level recorded since 2007 (Table 1.1).
    - Incidence rate in the HRA followed a similar trend to England overall, declining significantly in 2023 (driven by a 25% reduction in new OTF-W incidents compared to 2022) to the lowest level seen since 2006, and continuing a significant decline over the last decade (Table 1.1).
    - Incidence rate declined non-significantly in the Edge Area in 2023, the third consecutive year of decrease, and remained very low in the LRA (Table 1.1).
6. Herd prevalence of TB: Average monthly TB prevalence fell significantly in 2023, by 12% compared to 2022, despite a 2% decrease in the average monthly number of active cattle herds (Table 1.1).
    - This trend was also seen in the HRA, where prevalence fell significantly and to the lowest level observed over the previous 10-years.
    - Prevalence plateaued in the Edge Area after a tendency to decrease since 2019 and remained consistently very low in the LRA.
7. Endemic area of TB: Between 2022 and 2023, there was a net retraction of over 2,000 km^2 in the size of the overall area considered to harbour endemic *M. bovis* infection in England. Although the HRA and parts of the Edge Area (particularly along the HRA border) continued to be a stable endemic area, there were also portions of the HRA and Edge Area that experienced considerable retraction.
    - Further information on endemic infection, including detail on spread and retraction of the endemic region, is provided in Figure 3.1.6 and in Chapter 3.1: Incidence and Distribution.
8. Recurrent TB incidents: Over half of new TB incidents occurring in 2023 in England and in the Edge Area, and nearly 60% of those in the HRA, were disclosed in herds that had previously experienced a TB incident in the preceding three years (recurrent herds). Therefore, recurrent infection of cattle herds remains an important driver of the epidemic in these risk areas (Table 1.1).
9. Risk factors for TB in herds: In 2023, as in previous years, herds located in the HRA, herds with over 300 cattle (which are more common in the HRA than elsewhere) and herds that had a history of previous TB incidents, were at the highest risk of experiencing a new TB incident.
    - Dairy herds were also found to have an additional risk of infection that could not be fully explained by their herd size, testing history or location.
10. Source of TB infection in herds: A data-driven method to quantify the likelihood of two specific risk pathways for TB infection, which was developed by APHA and first applied to surveillance data in 2022, has continued to be applied to the 2023 data.

- For most new TB incidents in 2023, across all risk areas, there was no evidence of cattle movements associated with a high likelihood of infection and there was no WGS data available to explore evidence of any local transmission of infection. Therefore, there is insufficient evidence for these herds to determine a likely infection pathway. This applied to 65% of all (OTF-W and OTF-S) new TB incidents in the HRA, 60% in the Edge Area and 63% in the LRA.
- WGS data was available for 694 OTF-W incidents in England in 2023 (28% of all new TB incidents). WGS identified a local reservoir of infection event, with no cattle movements associated with a high likelihood of infection, for 56% of OTF-W incidents with WGS in the HRA, 60% in the Edge Area and 30% in the LRA in 2023.
- Amongst the 694 incidents with WGS data in England, 12% had cattle movements associated with a high likelihood of infection, with no evidence of local transmission of infection. This represented 11%, 9% and 45% of incidents with WGS data in the HRA, Edge Area and LRA respectively.
- Breakdown of the source of infection data with all new TB incidents in England is presented in Appendix 1 in the Supplementary Figures to the England Bovine TB Report .

11. Molecular typing of *M. bovis* isolates from cattle: It was possible to identify the causative clade of *M. bovis* from a total of 1,313 new TB incidents in 2023 using WGS. Of all the bacterial isolates identified in 2023, over half belonged to three WGS clades: B6-11 (19%), B6-85 (19%), and B3-11 (17%). The homeranges of those three clades cover extensive areas in the Southwest and West (Midlands) of England.

Table 1.1 Key bovine TB epidemiological parameters for all TB incidents (OTF-W and OTF-S) in 2023, with selected 2022 values in parentheses

	HRA	Edge Area	LRA	England
Number of new TB herd incidents detected	**1,855**	**447**	**133**	**2,435**
(2022)	(2294)	(490)	(145)	(2929)
Number of new OTF-W TB incidents that were lesion or culture positive, or both	**805**	**199**	**42**	**1,046**
(2022)	(1079)	(232)	(40)	(1351)
Number of open (continuing) TB incidents at the end of the year	**1,319**	**288**	**62**	**1,669**
(2022)	(1488)	(288)	(66)	(1842)
Herd incidence per 100 herd-years at risk	**13.2**	**7.2**	**1.0**	**7.3**
(2022)	(14.4)	(7.7)	(1.1)	(8.4)
Average monthly prevalence (%)	**8.0**	**4.1**	**0.4**	**4.1**
(2022)	(9.1)	(4.4)	(0.4)	(4.7)
Median duration of restrictions for incidents that closed in 2023 (in days)	**203**	**188**	**148.5**	**197**
(25th, 75th percentiles)	(166-293)	(159-265)	(102.5-191)	(163-283)
Median duration of restrictions for incidents that closed in 2022 (in days)	**189**	**183**	**150**	**187**
(25th, 75th percentiles)	(163-278)	(159-263)	(98-194)	(160-273)
Percentage of incidents that ended in the year that were persistent, duration was greater than 550 days (%)	**5.5**	**3.4**	**1.5**	**4.9**
(2022)	(5.8)	(5.2)	(1.5)	(5.5)
Number of persistent incidents, with a duration greater than 550 days, ongoing at the end of the year	**93**	**13**	**2**	**108**

	HRA	Edge Area	LRA	England
(2022)	(98)	(11)	(1)	(110)
Percentage of new TB incidents in the year in that occurred in herds that suffered another TB incident in the preceding 36 months (Recurrence, %)	**57.1**	**52.0**	**20.6**	**53.8**
(2022)	(55.8)	(48)	(15.3)	(52.4)

2. Preface

2.1 Intended audience

This report describes the level and distribution of tuberculosis in cattle herds in England in 2023. Tuberculosis in cattle (bovine TB) and other animals is primarily caused by infection with the bacterium Mycobacterium bovis (M. bovis) and is referred to hereafter as 'TB'. In this report, 'cattle herds' includes a small number of farmed water buffalo and bison herds, which are subject to the same TB surveillance and control regime as domestic cattle. This report is primarily 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 report for England is part of a suite of regular reports produced by APHA that provide surveillance information 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 2023 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 2023: 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, 2019 to 2022. 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 quarterly National Statistics on the incidence and prevalence of TB in cattle in Great Britain and other regular statistical reports such as TB movement testing of cattle. However, 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 report includes commentary and analyses of cattle TB statistics in England, in the context of disease control and eradication policies. It reports both the frequency and geographic distribution of the disease in cattle herds in 2023, and its trends over time. It also explores the different TB surveillance streams employed to identify infected herds, and the impact of disease and control measures.

Use of jargon has emerged amongst those who seek to control and eradicate the disease. Use of jargon is limited in this report, and explanatory text is included where required. Technical language is explained when first used, and there is a glossary within the Explanatory Supplement.

2.3 Interpretation of the data

TB in cattle is generally a chronic and insidious infection, and most infected animals do not display clinical signs. The likelihood of detecting TB infected herds is therefore directly related to (a) how hard we actively look for the infection (type and frequency of on-farm surveillance and thoroughness of post-mortem meat inspection at slaughter), and (b) the underlying frequency of disease (prevalence of infection) in the cattle population. Both of these vary between risk areas.

Several factors also affect the probability of a herd becoming infected with TB, and 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. Existence of local M. bovis reservoirs shared by cattle, badgers and other species. Wildlife reservoirs are more common in the HRA and the western and northern parts of the Edge Area.

Furthermore, changes in surveillance intensity and control measures over time affect the measures used to track changes in the TB epidemic.

This report aims to highlight the potential influence of such factors in surveillance trends, and where possible account for them when measuring the relative risk and frequency of TB in different herds. This enables more accurate assessment of the efficacy of disease control measures.

2.4 Eradication of bovine tuberculosis (TB) in England

TB is one of the most pressing animal health problems in England. It is an infectious and contagious bacterial disease of cattle and other mammals, with a significant wildlife reservoir (i.e. badgers) present in large areas of England. This complicates the eradication of infection in 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 Great Britain since the 1950s. Substantial progress was made over the first three decades of the programme. However, progress stalled in the late 1980s and incidence and the range of endemic areas of disease increased steadily until 2010-11. In April 2014, the 2010-2016 Cameron Conservative Government published its Strategy for achieving Officially Bovine Tuberculosis Free Status (OTF) for England (with current policies in place summarised in Figure 2.1).

Changes to the policies that were introduced in England and in Great Britain can be found in the Explanatory Supplement to the Annual TB Surveillance Reports.

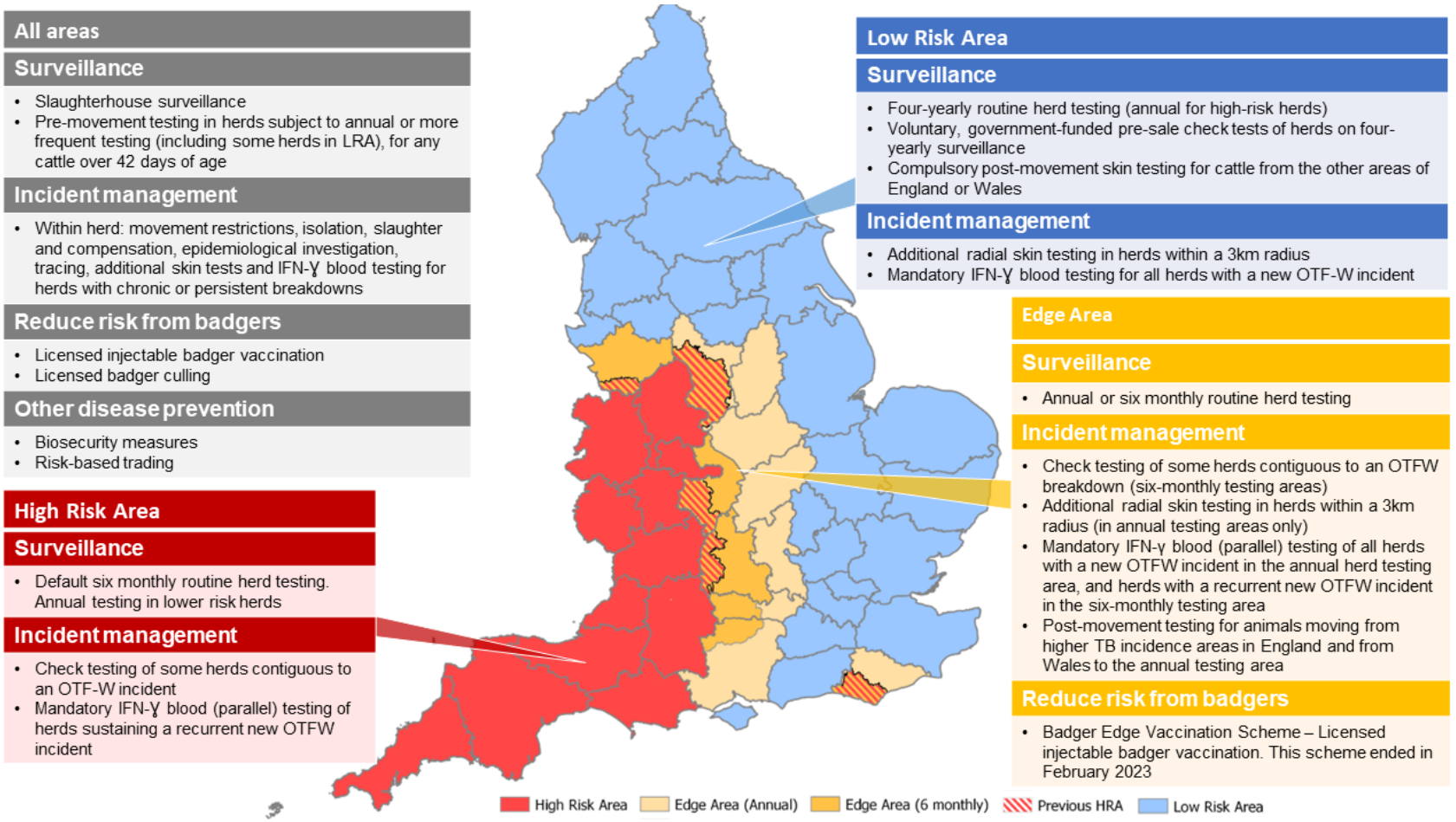


Figure 2.1 Summary graphic of the England TB Eradication Strategy, with policies currently in place in England in 2023.

Figure 2.1 Description: Map of England, showing the risk areas in England with a text box containing the measures in place for each risk area and in England overall. The High Risk Area, is shown in red and to the south-west of the country; the Low Risk Area runs all along the east coast of England and shown in blue; and the Edge area is in yellow in the middle, with the six monthly testing area shown in darker yellow across the affected counties. Details on the policies in place in each risk area are summarized in the text boxes and referenced to in the text and on tbhub.co.uk. Across all areas, slaughterhouse surveillance, pre-movement testing in herds subject to at least annual testing and over 42 days of age are used as methods of surveillance. Incident management occurs through within herd restrictions including movement restrictions, isolation, slaughter and compensation, epidemiological investigation, tracing, additional skin tests and gamma testing for herds with chronic or persistent incidents. The badger risk is reduced through licensed badger vaccination and licensed badger culling. Other measures, such as biosecurity measures on farms and risk based trading, also help eradicate TB.
In each risk area there are specific measures targeted to help eradicated TB in these areas. In the HRA, this includes six monthly routine testing (annual in lower risk herds); check testing of herds contiguous to a OTF-W incident; and mandatory parallel blood tests (using gamma testing) of herds with recurrent new OTF-W incidents. In the Edge area, which is on annual or six monthly testing, measures focus on incident management. This includes check testing of herds contiguous to an OTF-W in the six-monthly testing area; mandatory parallel blood tests (using gamma testing) of herds with a new TB incident in the annual testing area (and for herds with a recurrent TB incident in the six monthly testing area); and post-movement testing for animals moving from higher incident areas in England/Wales to the annual testing area. There are also measures to reduce the risk from badgers specifically within the Edge, which are the Badger Edge Vaccination scheme (though this scheme ended in February 2023). In the LRA, measures focus on surveillance. These are using four yearly herd testing (annual for high risk herds), voluntary government funded check tests of herds; and compulsory post-movement skin testing from cattle purchased in other areas of England and Wales. Incident management in the LRA relies on radial skin testing of herds within a 3km radius and mandatory parallel blood tests (using gamma testing) of herds with a new TB incident.

The 2014 published strategy defined 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, critically, 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 surveillance and control measures. Mandatory TB controls are based on the regular testing of herds, slaughter of positive animals and the imposition of movement restrictions following a non-negative test result. Movement restrictions remain in place until there is sufficient evidence that M. bovis infection has been removed from the herd through further testing. Such evidence will differ according to local circumstances, in particular the risk area in which the herd resides.

In 2018, the Defra Secretary of State commissioned an independent review of the 2014 TB eradication strategy led by Professor Sir John Godfray. The government considered the review report published in October 2018 in partnership with stakeholders and published its response in March 2020. The response set out five priorities for the subsequent five years, which are summarised below. Full details can be found in the government’s response to the review.

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

On 30 August 2024, Defra announced the launch of a strategy refresh and will be working with farmers, vets, scientists and conservationists to rapidly strengthen and deploy a range of disease control measures.

3. The TB epidemic in England

3.1 Incidence, geographic distribution, and trends over time

- In 2023, there were 2,435 new TB herd incidents in England, a significant decrease of 17% compared to 2022 ($p<0.001$, chi-squared).
- As in previous years, most new TB incidents (76%) occurred in the HRA, with 18% in the Edge Area and the remaining 6% in the LRA.
- Between 2022 and 2023, the number of new TB incidents fell by 19% in the HRA, 9% in the Edge Area, and 8% in the LRA. Only the decrease in the HRA was statistically significant ($p<0.001$, chi-squared).
- The number of new lesion or laboratory-positive (OTF-W) TB incidents fell significantly in the HRA in 2023, by 25% compared to 2022 ($p=0.007$, chi-squared), declined non-significantly in the Edge Area, and increased non-significantly in the LRA.
- The quarterly total number of incidents in England in 2023 remain more than double the quarterly totals seen before the outbreak of foot-and-mouth disease in 2001. However, when considering the last seven years (2017-2023) of the TB epidemic, there is strong evidence that it is now declining (halving time of 9.9 years, $p<0.001$).
- Overall, the TB incidence rate in England decreased significantly to 7.3 incidents per 100 HYR in 2023, from 8.4 in 2022 (a 13% decrease, $p<0.001$). This was the lowest annual TB incidence rate recorded since 2007.
- In the HRA, TB incidence rate fell significantly from 14.4 in 2022 to 13.2 in 2023 ($p=0.005$, incident rate ratio). This was the lowest incidence rate observed in the HRA since 2006 and continues a significant decreasing trend in incidence rate in the HRA, observed over the last 10-years (linear regression, $p<0.001$).
- Incidence rate also fell for the second consecutive year in the Edge Area to 7.2 (down from 7.7 in 2022, and 8.9 in 2021), although this decline was not statistically significant. Incidence rate remained very low and stable in the LRA (1.0), similar to 2022.
- Cattle with lesions typical of TB at slaughter, positive culture (or PCR test) results for M. bovis, or both, were found in 43% of all new TB incidents in the HRA, 45% in the Edge Area and 32% in the LRA in 2023. This compares to 47% in the HRA, 47% in the Edge, and 28% in the LRA in 2022.

- There was a net retraction of 2,315.20km^2 from 2022 to 2023 in the size of the overall area considered to harbour endemic M. bovis infection in England, meaning retraction of certain parts of the ‘endemic TB area’ exceeded expansion elsewhere.

- No new Badger Control Programme (BCP) areas were licensed in 2023, in line with the previously announced ‘phase-out’ of badger culling. A total of 3,064 badgers were vaccinated against TB across nineteen counties (including 3 within the LRA) in 2023.

Number of TB-infected herds

The number of Officially Tuberculosis Free (OTF) herds in which TB was detected in 2023 is referred to as the number of new TB incidents. The incidence rate shows the number of new TB incidents detected in herds over time, considering periods when herds are not at risk of infection, for example because they are already under TB movement restrictions (see Explanatory Supplement). 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 from year to year and between TB risk areas. These variables can 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, and is examined in a subsequent section of this chapter.

The HRA and the LRA contain 82% (41% each) of the cattle herds registered in England, while the remaining 18% are in the Edge Area. Approximately one in ten herds (10%) had a new TB incident in the HRA in 2023, compared to around one in 16 (6%) in the Edge Area. This proportion decreased in the HRA compared to 2022 and remained the same in the Edge Area. In the LRA, fewer than 1 in 100 herds had a new TB incident in 2023, with one in 500 herds having an OTF-W incident. However, it is important to note that most herds in the LRA are routinely tested for TB once every four years.

The number of new TB incidents decreased significantly, by 17% in England in 2023 (2,435) compared to 2022 (2,929, $p<0.001$, chi-squared). This reduction was driven by the fall in numbers of OTF-W incidents in the HRA and Edge Area, and the reduced numbers of OTF-S incidents across all risk areas compared to 2022. In 2023, most TB incidents in England (76%) occurred in the HRA, followed by the Edge Area (18%), and LRA (6%) (Figure 3.1.1.). However, the percentage occurring in the HRA reduced compared to 2022 (78%) and increased marginally in the Edge Area (17%) and LRA (5%).

The largest reduction was seen in the HRA, where the number of new TB incidents fell significantly, by almost a fifth (19%) from 2,294 in 2022 to 1,855 in 2023 ($p<0.001$, chi-squared). This decrease was mainly driven by a 25% fall in the number of OTF-W incidents, alongside a 14% decline in the number of OTF-S incidents in 2023 compared to 2022. The declines in OTF-W and OTF-S incidents were also statistically significant ($p=0.007$ and $p=0.004$, chi-squared, respectively).

The Edge Area recorded a reduction In the number of new TB incidents for the third consecutive year, where 9% fewer incidents overall were identified in 2023 (447) than in 2022 (490, $p=0.699$, chi-squared). There was a greater decline in the number of OTF-W incidents than OTF-S incidents, which both fell non-significantly by 14% and 4% respectively ($p=0.293$, and $p=0.690$, chi-squared, respectively). The decline in number of new incidents was mostly seen in the annual TB surveillance testing portion of the Edge

Area, where the number of incidents fell by 18% and OTF-W incidents fell by 32%, compared to the six-monthly testing section of the Edge Area where total and OTF-W incidents fell by 4% and 6%, respectively. However, for both the Edge Area and the HRA, it is prudent to interpret single inter-year changes with caution, and multiple parameters should be used to explore TB statistical trends in the cattle population, rather than be considered in isolation.

The incidence rate of TB and number of new TB incidents in the LRA remained low (1.0 incidents per 100 HYR and 133 new incidents in 2023, compared to 1.1 incidents per 100 HYR and 145 incidents in 2022). Neither the change in TB incidence rate or number of new TB incidents were significant (p=0.292, incidence rate ratio (IRR), and p=0.269, chi-squared, respectively). It is difficult to determine whether the fluctuations seen in this part of England can be explained by normal variations in the inter-year pattern of disease. Further information about TB is available at county level in the Edge and LRA reports.

In all risk areas, the percentage of TB incidents that were OTF-W remained fairly stable in 2023 compared to 2022, decreasing by 4% and 2% in the HRA and Edge Area respectively, and increasing by 4% in the LRA (43%, 45%, and 32% for the HRA, Edge Area, and LRA, respectively). Even so, the relatively high prevalence of TB in both the Edge Area and HRA means that a positive skin test result (a test reactor) is a very good indicator of infection irrespective of post-mortem and laboratory results (see Explanatory Supplement for further details).

Table 3.1.1 Number of new TB incidents and incidence rate in England, by risk area, during 2022 and 2023

	HRA	Edge Area	LRA	England
Number of active cattle herds in 2023	18,249	7,952	18,470	44,671
All new TB incidents in 2023	1,855	447	133	2,435
(Percentage of total for England)	(76%)	(18%)	(6%)	
All new TB incidents in 2022	2294	490	145	2,929
(Percentage of total for England)	(78%)	(17%)	(5%)	
Percentage change in all new TB incidents from 2022 to 2023	-19%	-9%	-8%	-17%
New TB incidents in 2023 that were OTF-W	805	199	42	1,046
(Percentage of total incidents for risk area)	(43%)	(45%)	(32%)	(43%)
New TB incidents in 2022 that were OTF-W	1,079	232	40	1,351
(Percentage of total incidents for risk area)	(47%)	(47%)	(28%)	(46%)
Percentage change in new OTF-W TB incidents from 2022 to 2023	-25%	-14%	+5%	-23%
TB incidence rate (OTF-W and OTF-S) per 100 HYR in 2023	13.2	7.2	1.0	7.3
TB incidence rate (OTF-W and OTF-S) per 100 HYR in 2022	14.4	7.7	1.1	8.4
Percentage change in TB incidence rate per 100 HYR from 2022 to 2023	-8%	-6%	-12%[1]	-13%

[1] The 12% change in incidence rate between 2023 and 2022 for the LRA is due to the very small fluctuation in the low incidence rate (1.141 incidents per 100 HYR in 2022 and 1.005 incidents per 100 HYR in 2023).

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 annual total number of new TB incidents increased by around 14% each year. The interval for the epidemic to double in size over that period 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, growing 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 3.1.1). 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 that time was 6% (doubling time of 12.8 years). Between 2011 and 2016 the epidemic plateaued in England as a whole. There is now significant evidence that the epidemic has been decreasing since 2017. Between 2017 and 2023, quarterly TB incidents had a halving time of 9.9 years ($p<0.001$), and an average annual rate of decrease of 7%. Although this is

encouraging, the current quarterly number of incidents is still more than double that from before the FMD epidemic.

Figure 3.1.1 Quarterly total numbers of new TB incidents detected in England between January 2001 and December 2023

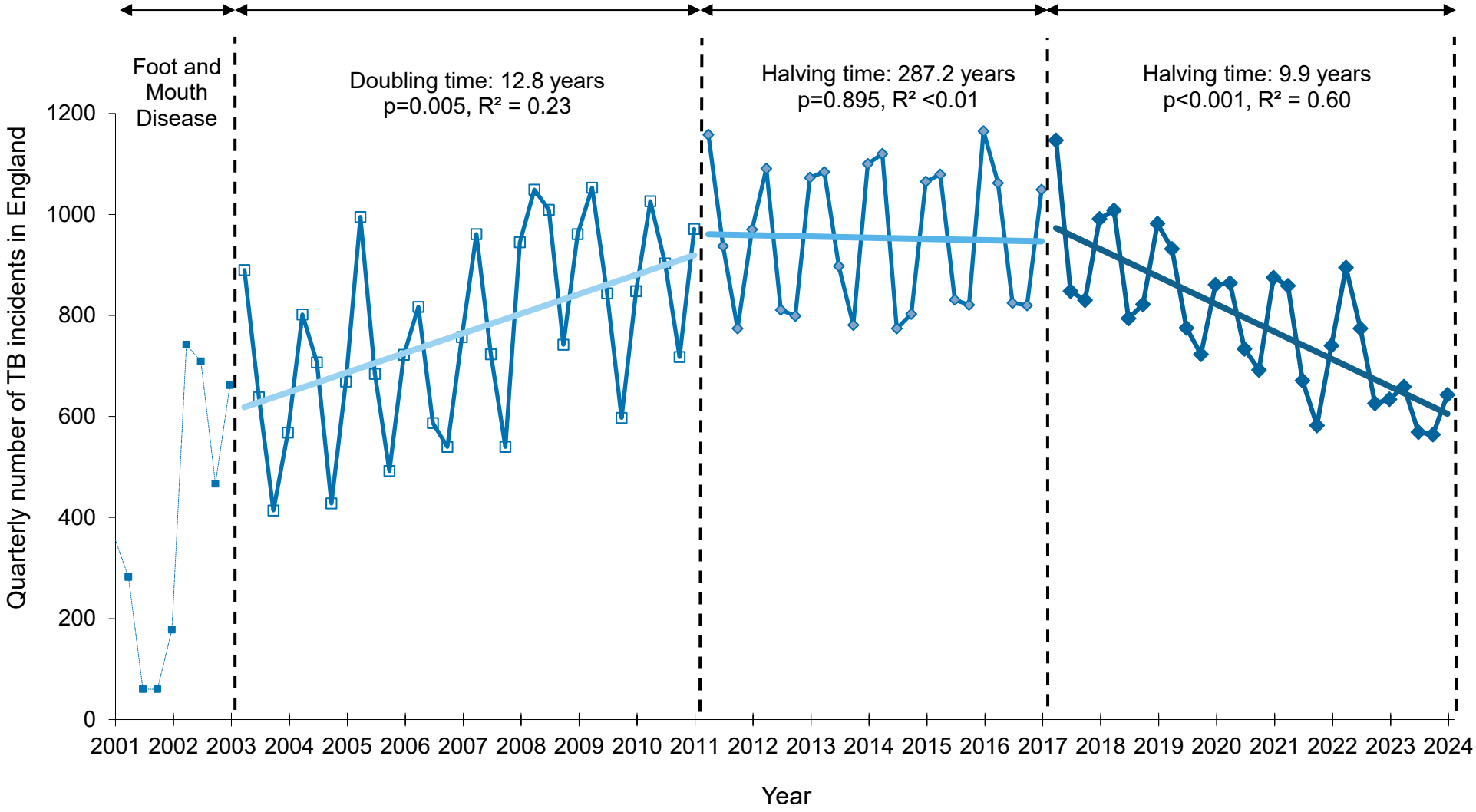


Figure 3.1.1 description: Chart showing the number of incidents every quarter between 2001 and 2024. Trend lines are shown for the three periods 2003-2010, 2011-2016 and 2017-2023. The doubling time for the period 2003-2010 indicates the time it would take for the annual number of TB incidents to double in number, given the trend of the data. The halving trends in 2011-2016 and 2017 to 2023 indicate the time it would take for the annual number of TB incidents to halve in number, given the trend. The R^2 value indicates 'goodness of fit' of the trend line to the raw data (an R^2 of 1 would indicate a perfect fit). The declining trend for the period 2017-2023 was statistically significant (halving time of 9.9 years, $p<0.001$).

The decrease in new TB incidents occurring in England in 2023 compared to 2022 marks a continuation in the downward trend observed between 2018 and 2021, after a slight increase in number of new incidents observed in 2022. That increase was explained by the changes to the routine testing schedule of the HRA from annual to six-monthly tests, beginning in Shropshire and Staffordshire in September 2020, followed by the rest of the HRA in June 2021 (Figure 3.1.2). Prior to 2018, the level of TB was relatively stable, remaining between 3,600 and 4,000 incidents per year between 2010 and 2018 (Figure 3.1.2).

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

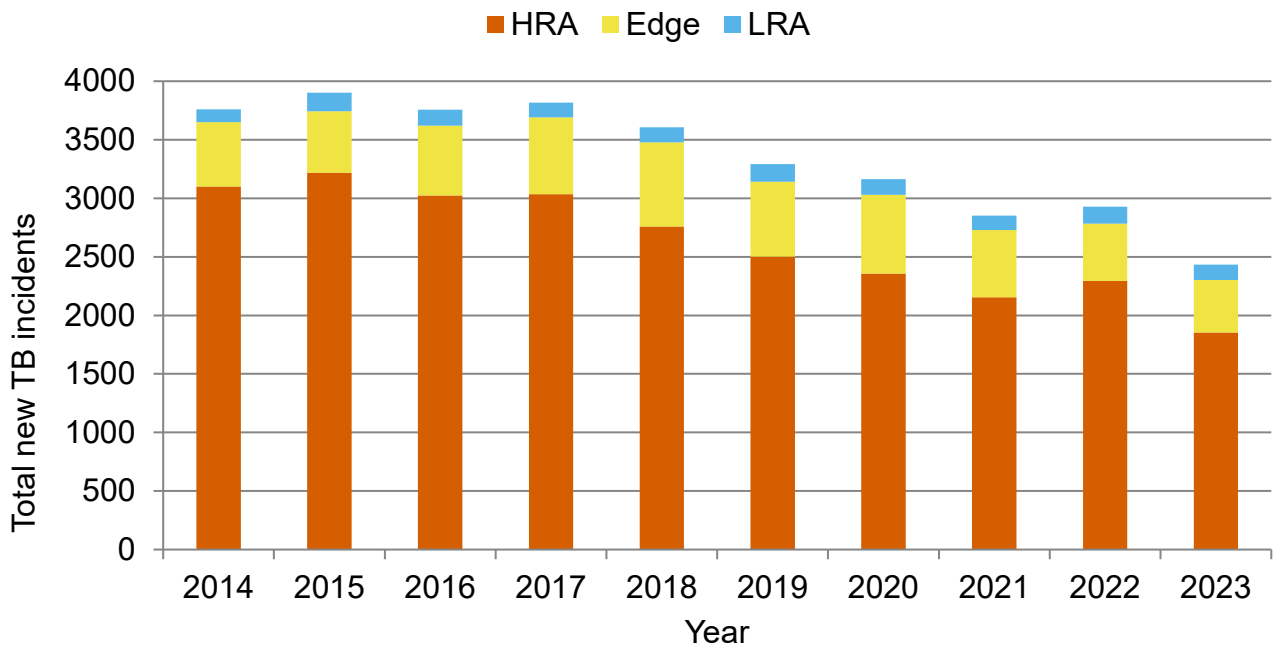


Figure 3.1.2 description: Bar chart showing the total number of new TB incidents in England overall, between 2014 and 2023. The number fell significantly by 17% between 2022 and 2023 (chi-squared test, $p<0.001$), driven by decreases in the number of OTF-W incidents in the HRA and Edge Area, alongside a decrease in OTF-S incidents in all risk areas. The number of new TB incidents decreased in the Edge Area in 2023, for the third consecutive year, from 673 in 2020, to 574 in 2021, 490 in 2022, and 447 in 2023.

In the HRA, all counties saw a decrease in the total number of new TB incidents in 2023 compared to 2022 (see chapter 4.1 for more details). Statistically significant decreases were seen in Hereford and Worcester, Shropshire, Cornwall, and Devon, where the total number of new TB incidents dropped by 33%, 28%, 23%, and 14%, respectively, ($p<0.001$, $p=0.001$, $p=0.002$, and $p=0.018$ chi-squared, respectively). All HRA counties also experienced reductions in the number of OTF-W incidents in 2023, with the greatest falls observed in Dorset, Cornwall, and Hereford and Worcester, decreasing by 51%, 36%, and 28%, respectively. The fall in new OTF-W TB incidents seen in Dorset was statistically significant, but in Cornwall, and Hereford and Worcester it was not ($p=0.026$, $p=0.053$, $p=0.480$, chi-squared, respectively).

In contrast, the picture in the Edge Area counties was not uniform, despite overall reductions in both the numbers of total and OTF-W incidents. Oxfordshire, East Sussex, and Hampshire experienced increases in the total number of incidents compared to 2022 (23%, 23% and 14% respectively). For Oxfordshire, this was driven by the number of OTF-W incidents rising by a third since last year. This is the first year that both OTF-W incidents and total TB incidents in Oxfordshire have increased since 2017. East Sussex and Hampshire also sustained increases in the number of OTF-W incidents, but these were due to variations involving only a small number of cases (5 and 6 in 2022 compared to 9 and 7 in 2023, respectively). None of the increases seen in these counties in 2023 were statistically significant. More detail on the epidemiology of TB within these counties is available in the 2023 county-level Edge Area reports.

Decreases in the number of OTF-W incidents were seen in all other Edge Area counties. Most of these also experienced decreases in the total number of incidents, except Northamptonshire, where the number of TB incidents did not change compared to 2022. The greatest decreases were seen in Buckinghamshire, Nottinghamshire, and Leicestershire, where total number of incidents fell by 39%, 33%, and 31%, respectively. In Leicestershire and Nottinghamshire, these decreases were driven by the number of OTF-W incidents falling by 68% and 33%, respectively. However, in Buckinghamshire the number of OTF-W incidents only fell by 7% (one incident), making the 65% drop in OTF-S incidents the main driver for the overall reduction in number of incidents. This was the first year since 2020 that the number of incidents decreased in Buckinghamshire. The only statistically significant decrease observed was in the number of new OTF-W TB incidents in Leicestershire ($p=0.026$, chi-squared), all other decreases in these counties in 2023 were not significant.

The total number of TB incidents in the LRA decreased in 2023 (n=133) compared to 2022 (n=145), although the number of OTF-W incidents in the LRA increased marginally in 2023 (n=42) compared to 2022 (n=40). Neither of these changes were statistically significant ($p=0.269$ and $p=0.441$, chi-squared, respectively). In the previous five years, the highest total number of TB incidents was 148, in 2019 (Figure 3.1.3).

The total number of TB incidents increased in nine counties in the LRA, however, ten counties experienced a reduction between 2022 and 2023. Three of these reduced by one incident, and a further three reduced by two TB incidents. The remaining four counties that experienced a greater reduction were Lancashire (11, down from 17 incidents), Essex (3 incidents, down from 9), Cumbria (17, down from 22), and Greater Manchester (5, down from 9). A third of counties in the LRA experienced increases in the number of OTF-W incidents, which were very small, and lead to the overall increase in OTF-W incidents in the LRA. Thus, the decrease in incidents seen in the LRA overall was driven by a decrease in the number of OTF-S incidents. None of the changes seen in these counties in 2023 were statistically significant. More details about TB incidents in the LRA are available in Chapters 3.2 and 4.3 of this report, as well as in the individual 2023 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)

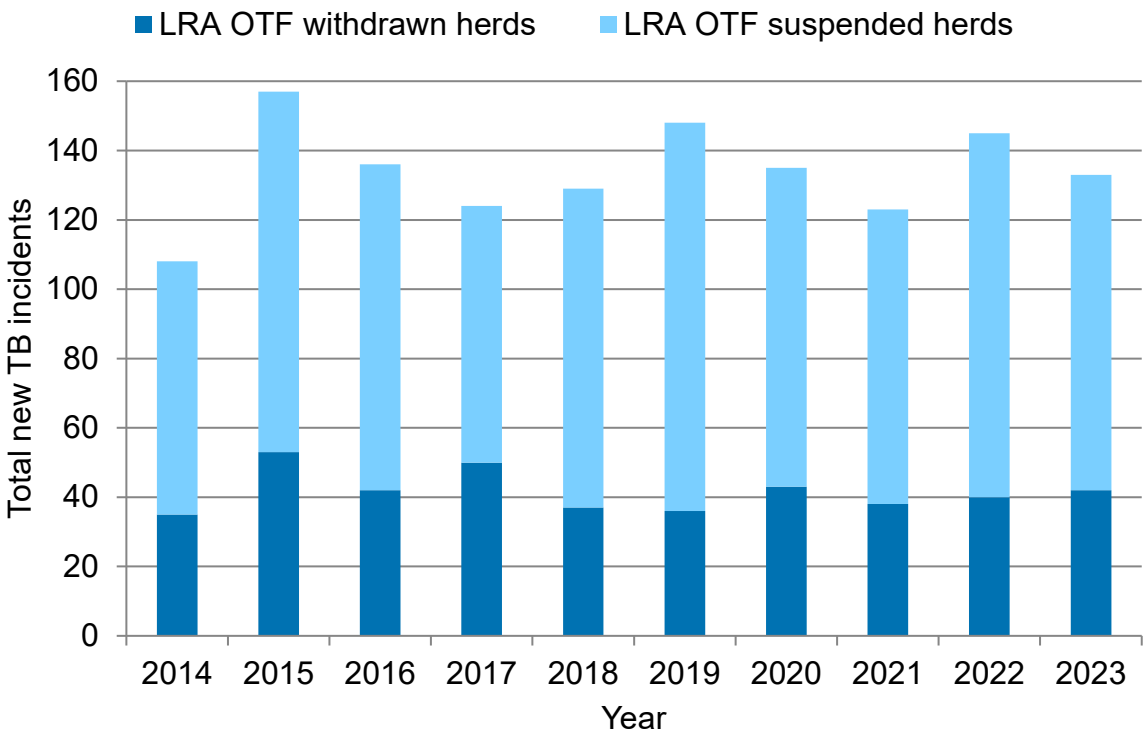


Figure 3.1.3 description: Bar chart showing the number of new infected herds in the LRA containing at least one reactor with visible lesions and/or an M. bovis culture/PCR-positive animal (new OTF-W incidents) between 2014 and 2023. The number of new OTF-W herds increased slightly in 2023 compared to 2022 (42 and 40, respectively), but the numbers have been relatively stable over the last decade. The number of new OTF-W incidents was highest in 2015 (n=53), but there is no clear temporal trend. The percentage of new OTF-

W incidents in the LRA increased slightly in 2023 compared to 2022 (32% and 28% respectively).

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 OTF herds experience new TB incidents. The incidence rate in this report is calculated as the number of new TB incidents per '100 herd-years at risk' (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
- periods when herds are under TB movement restriction due to test reactors or culture-positive slaughterhouse incidents (and therefore, not at risk of disclosing a new TB incident).

Whilst using HYR enables a more accurate comparison between areas than the number of new TB incidents disclosed, it is sensitive to changes in routine testing intervals within an area. This is particularly relevant when comparing incidence rate trends in risk areas that have moved between annual and six-monthly testing (such as the Edge Area in 2018, Shropshire and Staffordshire (HRA counties) in 2020, and all remaining HRA counties in 2021). 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 herd incidence rate for England and by risk area, from 2014 to 2023. Annual rates are also presented separately for the six-monthly and annual testing portions of the Edge Area (according to parish testing status in 2023). Overall, the incidence rate of TB in England fell by 13% in 2023, from 8.4 in 2022 to 7.3 TB incidents per 100 HYR in 2023 (IRR=0.87, $p<0.001$). This was the lowest incidence rate observed since 2007 (7.0) and continued a significant decreasing trend seen since 2017 (linear regression, $p=0.003$).

The level and trend in TB incidence rate varies between risk areas in England. The incidence rate in the HRA in 2023 was 13.2 incidents per 100 HYR. This represented a significant reduction of 8% compared to 2022 (14.4, IRR=0.92, $p=0.005$). This marked the lowest level seen since 2006 (11.0) and continued the significant downward trend observed over the last 10-years (linear regression, $p<0.001$). The decrease compared to 2022 can be attributed to a 19% reduction in the total number of TB incidents, despite a 12% decrease in time at risk (the denominator) in 2023 compared to 2022. The fall in incidents is mainly due to a 25% drop in the number of OTF-W incidents in 2023. This represents a statistically significant fall in OTF-W incidence rate in the HRA from 6.8

incidents per 100 HYR in 2022 to 5.7 in 2023 (IRR=0.85, p=<0.001). The number of OTF-S incidents in the HRA also fell in 2023, but the respective change in incidence rate was not significant (p=0.63, IRR).

In the Edge Area, the TB incidence rate fell for the third consecutive year to 7.2 TB incidents per 100 HYR in 2023, from 7.7 in 2022 (Table 3.1.1 and Figure 3.1.4). However, this decrease was not statistically significant (p=0.33, IRR). The fall in incidence rate in the Edge Area was mainly driven by a reduction in the number of OTF-W incidents in 2023 compared to 2022, particularly in the annually tested area (49 TB incidents in 2023 compared to 72 in 2022).

In the LRA, the incidence rate reduced non-significantly in 2023 compared to 2022 (1.0 incidents per 100 HYR in 2023 compared to 1.1 in 2022, p=0.29, IRR). Moreover, there was a marginal, non-significant rise in the OTF-W incidence rate in the LRA (0.32 in 2023 compared to 0.31 in 2022, p=0.97, IRR) – as both the number of OTF-W incidents and the time at risk increased slightly in 2023. However, the OTF-S incidence rate decreased non-significantly in 2023 (0.83 in 2022 compared to 0.69 in 2023, p=0.20, IRR). These small fluctuations in the incidence rates for total, OTF-W and OTF-S incidents reflect the very small number of incidents occurring in the LRA.

Figure 3.1.4 Annual incidence rate (per 100 HYR) for England and by risk area, including OTF-W incidence rate for the LRA, from 2014 to 2023. The orange vertical line represents the year in which counties straddling the HRA and Edge Area were moved fully into Edge Area on six-monthly testing, and the black vertical line shows the year all HRA counties moved to six-monthly testing.

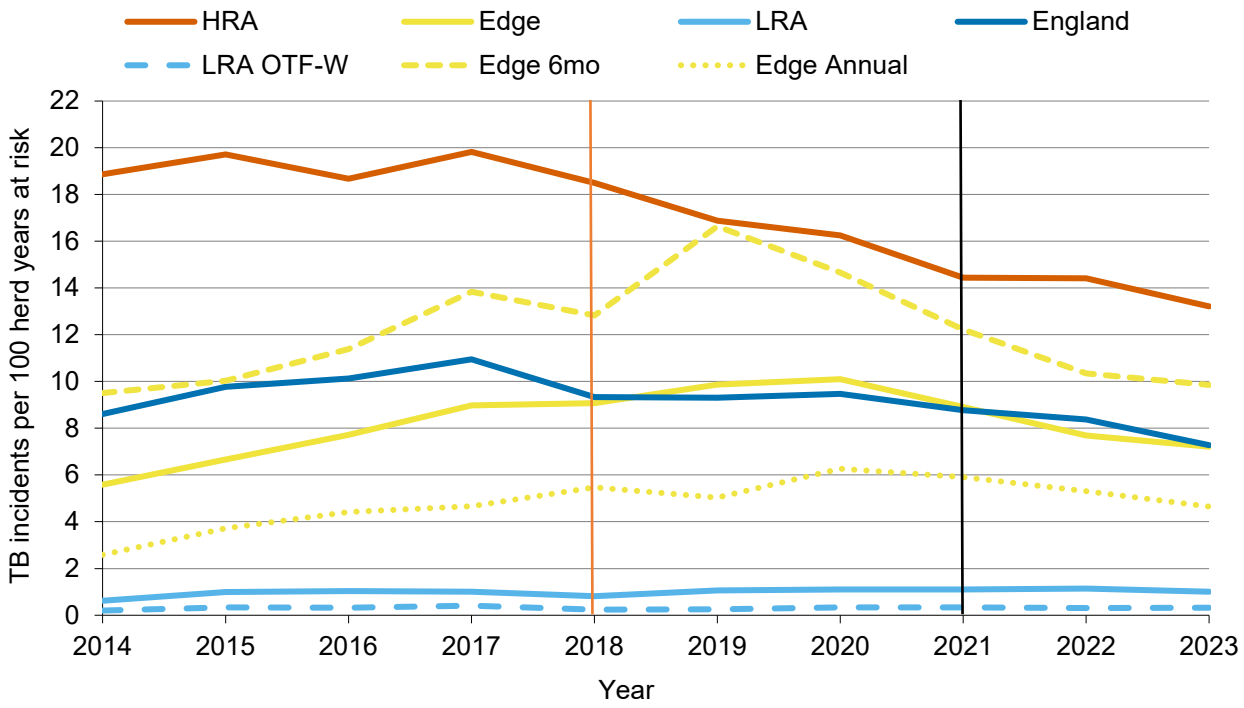


Figure 3.1.4: Line chart showing the incidence rate between 2014 and 2023 in England, the HRA, the Edge Area, the LRA, the Edge six monthly area, the Edge annual testing area, and for LRA OTF-W incidents. The incidence rate in England overall decreased significantly from 8.4 incidents per 100 HYR in 2022 to 7.3 in 2023 ($p<0.001$). This is the lowest level seen since 2007 (7.0). Details on the trends are provided in the text.

Figure 3.1.5 shows the incidence rate (per 100 HYR) for each county of England during 2023. In the HRA, the counties with the highest incidence rate in 2023 were Gloucestershire (16.9) and Wiltshire (16.2). The incidence rate in the HRA overall in 2023 decreased significantly compared to 2022, reaching its lowest level since 2006. Within the HRA, the incidence rate decreased in 8 counties in 2023 compared to 2022: Avon, Somerset, Dorset, Staffordshire, Cornwall, Hereford and Worcester, Shropshire, and the West Midlands. However, this decrease was only statistically significant in Hereford and Worcester, and Shropshire (12.4 and 12.1 in 2023 compared to 16.3 and 16.7 in 2022, $p=0.007$ and $p=0.002$, IRR, respectively). Of the three counties that recorded rises in incidence rate in 2023 (Gloucestershire, Wiltshire, and Devon), none were statistically significant. Incidence rate increased in these three counties despite the number of new TB incidents declining by 12%, 11%, and 14% in Gloucestershire, Wiltshire, and Devon respectively in 2023. This is because these counties experienced a greater decline in time at risk, where it decreased by 18%, 17%, and 15% in Gloucestershire, Wiltshire, and Devon respectively in 2023, leading to an increase in incidence rate.

In the Edge Area, the incidence rate decreased in 2023 for all but three counties, Oxfordshire, East Sussex and Hampshire. Incidence rate increased by 22%, 32%, and 13% respectively in these counties, but these trends were not statistically significant. This is because there were only relatively small increases in the number of TB incidents for the three counties and the time at risk for herds in these counties remained similar between 2022 and 2023.

The incidence rate remained low and stable in the LRA, with a third of the counties seeing a non-significant increase in 2023 compared to 2022, and around half seeing a similar non-significant decrease over the same period. Of note, the incidence rate decreased in Cambridgeshire, Essex, Kent, and Lancashire, curbing the increased incidence rate seen in these counties since 2018 – however, none of these changes were statistically significant.

Figure 3.1.5 County herd incidence rate (all new TB incidents per 100 HYR) in England in 2023

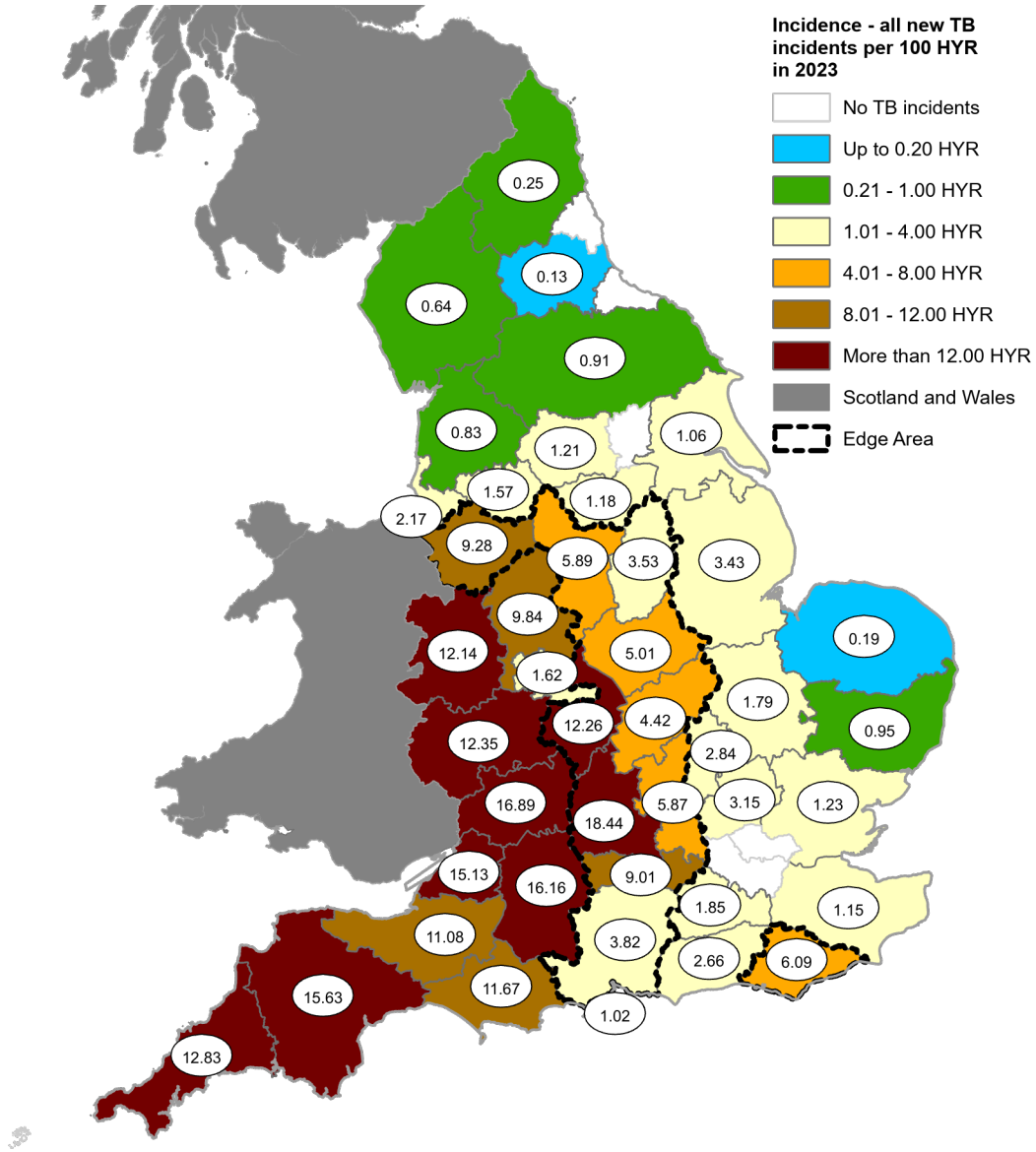


Figure 3.1.5: Map of England showing the incidence rate for each county, with the colour of the county based on the incidence rate within. There continues to be wide variation in incidence rates by county and risk area. The incidence rate was highest overall in the Edge Area and HRA counties of Oxfordshire, and Gloucestershire, respectively. Eight HRA counties experienced declines in incidence rate in 2023, including Shropshire and Hereford and Worcester, where the decrease was significant.

Spatial changes in the TB epidemic

Changes between 2023 and 2022 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). This methodology can be influenced by both low cattle density and local purchasing behaviour, and in isolated cases may give the appearance of

spread or retraction as a result of these factors, rather than true endemicity of TB in cattle populations.

Overall, this comparison shows that the majority of the HRA remained ‘endemically’ infected, along with parts of the Edge Area, particularly where it borders the HRA. However, there were large areas of retraction around north and west Dorset, into south Somerset in the HRA. Moreover, in the Edge Area, there were large areas of retraction of the endemic area, particularly around south and central Derbyshire, in south Northamptonshire and in north Leicestershire. There was a large area of spread in Oxfordshire, and some further spread into central Buckinghamshire in the 2021-2022 period, became endemic in 2022-2023.

As seen in previous years, most of the rest of England, particularly the LRA, remained free of endemic infection. Small areas of retraction were seen within the LRA in Lincolnshire around confirmed Hotspot 23 (in the southwest of the county), and on the northern end of the small endemic area in North Yorkshire. There has been an area of retraction in the east of Lancashire since the 2021-2022 period, alongside slight areas of spread in the central endemic area of the county. Additionally, areas of spread which appeared in 2021/2022 in Cumbria (north of confirmed Hotspot 21, resulting in the establishment of Hotspot 29, confirmed in the latter portion of 2023) have now become endemic by this methodology. However, there was also slight retraction towards the south of this endemic area in Cumbria. The endemic area in the east of Lincolnshire remained largely unchanged since the 2021-2022 period. For further information on potential and confirmed TB Hotspots in England, see Chapter 4.3.

APHA veterinary assessment has highlighted that the spread of endemic disease from Oxfordshire into Buckinghamshire includes some areas in the LRA which are being kept under observation, such as the creation in 2023 of a new confirmed TB hotspot area straddling the border with Hertfordshire (Hotspot 30). Additionally, the areas of spread in North Yorkshire, Lancashire, the north of Hampshire, the east of Berkshire, and East Sussex are also being monitored. Further details on spread of the endemic TB areas can be found in the LRA and Edge County Reports for more information).

The endemically infected area of England spread by approximately 2,084.88 km² in some parts, but contracted by 4,400.08 km² in other parts, resulting in a net overall retraction of 2,315.20 km^2 since 2021-2022. The net change refers to the area for which rate of spread could 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 2023 compared to 2022. A geographical unit (500 by 500 metre grid cell) was considered endemic if there are at least three OTF-W incidents within a 7 km radius within a two-year period.

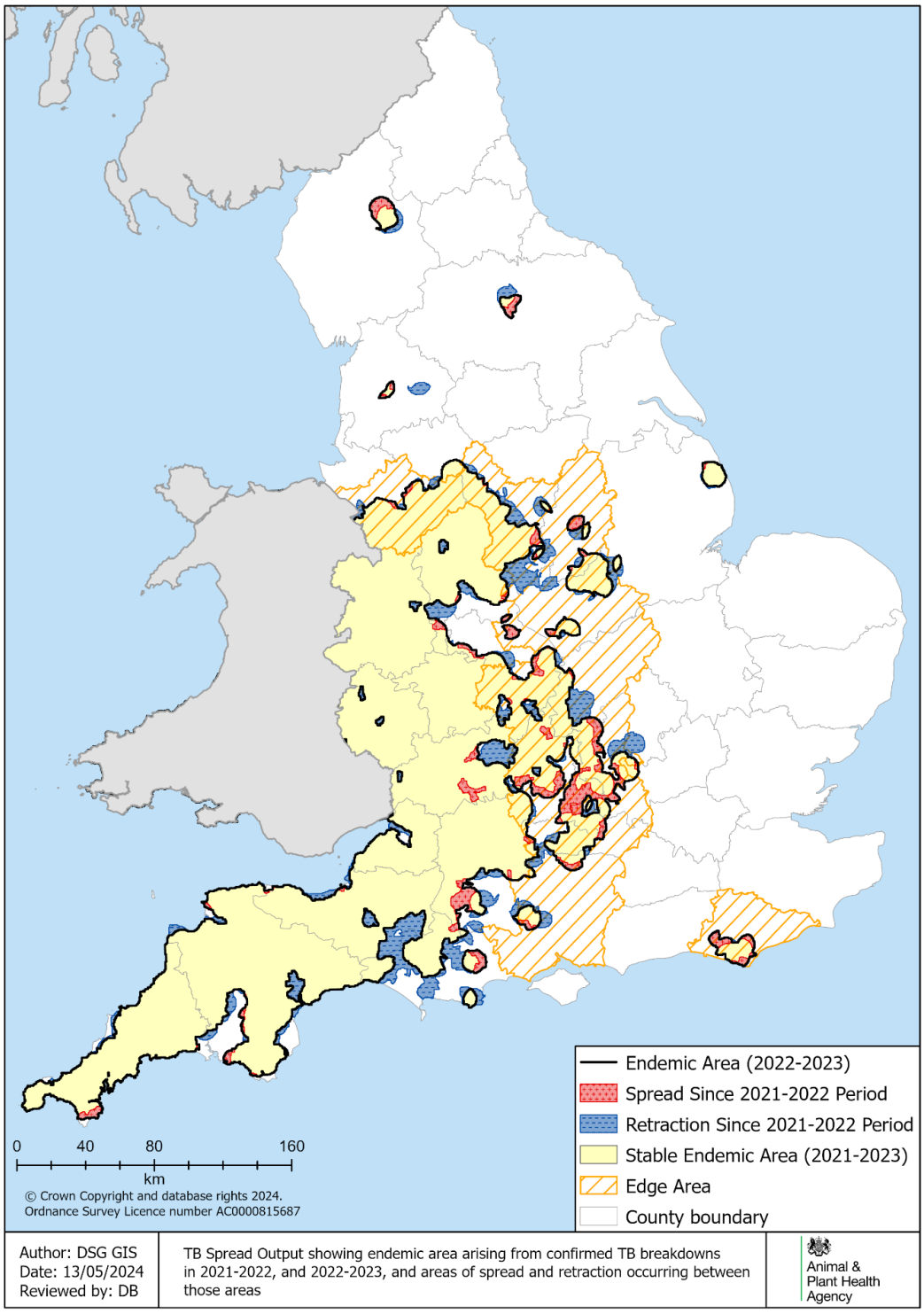


Figure 3.1.6 description: Map of England showing the amount of spread and retraction of the endemic area arising from confirmed TB breakdowns. Details on the areas of spread and retractions are described in the text.

TB control in wildlife

Although the bovine TB bacterium (*Mycobacterium bovis*) can potentially infect any mammal, the main wildlife reservoir in England is the European badger (*Meles meles*; Clifton-Hadley, 1993). The policy of intensive badger culling for TB control purposes has been implemented in the HRA since 2013 and in the Edge Area since 2017. It is carried out under licences issued by Natural England. TB in badgers is also controlled through the licensed use of injectable BCG vaccine. Licensed badger culling and badger vaccination activities undertaken in 2023 are summarised below.

Licensed badger culling

In 2023, no new intensive badger culling areas were licensed in England. However, 29 areas continued to operate under existing licenses. Additionally, a further 29 areas underwent Supplementary Badger Control in 2023 (having already completed four annual seasons of intensive culling). Further information can be found in the Summary of badger control monitoring during 2023.

Licensed badger vaccination

Badger vaccination took place in 19 counties in 2023: ten in the HRA, six in the Edge and three in the LRA. Badger vaccination operations were carried out during the trap season of 1st May to 30 November 2023, with 3,064 badgers vaccinated across England. Under the licences to cage-trap and mark badgers for bovine TB vaccination, the area where the respective landholder has permitted access for badger vaccination, is not routinely mapped, and thus an estimation of the area covered by these licenses can no longer be provided. More details can be found in the Summary of badger vaccination in 2023.

TB in non-bovine domestic and captive species in 2023

Mammals other than bovines and the European badger are also susceptible to *M. bovis* infection and can develop TB. This section therefore aims to quantify the number of laboratory-positive *M. bovis* infections in non-bovine domestic farmed species (and deer) in England, using TB surveillance data collected by APHA. This includes *M. bovis* isolations from notified suspect clinical and post-mortem incidents of TB in non-bovine and captive species.

There is no statutory routine TB surveillance of non-bovine species, apart from post mortem examination (PME) of animals slaughtered for human consumption (deer, goats, pigs and sheep). Targeted ante-mortem TB testing takes place in a small number of non-bovine herds with laboratory positive *M. bovis* infection, and in specific herds of camelids, goats and captive deer at an elevated risk of infection, such as those that are contiguous to (or co-located with) cattle herds affected by OTF-W incidents.

The number of total ante-mortem TB tests carried out on individual animals in England for all non-bovine species was 15,062, an 11% increase from 2022 (13,591). This increase was largely driven by a 180% rise in the number of goats submitted for testing (5,195 in 2023 compared to 1,858 in 2022), due to a single explosive laboratory positive TB incident involving a commercial herd of dairy goats in Essex, that ended up in the depopulation of the unit. However, this is still far below the number of goats tested between 2018-2021, where the annual number of goats tested did not drop below 10,000. The number of tests carried out on live deer also increased by 14%, from 3,545 in 2022 to 4,055 in 2023, the highest number of TB tests in deer recorded in England since 2011. In contrast, there was a 90% reduction in the number of TB tests carried out on live pigs (484 in 2022 compared to 46 in 2023). This drop is partly due to a single large herd testing 388 pigs in 2022. There were also reductions in the number of TB tests carried out on live sheep, South American camelids, and those categorised as other species, decreasing by 38%, 13% and 49%, respectively.

The number of test-positive animals slaughtered for TB control reasons increased slightly by 12% in 2023, mainly due to a nearly 20-fold increase in the number of slaughtered test-positive goats, rising from 8 in 2022 to 150 in 2023. Additionally, the number of laboratory positive tests (in individual animals) more than doubled in 2023 (140) compared to 2022 (64). This was largely driven by a rise in culture-positive results from deer and goat samples (68 and 27 in 2023 compared to 34 and 0 in 2022, respectively).

Overall, the number of laboratory-positive TB incidents (in herds) increased by just over fivefold between 2022 and 2023 (from 5 incidents in 2022 to 26 in 2023), with a nearly fourfold increase in the number of laboratory test-positive TB incidents in deer (3 in 2022, 11 in 2023), and sevenfold rise in other species (1 in 2022, 7 in 2023). These changes are not unexpected due to the small numbers of incidents involved.

Table 3.1.2: Results of TB surveillance in non-bovine farmed and captive animal species in England in 2022 and 2023. Data adapted from the statistical dataset of TB in Non-Bovine Species 2011-2023 published by Defra on 22 May 2024.

	2022	2023
Total ante-mortem tests		
South American (SA) Camelids	3,880	3,383
Sheep	3,787	2,362
Goats	1,858	5,195
Pigs	484	46
Deer	3,545	4,055
Other[1]	41	21
Total for all non-bovines	13,591	15,062
Total TB Positive animals slaughtered (%)		
SA Camelids	92 (2.4%)	36 (1.1%)
Sheep	3 (0.1%)	16 (0.7%)
Goats	8 (0.4%)	150 (2.9%)
Pigs	0 (0.0%)	4 (8.7%)
Deer	172 (4.9%)	103 (2.5%)
Other[1]	0 (0.0%)	0 (0.0%)
Total for all non-bovines	275	309
Total PCR or culture positive tests (% of PCR tested or cultured specimens)		
SA Camelids	10 (20.0%)	7 (20.0%)
Sheep	4 (50.0%)	6 (30.0%)
Goats	0 (0.0%)	27 (93.1%)
Pigs	9 (4.5%)	19 (30.2%)
Deer	34 (72.3%%)	68 (56.2%)
Other[1]	7 (33.3%)	13 (28.3%)
Total for all non-bovines	64	140
Total laboratory positive TB incidents		
SA Camelids	0	3
Sheep	1	2
Goats	0	1
Pigs	0	2
Deer	3	11
Other[1]	1	7
Total for all non-bovines	5	26

[1] The“"Other”" category includes mainly pets (cats and dogs) and the occasional sample from exotic mammals kept in zoosor safari parks. The percentage of culture positive tests is the proportion of culture positive tests from the number of animal specimens that underwent culture for the year of interest for each species of interest – this is provided in the statistics of TB in Non-Bovine Species 2011-2023.

3.2 Characteristics of (and sources of infection for) herds with a new TB incident

- As in 2022, four key factors significantly increased the risk of a herd having a new TB incident in England in 2023 namely: i) having over 300 cattle, ii) being in the HRA, iii) being a dairy herd and iv) having experienced a TB incident in the previous three years.
- There is a substantial population of cattle in the north of England that remains largely uninfected, showing that other factors are also important in the occurrence of TB in cattle herds, such as the existing level of infection in the local cattle population and the presence of a local reservoir of M. bovis infection in wildlife (particularly badgers).
- Analysis shows that the probability of TB being found in a dairy herd was almost fourfold 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 each TB risk area), dairy herds were 46% more likely to have a TB incident than beef herds (adjusted IRR=1.46, 95% CI 1.33-1.60, $p<0.001$). 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.
- A history of TB infection in the herd was also an important risk factor in all risk areas. Across England, over half of herds (54%) that had a new TB incident disclosed in 2023 had sustained a TB incident within the previous three years (recurrent infection). The probability of recurrence was highest in the HRA and the six-monthly TB surveillance section of the Edge Area (57% of herds with new incidents in 2023 each), followed by the annual surveillance portion of the Edge Area (42%) and the LRA (21%).
- WGS data identified a local reservoir of infection, and with no cattle movements associated with a high likelihood of infection for 15% new TB incidents in the HRA, 20% in the Edge Area and 8% in the LRA in 2023.
- Most TB incidents (79%) from which M. bovis was isolated and subjected to whole genome sequencing (WGS) occurred within the ‘homerange’ of the WGS clade of the that isolate, indicating the clade 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 introductions) and local environmental or wildlife factors.

Local herd density

Herd size and local density 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 2023.

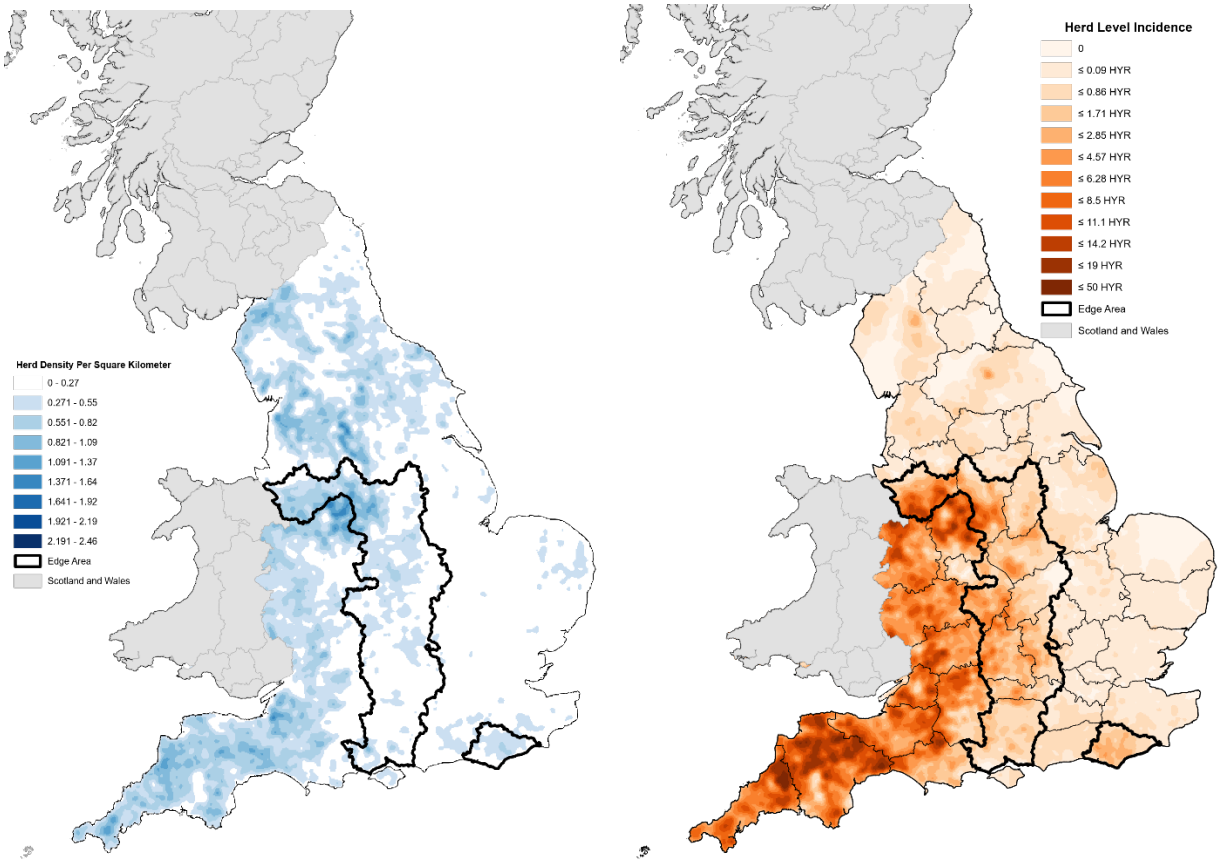


Figure 3.2.1 description: Two maps of England, showing the herd density per square kilometre on the left, and the a kernel density map of herd level incidence on the right. Herd density is measured as the number of herds per square kilometre; herd incidence is the average incidence per 100 herd years at risk in the 100 closest herds to each herd location, which ‘smooths’ the effect of administrative boundaries. The highest numbers of cattle and herd density are primarily in the HRA and parts of the Edge Area. The lowest population in terms of both holding and cattle numbers is found in the eastern portion of

the LRA. However, cattle demographics alone do not explain the geographic distribution of TB, as there is high cattle and herd density in parts of Northern England where TB incidence is low.

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 the highest risk of infection with TB. These constitute 14%, 12%, 9% and 8% of all herds in the six-monthly surveillance part of the Edge Area, HRA, LRA and annual-testing part of the Edge Area, respectively. This is comparable to observations in 2022.

Figure 3.2.2: Number of herds by herd size and type in each risk area of England in 2023

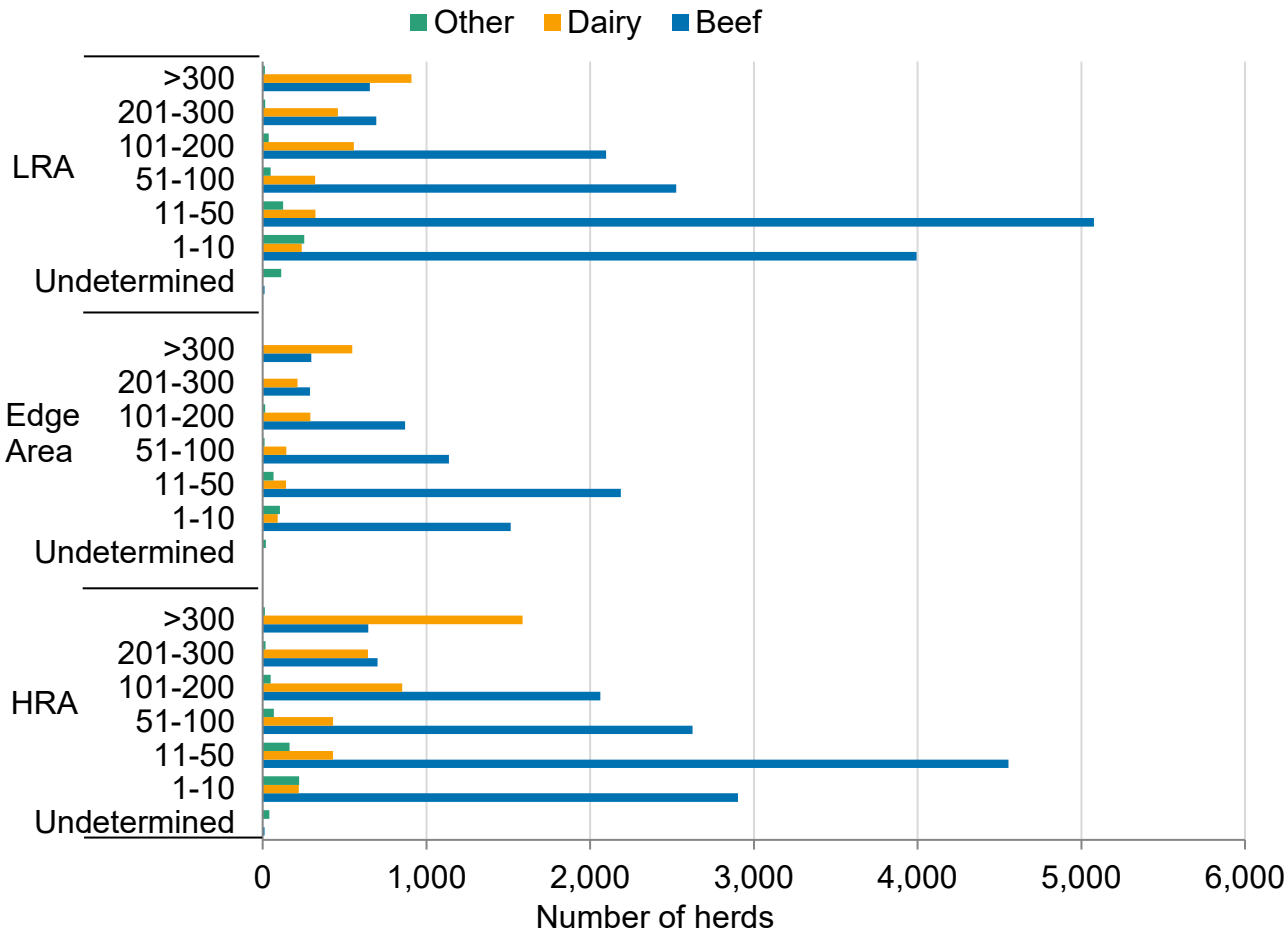


Figure 3.2.2 description: Bar chart showing the number of herds by herd size and herd type (dairy, beer or other). There are proportionally more large herds and dairy herds in the HRA compared with the other two risk areas. This may explain some of the spatial distribution of TB infection in cattle.

The percentage of TB incidents disclosed in beef (52.6%), dairy (46.4%) and “other” (1.0%) herds in 2023 represented a decrease of 1.4% in beef herds and an increase of

0.8% in dairy herds compared to 2022 (54.0% and 45.6% respectively). This increasing trend in the percentage of TB incidents affecting dairy herds is consistent with previous years (since 2007).

As there are many more beef than dairy herds in England, the percentage of new TB incidents by herd type does not truly reflect their likelihood of becoming infected. Figure 3.2.3a shows the (unadjusted) incidence rates according to different characteristics (size, production type and location) of herds in England. This demonstrates that dairy herds were over twofold more likely to become infected with TB than beef herds in 2023. However, dairy herds also tend to be larger and are more often 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 (unadjusted) in herds of different size and type, and in each risk area of England, in 2023

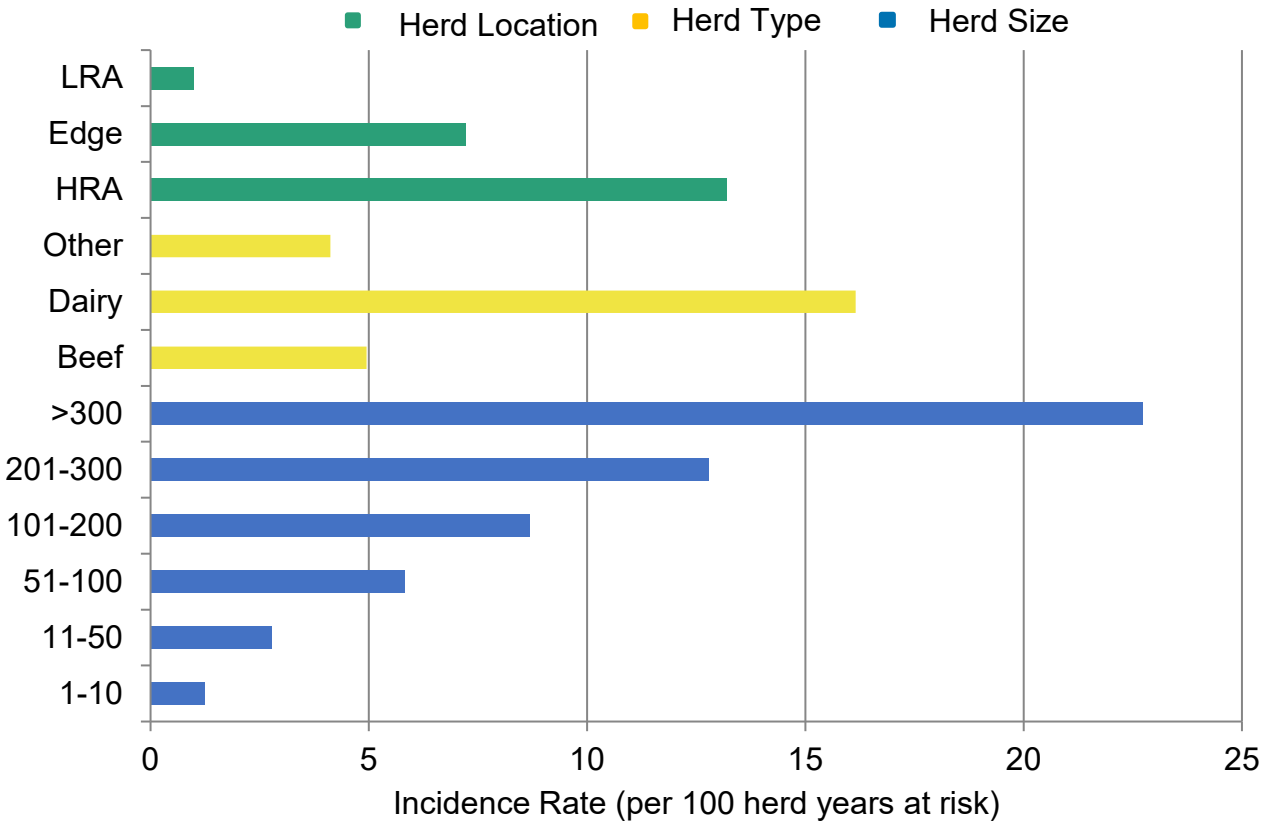


Figure 3.2.3a description: Bar chart showing the unadjusted incidence rate in herds of different size and type for each risk area in England, herd type and herd size. Herd size was strongly associated with the likelihood of becoming infected with TB; herds with over 300 cattle had an incidence rate of approximately 23 new TB incidents per 100 HYR in 2023, while it was under 5 in herds with 50 or fewer cattle. Dairy herds were over threefold more likely to suffer a TB incident in 2023 than beef herds. The herd incidence rate in the HRA was 1.8 times greater than when compared to the Edge Area and just over 13-fold greater than that in the LRA.

Potential risk factors were explored further by comparing IRR's. This is the comparative proportion of herds in each category that become infected. Other factors that may affect the rate of infection can then be adjusted for. These comparative ratios are shown in Figure 3.2.3b.

For herd size, if location and herd type are adjusted for when calculating the IRR, the adjusted IRR remains similar to the unadjusted IRR. This indicates that herd size may be the main factor driving the observed trends. The adjusted IRR for herds with 300 or fewer animals ranged from 0.06 to 0.66-fold the rate of TB infection in herds with over 300 animals (the reference herd size range). As seen in previous years, the rate ratios increased with herd size.

The high IRR in dairy herds is primarily because they tend to be larger and more often located in the HRA than beef herds. Adjusting for both herd size and location significantly reduced the estimated risk associated with being a dairy herd. However, as in previous years, dairy herds remained at a higher risk of new infections in 2023 than beef herds (adjusted IRR=1.46, 95% CI 1.33 to 1.60, $p<0.001$).

The IRR was significantly lower in the Edge Area and LRA compared to the HRA (Figure 3.2.3b), even after adjusting for the effects of herd size and type. This indicates that geographical (risk area) location remains an important risk factor.

In 2023, the adjusted IRR for herds in the Edge Area compared to the HRA was 0.58 (95% CI 0.53-0.65). 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, increasing to 0.49 in 2018, 0.6 in 2019, 0.64 in 2020, 0.65 in 2021, and 0.67 in 2022.

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, the explanatory supplement to the reports. 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 2023. The “Ref.” acronym refers to the reference category used when calculating the incidence rate ratio. Error bars shown represent the 95% confidence interval for the incidence rate ratio

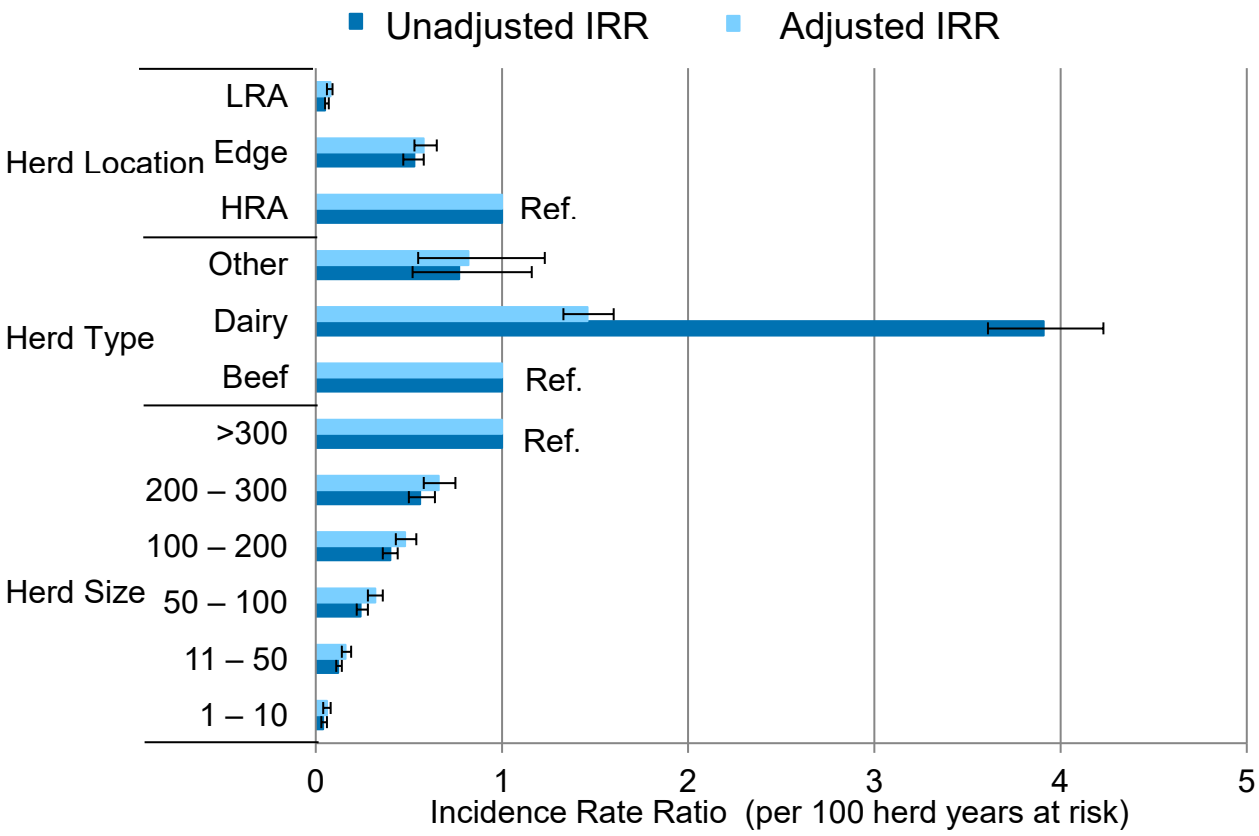


Figure 3.2.3b description: Bar chart showing the unadjusted and adjusted Herd size and location are the most important explanatory (risk) factors for the incidence rate. The incidence rate ratio for herds in the Edge Area was over half the rate for herds in the HRA. The unadjusted incidence rate in dairy herds was nearly fourfold 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 46% more likely to have a TB incident than beef herds (42% in 2022).

Recurrent TB incidents

Where a herd has history of TB, this is linked to increased odds of infection occurring in any given year. For the purposes of this report, a recurrent incident is a new TB incident in a herd that had another TB incident in the previous three years. The percentage of recurrent infected herds are explored in two ways.

1. The percentage of all herds with a history of TB in the last three years that went on to experience a new TB incident in 2023, compared to the percentage of all herds without a history of TB in the last three years that went on to have a TB incident in 2023 (forward-looking recurrence – comparing a cohort of herds from the past to their present outcomes). Forward recurrence is important to determine whether a herd that has had a history of TB is more likely to experience another TB incident in the future, with a focus on what happened to the herds in the current reporting year.
2. The percentage of herds with a new TB incident in 2023 that had sustained another TB incident in the previous three years (backward-looking recurrence – checking the TB history of herds that had an incident this reporting year). Backwards looking recurrence is important to help understand whether there are risk factors in herds that make them more likely to experience a TB incident later on, such as having had a TB incident in the past.

Recurrence may result from multiple factors: residual (undetected) cattle infection from a previous TB incident in the same herd, continuous exposure to local infection in wildlife or cattle reservoirs, or introductions of undetected infected cattle to a herd. Farmers' awareness of the risk factors involved in contracting TB in their herds may also help those keepers with a history of TB infection, to make informed decisions about their management and biosecurity practices, using available information from places such as the TB Hub and iBTB. The annual trend in the annual percentage of new TB incidents detected in each risk area of England that had a history of TB in the preceding three years is shown in Figure 3.2.4a. Recurrence in England overall was 54% in 2023, similar to 2022 (52%). Recurrence was consistently highest in the HRA, along with the six-monthly TB surveillance part of the Edge Area in recent years, and lowest in the LRA. The percentage of recurrent incidents remained similar in the HRA (57%) but increased in the Edge Area (from 56% to 57% in the six-monthly testing area and from 34% to 42% in the annual testing area). Recurrence in the LRA (21%) was much lower than in the other TB risk areas of England, although it has doubled since 2021 (10%). The annual percentage of recurrent incidents in this area has fluctuated over time around the 10% mark, but has been increasing in the last two years (15% in 2022 and 21% in 2023).

Figure 3.2.4a Annual percentage of TB incidents with a history of TB in the previous three years, by risk area, from 2014 to 2023

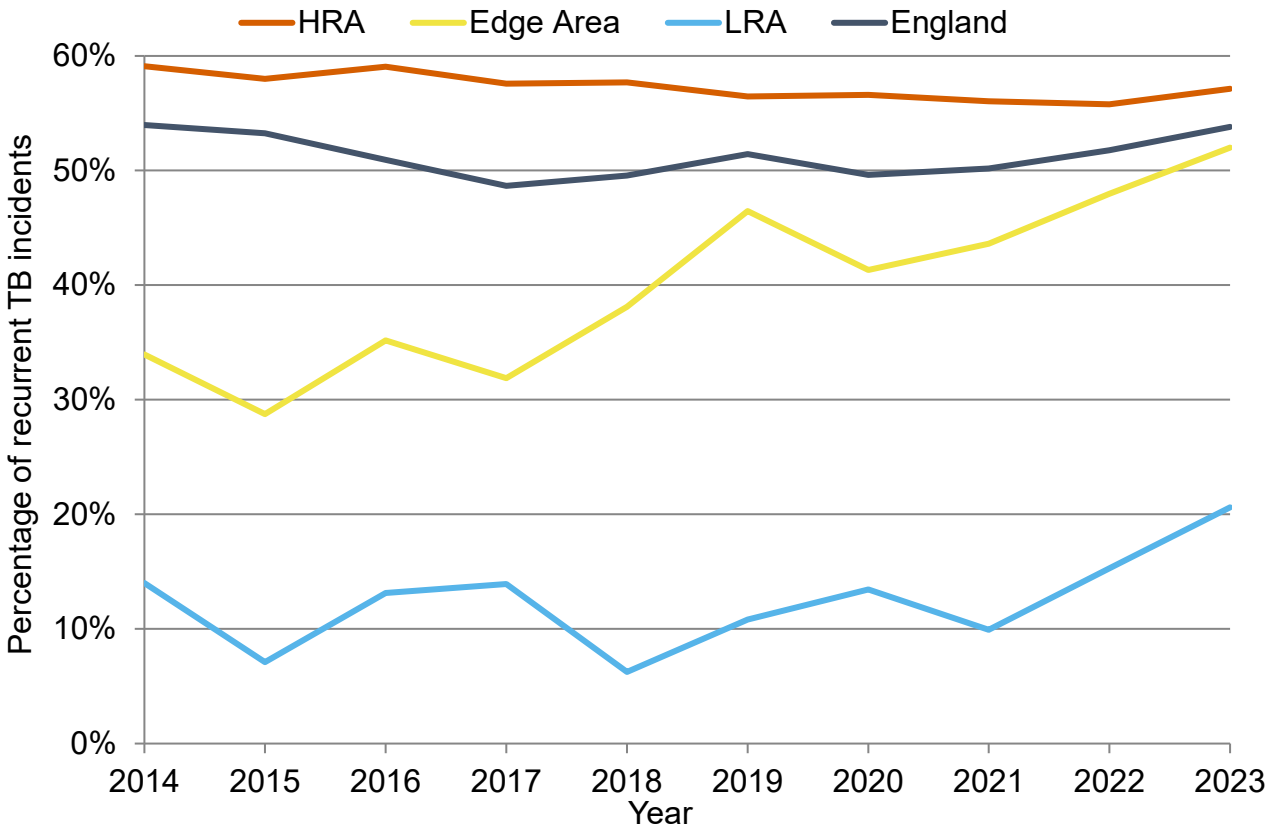


Figure 3.2.4a description: Line chart showing the annual percentage of recurrent TB incidents with a history of TB in the previous 3 years between 2014 and 2023 by risk area and in England overall. The percentage of recurrent incidents has shown a consistent (but not significant) downward trend in the HRA since 2014. The percentage of recurrent TB incidents increased for the third year in the Edge Area in 2023 (52%). In the LRA, the percentage of recurrent TB incidents increased to 21% in 2023, from 15% in 2022 and 10% in 2021.

Figure 3.2.4b Annual percentage of TB incidents with a history of TB in the previous 18 months, by risk area, from 2014 to 2023

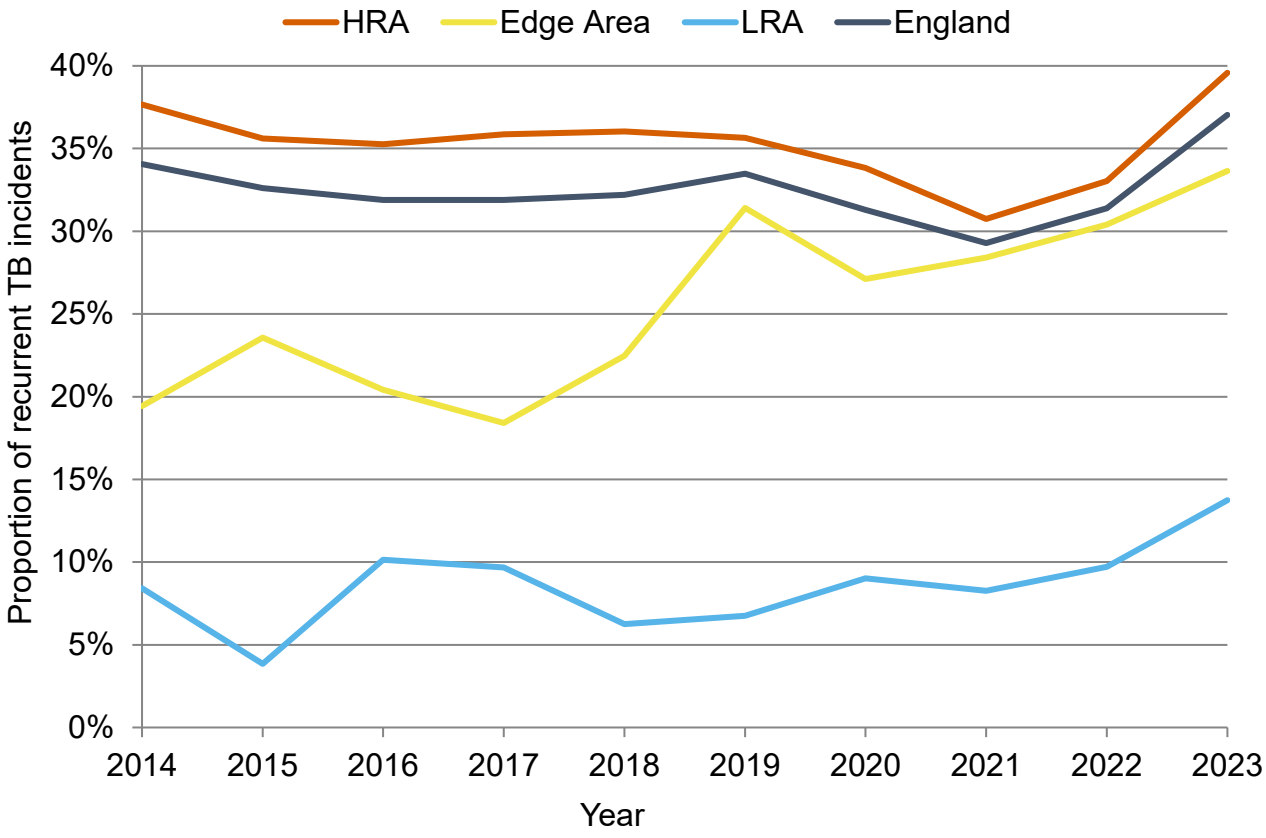


Figure 3.2.4b: Line chart showing the annual percentage of TB incidents with a history of TB in the herd in the previous 18 months. When only the previous 18 months were considered, the percentage of recurrent TB incidents in the HRA increased from 33% in 2022 to 40% in 2023. The percentage of recurrent TB incidents increased for the third year in the Edge Area in 2023 (34%) and was higher than the previous peak of recurrence in 2019 (31%). The percentage of recurrent TB incidents has remained relatively stable in the LRA, however it increased from 10% in 2022 to 14% in 2023.

Forward-looking recurrence

In 2023, herds in the HRA with a history of TB in the previous three years were 2.1-fold as likely to have a new TB incident, compared to herds with no history of TB (95% CI: 1.9–-2.3). Herds with a history of TB in the Edge Area were 3.2-fold as likely to have a TB incident than herds without a TB history (95% CI 2.6-4.0). The odds of forward recurrence were highest in the LRA, where herds with a history of TB in the previous three years were 8.7-fold more likely to have a new TB incident in 2023 (95% CI 5.6-13.6). The confidence interval also does not overlap with either the HRA or the Edge Area intervals, highlighting that the risk of an incident in the LRA was associated with previous TB history to a greater extent than it was in either the HRA or Edge Area. This is potentially due to the impact of

hotspot areas and recurrent independent incidents in beef fattening units which regularly bring in cattle from the higher TB risk areas of England and Wales (Figure 3.2.6a).

The recurrence odds ratio (OR) has been relatively stable in the HRA in recent years (around 2.0), but more variable in the Edge Area. In 2023, the Edge Area recurrence odds ratio (3.2) was higher compared to the previous years (OR 2.5, 95% CI 2.1-3.0 in 2022, OR 2.2, 95% CI 1.8-2.6 in 2021 and OR 2.3, 95% CI 1.9-2.7 in 2020), 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, whilst other areas have a low incidence of TB (i.e., TB in the Edge Area is heterogenous). When recurrence is calculated for the Edge Area, the odds of herds with a TB history having a new incident in 2023 is higher than the odds in the HRA. However, the odds of TB in herds with no TB history is lower than in the HRA.

The odds of having TB were similar (between 2 and 3-fold) across all herd types (beef, dairy and ‘other’ herds) with a TB history, compared to herds with no TB history, showing that production type was not important in determining the risk of recurrence in a herd (Figure 3.2.6a).

When the same analyses were run on herds which had suffered previous OTF-W incidents only (rather than any incident), the odds of recurrence remained broadly the same, which was also the case in 2022.

The odds ratios for recurrent incidents in herds with a history of an OTF-W incident only were lowest in the HRA (OR=1.8, 95% CI 1.6-2.0), increasing to 2.8 in the Edge Area (95% CI 2.2-3.5), and 9.4 in the LRA (95% CI 4.7-18.7).

The odds of having a TB incident in herds with a TB history, compared to herds without a history of TB incident, was similar between herd size categories (Figure 3.2.6a) as in 2022. However, for all herd sizes, the confidence intervals overlapped, showing that the risk of having a TB incident was similar for all herds regardless of size.

The majority of herds with multiple TB incidents in the last 3 years were located in the HRA, followed by the Edge Area, with only one of those herds within the LRA (Figure 3.2.5).

Figure 3.2.5: Map of TB incidents in the 3 years to December 2023 that had 2 or more previous incidents.

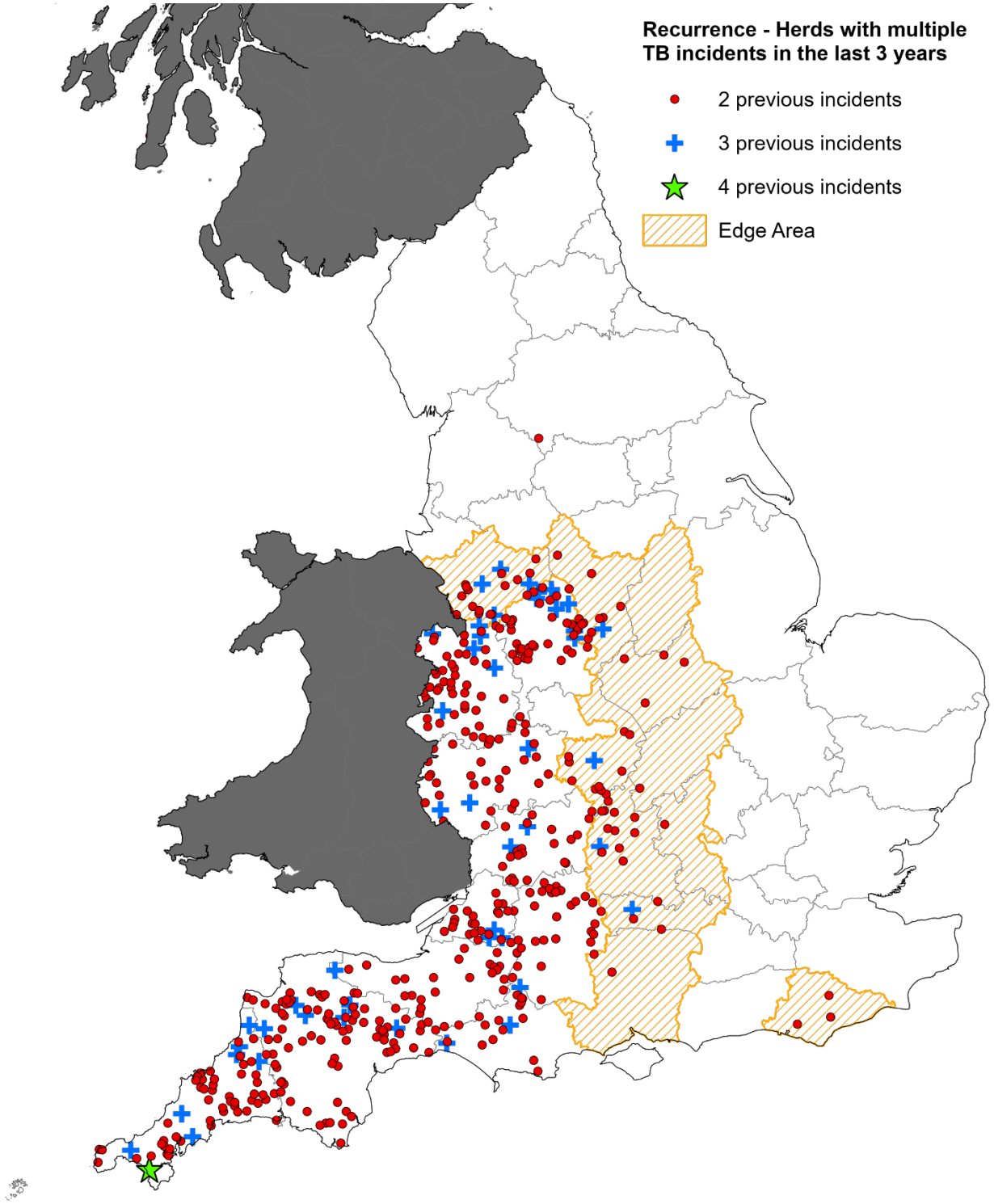


Figure 3.2.5: Map of England showing the location of TB incidents which had a history of 2 or more previous TB incidents in the past 3 years. The majority of 'multi-recurrent' TB incident herds had 2 previous incidents, and these were mainly within the HRA. Most of the herds within the Edge Area with more than 2 previous incidents were located towards the HRA border. TB incidents herds with 3 previous TB incidents were mainly found in the

HRA. There was one TB incident with 4 previous incidents, and this was located within the HRA.

Figure 3.2.6a: The odds ratios of recurrent infection in 2023 in herds with a history of TB (in the previous three years) compared to herds with no TB history, by herd size, herd type and risk area (error bars show 95% confidence intervals)

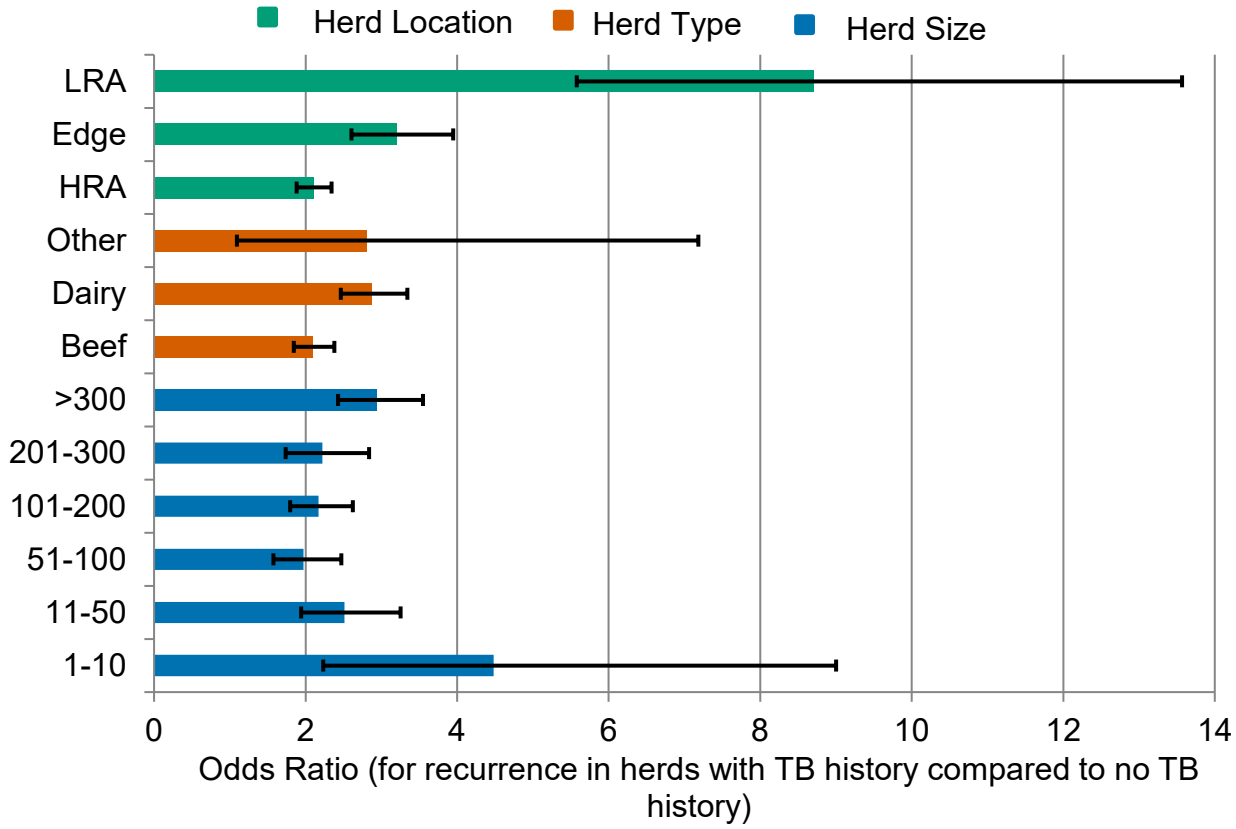


Figure 3.2.6a: Bar chart showing the odds of recurrence in herds with TB history compared to no TB history, by herd risk area location, herd type and her size, with confidence intervals. The odds of recurrence in herd with or without TB history were similar regardless of herd type. The odds of a recurrent incident in herds with TB history compared to no TB history was similar for all herds regardless of size. Odds of recurrence in the HRA is approximately twice as high in herds with a TB history compared to those without, and around three-fold as likely in the Edge Area. The LRA has the highest odds of recurrence in herds with TB history compared to no TB history at nearly 9-fold as likely, despite having fewer previous incidents in the past three years compared to the Edge and HRA.

Backward-looking recurrence

Backward-looking recurrence, as a percentage of all herds that were positive in 2023 only, was examined within each risk area and herd type category separately (Figure 3.2.6b).

Herds with a TB incident in 2023 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 13% of beef herds experiencing a recurrent infection, which is similar to 2022 (15%).

Figure 3.2.6b: The percentage of herds that went on to disclose a TB incident in 2023 with and without a history of TB in the previous three years, by risk area and herd type.

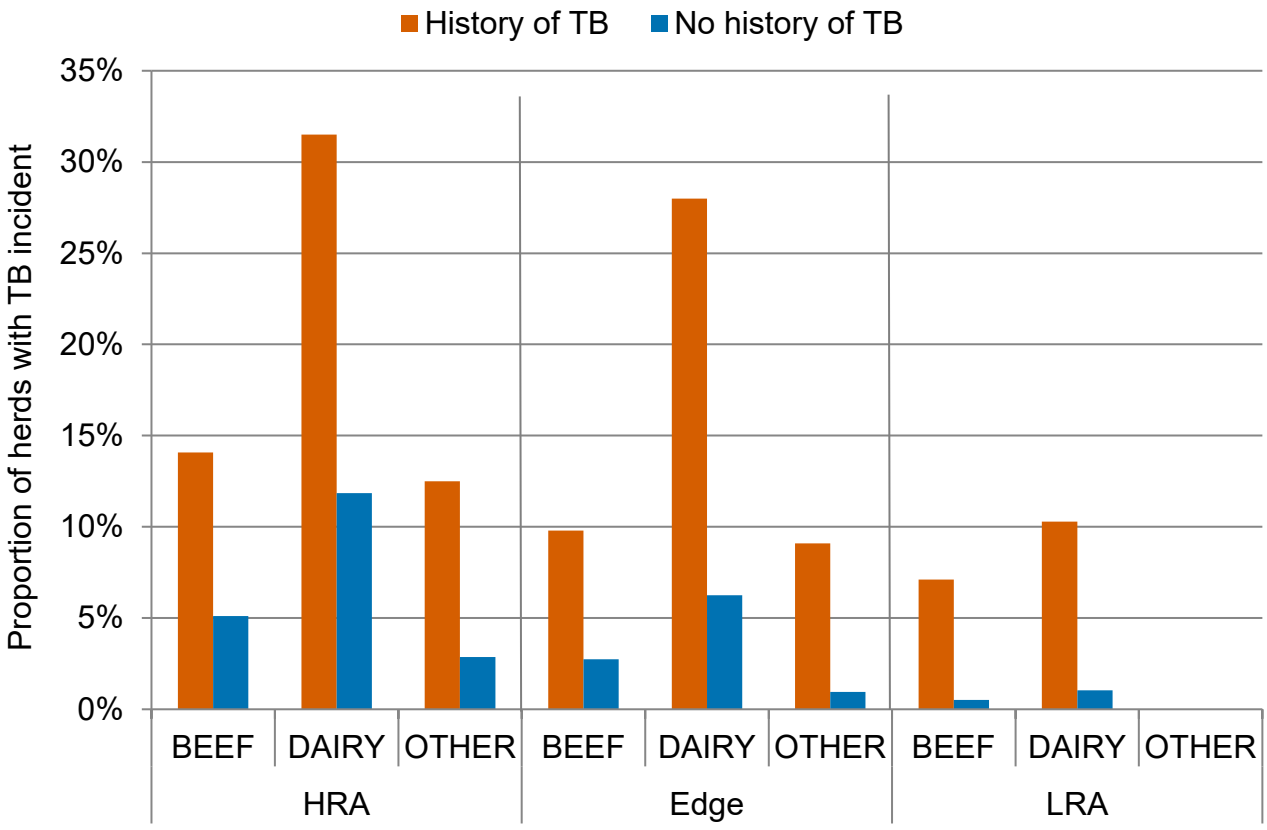


Figure 3.2.6b description: Bar chart showing the percentage of herds that went on to disclose a TB incident in 2023 with and without a history of TB in the previous three years, by risk area and herd type. The percentage of beef and dairy herds with a TB incident in 2023 was higher among herds with a TB history in the previous three years than those without, for all risk areas. Dairy herds with a history of TB accounted for the largest percentage of recurrent incidents in all three areas compared to beef and 'other' herds, and this is consistent with previous reporting years.

Molecular typing

APHA attempts to recover M. bovis from all TB incidents and to submit at least one isolate per PCR and culture-positive incident for genetic characterisation. Historically, in Great Britain this characterisation was initially based on a DNA technique known as spoligotyping. APHA later used a combination of spoligotyping and Variable Number Tandem Repeat (VNTR) typing results to generate a molecular type (genotype) for each M. bovis isolate. Finally, Whole Genome Sequencing (WGS) fully replaced spoligo- and VNTR-typing of M. bovis isolates at APHA from April 2021.

WGS examines the variation caused by mutations across the entire DNA sequence of the M. bovis genome (4.4 million nucleotide positions), whereas spoligotyping and VNTR-typing measured variation in only one and six small regions of the bacterial genome, respectively. WGS allows true evolutionary comparison of isolates and WGS clades are now routinely reported, instead of genotypes.

A clade is a group of genetically related isolates, based on similarities between their whole genome sequences. Most genotypes correspond to a single WGS clade, but this is not always the case. The combination of infected herd location and clade detection frequency can be used to describe areas where particular clades are commonly isolated (or endemic). Those areas are called ‘homeranges’. This then enables isolates from new TB incidents to be compared with the previous known geographic distribution of that clade. The improved granularity of WGS data provides greater discrimination between strains of M. bovis than the previous genotyping method, enabling evolutionary relatedness to be determined at a greater resolution. This allows more accurate determination of transmission pathways in incidents.

Of the 1,305 isolates with location and a full clade that had a calculated homerange identified in 2023 in England, 1,027 (79%) were within their homerange and the remaining 278 were reported as ‘out-of-homerange’ isolates. The most frequent clade found in England in 2023 was B6-11, which accounted for 19% of the M. bovis isolates subjected to WGS. This was followed by B6-85 (19%) and B3-11 (17%), based on 1,313 incidents starting in 2023 with a clade identified. These three clades accounted for 56% of all clades disclosed and cover extensive areas in the Southwest and West of England.

Further information about WGS of M. bovis is given in the Explanatory Supplement. The assessments described in the next section on source of infection have been informed by WGS data, where available. Further statistics on the clades of M. bovis identified in 2023 are included in the GB Data Report.

Figure 3.2.7a. Homeranges of the three WGS clades of M. bovis most commonly isolated in England (B6-11, B6-62 and B6-85), based on data from 2023.

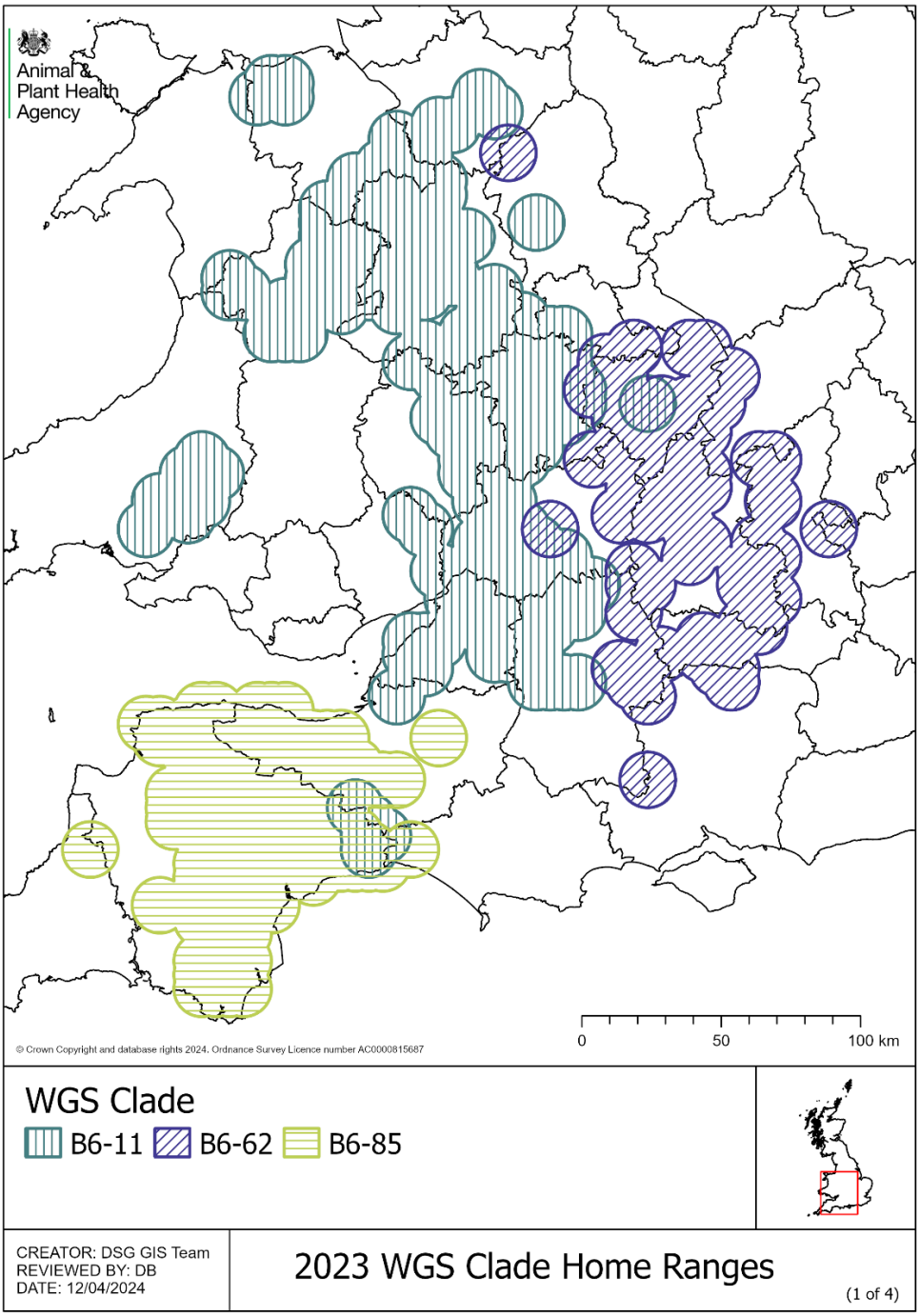


Figure 3.2.7a. description: Map of England and Wales, showing the homeranges of the three WGS clades of M. bovis most commonly isolated in England (B6-11, B6-62 and B6-85), based on data from 2023. B6-85 covers much of Devon and western Somerset, as well as parts of Cornwall and Dorset. B6-11 straddles much of the western HRA border with Wales, as well as southeast Carmarthenshire in Wales and the borders of Devon, Somerset, and Dorset. B6-62 covers parts of the southern Edge counties of Hampshire, Berkshire, Oxfordshire, Buckinghamshire, Warwickshire, Northamptonshire, and the West Midlands in the HRA.

Figure 3.2.7b: Homeranges of WGS clades B3-11, B6-14, B6-83, B4-11 and B6-51 of M. bovis, based on data from 2023.

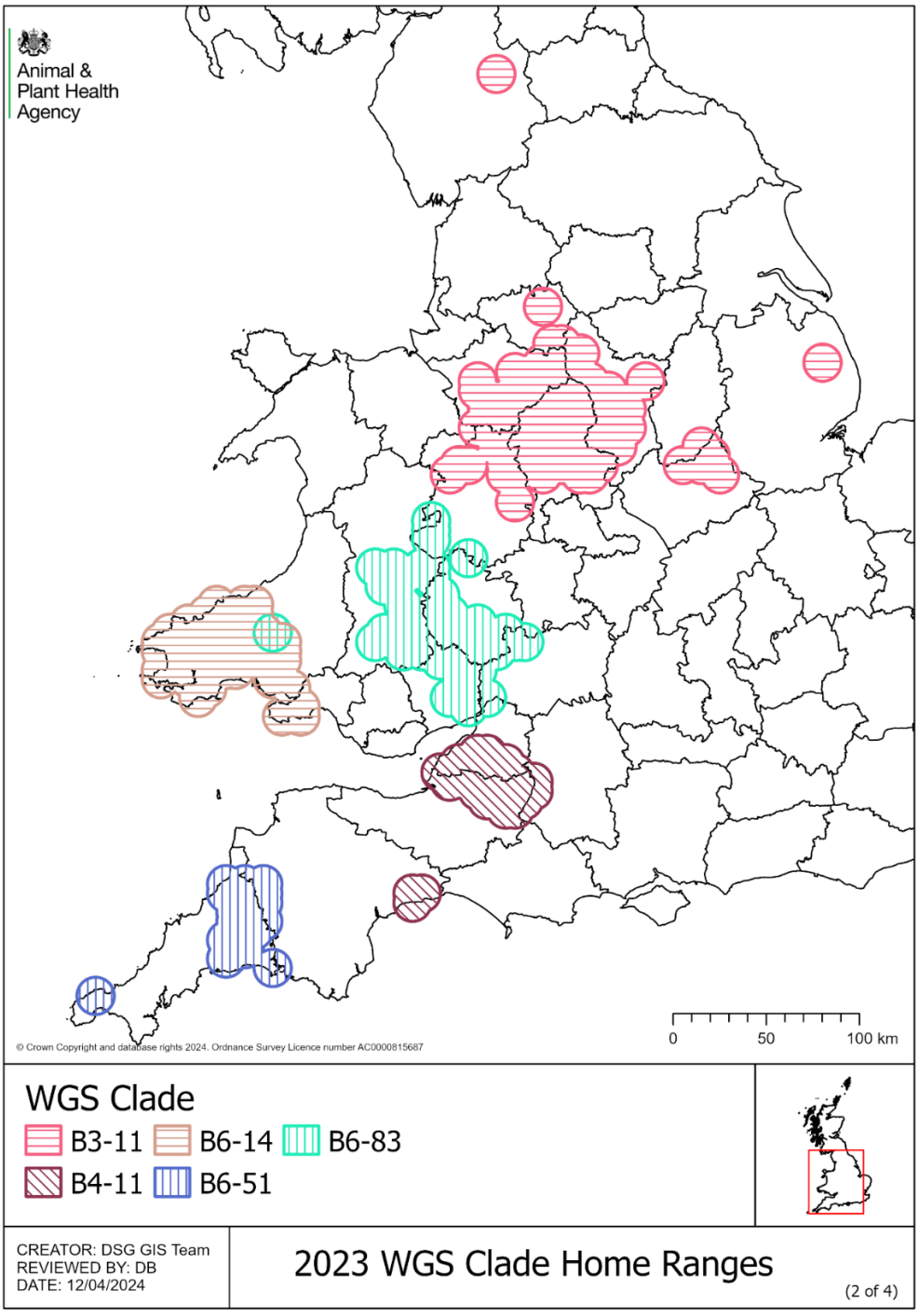


Figure 3.2.7b description: Map of England and Wales showing the homeranges of WGS clades B3-11, B6-14, B6-83, B4-11 and B6-51 of M. bovis, based on data from 2023. B3-11 is widespread over the northern Edge counties and in parts of Cumbria and Lincolnshire in the LRA. B6-83 straddles the southern Welsh and England border. B4-11 is found between Somerset, Avon and Wiltshire and a small part of Devon. B6-14 covers Pembrokeshire and Carmarthenshire in Wales, and B6-51 is mostly found in Cornwall.

Figure 3.2.7c. Homeranges of other (less widespread) WGS clades of M. bovis: B1-11, B6-42, B6-87, B6-13, B6-52 and B6-91 , based on data from 2023.

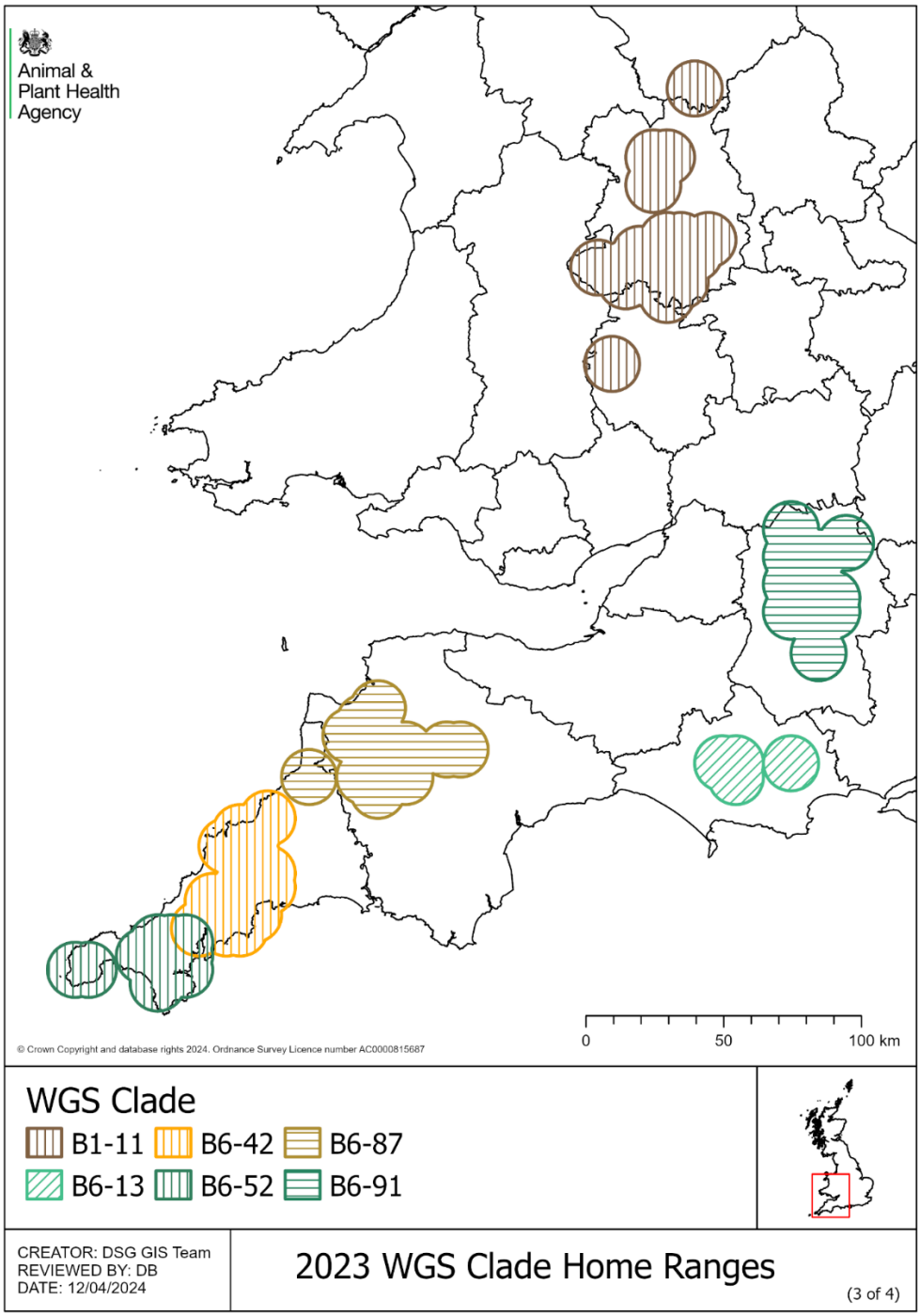


Figure 3.2.7c. description: Map of England and Wales showing the homeranges of other (less widespread) WGS clades of M. bovis: B1-11, B6-42, B6-87, B6-13, B6-52 and B6-91, based on data from 2023. B1-11 is found in Staffordshire and Shropshire. B6-91 is found in Wiltshire, B6-13 in Dorset. B6-87 in northwest Devon and Cornwall. B6-42 covers central Cornwall and B6-52 on the tip of Cornwall.

Figure 3.2.7d. Homeranges of other (less widespread) WGS clades of M. bovis: B2-11, B6-16, B6-41, B6-12, B6-15, B6-22 and B6-71, based on data from 2023.

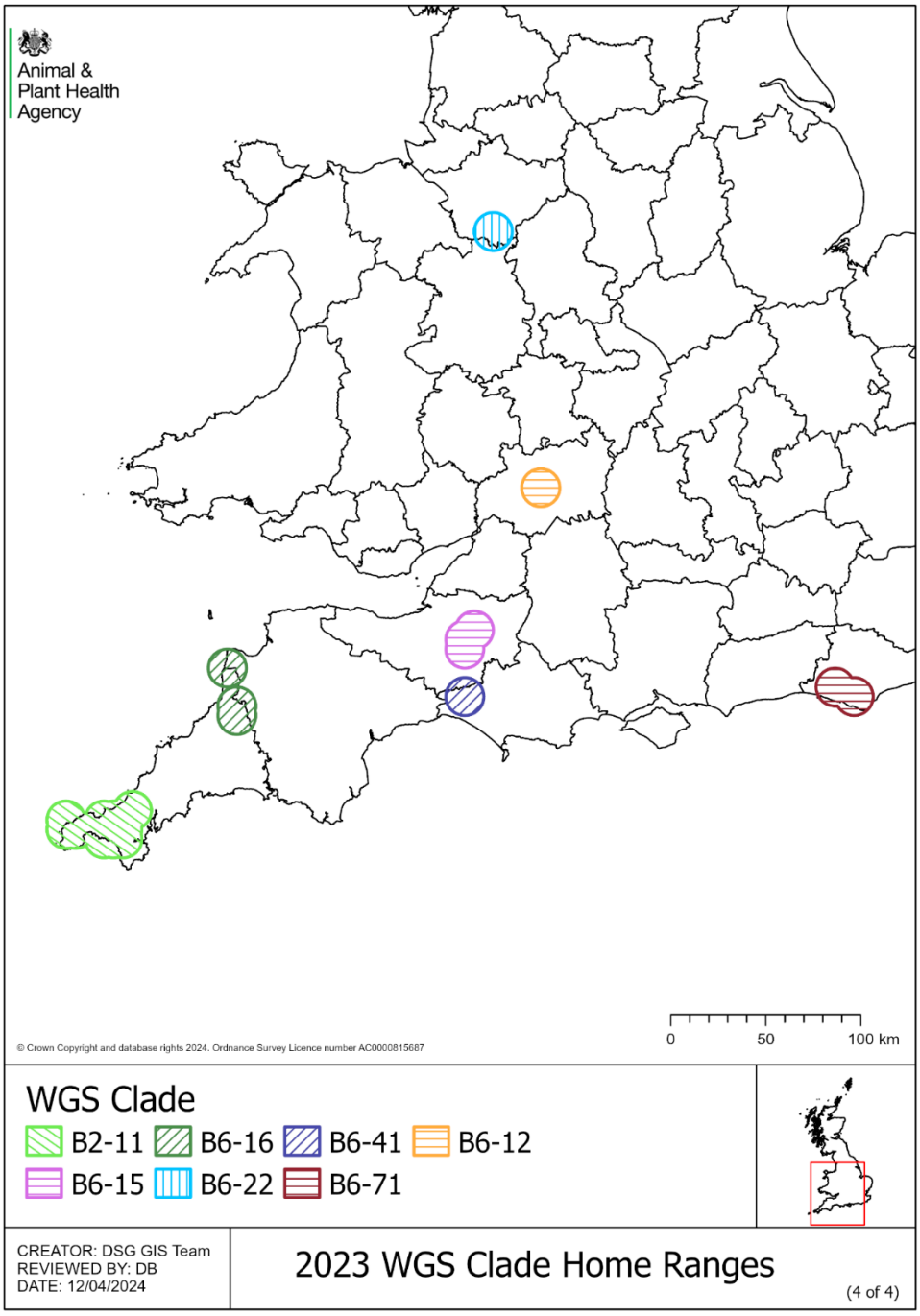


Figure 3.2.7d. description: Map of England and Wales showing the homeranges of other (less widespread) WGS clades of M. bovis: B2-11, B6-16, B6-41, B6-12, B6-15, B6-22 and B6-71, based on data from 2023.The homeranges for these clades are much small, occupying small portions of counties. B2-11 is found on the tip of Cornwall. B6-16 on the border between Cornwall and Devon. B6-41 on the north border of Dorset. B6-15 in central Somerset. B6-71 on the southwestern border of East Sussex. B6-12 within central Gloucestershire. B6-22 on the border of Cheshire and Shropshire.

Sources of infection for herds with a new TB incident in 2023

During 2023, fewer TB incidents than normally required underwent a preliminary or final APHA veterinary investigation (Disease Report Form) to identify the source of infection. This was due to the diversion of veterinary resource to respond to outbreaks of Avian Influenza and Bluetongue virus disease in England.

New data-driven methods to quantify the likelihood of risk pathways for TB infection have been developed by APHA to provide insights into the main drivers for TB at the county and risk area level. These new methods include the:

- Cattle Movement Algorithm
- WGS Local Transmission of Infection Indicator

The Cattle Movement Algorithm uses cattle movement data to identify individual animals that were moved into a TB incident herd as having a negligible, very low, low, medium, high or very high likelihood of being the source of the TB infection based on movement, animal and herd TB histories. Herds are classified as having either:

- cattle movements associated with a high likelihood of infection (a herd with any movements scored as a high or very high likelihood)
- no cattle movements with a high likelihood of infection (the highest likelihood score was negligible, very low, low or medium)

The cattle movement likelihood score is dictated by the highest likelihood animal movement into that herd, or where ten or more movements at low or medium level occur, then the likelihood is increased to the next level up. For example, ten medium-likelihood rated individual movements for animals in an incident herd would cause the likelihood of introduction to that herd via cattle movements to be rated as high. Where the risk of individual movements is very low, the threshold for aggregation of very low likelihood to low likelihood at the herd-level is 100 individual movements.

The WGS Local Transmission of Infection Indicator uses whole-genome sequence (WGS) data from cattle M. bovis isolates to identify TB incidents that are linked by genetics, time, and space. A local transmission of infection event is indicated for a new TB incident where at least one other TB incident is identified that satisfies all the following three criteria and can refer to cattle, wildlife or an environmental source:

- it has a WGS with no more than three single nucleotide polymorphism (SNP) differences relative to the TB incident of interest.
- it is within 4 years before or 6 months after the start date of the incident of interest.
- it is within a 9km radius of the incident of interest.

Further details about the methodology used can be found in the explanatory supplement to the annual reports 2023.

There is always a variable degree of uncertainty about the estimated true routes of TB infection into a herd. However, the absence of a local transmission of infection event or cattle movements associated with a high likelihood of infection does not completely negate these pathways. Nonetheless, the evidence provided by cattle movement and WGS data, when combined, can provide valuable insights into the possible risk pathways. Table 3.2.1 provides the combination of each evidence source for each new TB incident with WGS data in 2023, summarised by TB risk area and county.

Table 3.2.1a: Number and percentage of new TB incidents by result of the WGS local transmission event and cattle movement algorithm combined, for all new TB incidents with WGS data in 2023, by county in the HRA.

County	Local transmission event detected by WGS, and non-local cattle movements associated with a high likelihood of infection	Local transmission event detected by WGS, and local cattle movements associated with a high likelihood of infection	No local transmission event detected by WGS, and cattle movements associated with a high likelihood of infection	Local transmission event detected by WGS, no cattle movements associated with a high likelihood of infection	No local transmission event detected by WGS, no cattle movements associated with a high likelihood of infection	HRA Total
Avon	0 (0%)	4 (14.8%)	1 (3.7%)	14 (51.9%)	8 (29.6%)	27 (5.3%)
Cornwall	0 (0%)	3 (5.3%)	4 (7%)	38 (66.7%)	12 (21.1%)	57 (11.1%)
Devon	0 (0%)	14 (10.7%)	14 (10.7%)	72 (55%)	31 (23.7%)	131 (25.6%)
Dorset	0 (0%)	0 (0%)	0 (0%)	3 (37.5%)	5 (62.5%)	8 (1.6%)
Gloucestershire	0 (0%)	9 (29%)	2 (6.5%)	12 (38.7%)	8 (25.8%)	31 (6.1%)
Hereford & Worcester	0 (0%)	4 (7.3%)	4 (7.3%)	37 (67.3%)	10 (18.2%)	55 (10.7%)
Shropshire	0 (0%)	6 (9.5%)	3 (4.8%)	38 (60.3%)	16 (25.4%)	63 (12.3%)
Somerset	0 (0%)	10 (16.4%)	2 (3.3%)	34 (55.7%)	15 (24.6%)	61 (11.9%)
Staffordshire	0 (0%)	7 (14%)	6 (12%)	28 (56%)	9 (18%)	50 (9.8%)
West Midlands	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)	1 (0.2%)
Wiltshire	0 (0%)	1 (3.4%)	2 (6.9%)	11 (37.9%)	15 (51.7%)	29 (5.7%)
HRA	0 (0%)	57 (11.1%)	38 (7.4%)	288 (56.3%)	129 (25.2%)	512 (73.8%)
England Total	2 (0.3%)	86 (12.4%)	56 (8.1%)	387 (55.8%)	163 (23.5%)	694

Table 3.2.1b: Number and percentage of new TB incidents by result of the WGS local transmission event and cattle movement algorithm combined, for all new TB incidents with WGS data, by county in the Edge Area.

County	Local transmission event detected by WGS, and non-local cattle movements associated with a high likelihood of infection	Local transmission event detected by WGS, and local cattle movements associated with a high likelihood of infection	No local transmission event detected by WGS, and cattle movements associated with a high likelihood of infection	Local transmission event detected by WGS, no cattle movements associated with a high likelihood of infection	No local transmission event detected by WGS, no cattle movements associated with a high likelihood of infection	Edge Total
Berkshire	0 (0%)	1 (20%)	0 (0%)	4 (80%)	0 (0%)	5 (3.4%)
Buckinghamshire	0 (0%)	3 (33.3%)	0 (0%)	6 (66.7%)	0 (0%)	9 (6%)
Cheshire	0 (0%)	2 (4.9%)	5 (12.2%)	25 (61%)	9 (22%)	41 (27.5%)
Derbyshire	0 (0%)	2 (9.5%)	0 (0%)	12 (57.1%)	7 (33.3%)	21 (14.1%)
East Sussex	0 (0%)	0 (0%)	0 (0%)	3 (60%)	2 (40%)	5 (3.4%)
Hampshire	0 (0%)	1 (50%)	0 (0%)	1 (50%)	0 (0%)	2 (1.3%)
Leicestershire	0 (0%)	0 (0%)	2 (40%)	3 (60%)	0 (0%)	5 (3.4%)
Northamptonshire	0 (0%)	0 (0%)	3 (37.5%)	4 (50%)	1 (12.5%)	8 (5.4%)
Nottinghamshire	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (100%)	4 (2.7%)
Oxfordshire	1 (3.2%)	1 (3.2%)	4 (12.9%)	20 (64.5%)	5 (16.1%)	31 (20.8%)
Warwickshire	0 (0%)	4 (22.2%)	1 (5.6%)	11 (61.1%)	2 (11.1%)	18 (12.1%)
Edge Area	1 (0.7%)	14 (9.4%)	15 (10.1%)	89 (59.7%)	30 (20.1%)	149 (21.5%)
England Total	2 (0.3%)	86 (12.4%)	56 (8.1%)	387 (55.8%)	163 (23.5%)	694

Table 3.2.1c: Number and percentage of new TB incidents by result of the WGS local transmission event and cattle movement algorithm combined, for all new TB incidents with WGS data in 2023, by county in the LRA.

County	Local transmission event detected by WGS, and non-local cattle movements associated with a high likelihood of infection	Local transmission event detected by WGS, and local cattle movements associated with a high likelihood of infection	No local transmission event detected by WGS, and cattle movements associated with a high likelihood of infection	Local transmission event detected by WGS, no cattle movements associated with a high likelihood of infection	No local transmission event detected by WGS, no cattle movements associated with a high likelihood of infection	LRA Total
Bedfordshire	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Cambridgeshire	0 (0%%)	1 (100%%)	0 (0%%)	0 (0%%)	0 (0%%)	1 (3%)
Cumbria	0 (0%%)	1 (14.3%%)	1 (14.3%%)	4 (57.1%%)	1 (14.3%%)	7 (21.2%)
Durham	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Essex	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Greater Manchester	0 (0%%)	0 (0%%)	0 (0%%)	1 (100%%)	0 (0%%)	1 (3%)
Hertfordshire	0 (0%%)	1 (50%%)	0 (0%%)	1 (50%%)	0 (0%%)	2 (6.1%)
Humberside	0 (0%%)	2 (50%%)	0 (0%%)	0 (0%%)	2 (50%%)	4 (12.1%)
Isle of wight	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Kent	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Lancashire	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Lincolnshire	0 (0%%)	2 (33.3%%)	1 (16.7%%)	3 (50%%)	0 (0%%)	6 (18.2%)
Merseyside	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Norfolk	0 (0%%)	1 (100%%)	0 (0%%)	0 (0%%)	0 (0%%)	1 (3%)
North Yorkshire	1 (14.3%%)	5 (71.4%%)	1 (14.3%%)	0 (0%%)	0 (0%%)	7 (21.2%)
Northumberland	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
South Yorkshire	0 (0%%)	1 (100%%)	0 (0%%)	0 (0%%)	0 (0%%)	1 (3%)
Suffolk	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Surrey	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
West Sussex	0 (0%%)	1 (50%%)	0 (0%%)	0 (0%%)	1 (50%%)	2 (6.1%)
West Yorkshire	0 (0%%)	0 (0%%)	0 (0%%)	1 (100%%)	0 (0%%)	1 (3%)
LRA	1 (3%)	15 (45.5%)	3 (9.1%)	10 (30.3%)	4 (12.1%)	33 (4.8%)
England Total	2 (0.3%)	86 (12.4%)	56 (8.1%)	387 (55.8%)	163 (23.5%)	694

Risk pathway combinations identified by the WGS local transmission event and cattle movement algorithm for all new TB incidents with WGS data in the HRA, Edge Area and LRA are depicted in Tables 3.2.1a-c and Figures 3.2.8-11, respectively.

In England, all 2,433 new incidents in 2023 (1,853 in the HRA, 446 in the Edge Area and 134 in the LRA) were assessed using the data-driven algorithm. Of these, 694 (29%) had WGS data available to look for evidence of local transmission of infection alongside the likelihood of being associated to infected cattle movements. WGS data is only available for OTF-W incidents where M. bovis was successfully cultured and the resulting genetic sequence was of a sufficient quality for the analysis. This applied to 512 new TB incidents in the HRA, 149 in the Edge Area and 33 in the LRA.

Of the 694 new incidents in England with WGS, 475 incidents (68%) had evidence of a local transmission of infection. Of these, 345 incidents (50%) were in the HRA, 104 incidents (15%) in the Edge Area and 26 incidents (4%) were in the LRA. No incidents in the HRA and 1 incident in both the Edge Area and LRA had a local transmission event identified through WGS and evidence of non-local (more than 25km away from the infected herd) cattle movements associated with a high likelihood of infection.

For incidents with WGS data available, a local transmission of infection event was identified along with local cattle movements with a high likelihood of infection in 11% of new incidents in the HRA (57 incidents), 9% of new incidents in the Edge Area (14 incidents), and the majority (46%) of new TB incidents in the LRA (15 incidents). The source of infection for these incidents was unclear, as both cattle movements and local transmission events may have introduced infection in the herd.

Most of the 694 incidents in England with WGS available (387 incidents, 56%) had a local transmission event detected from the WGS data, with no evidence of cattle movements associated with a high likelihood of infection. For the majority of incidents in the HRA (288 incidents, 56%) and Edge Area (89 incidents, 60%) and only 30% of incidents in the LRA (10 incidents), there was evidence for a local transmission event but no evidence of cattle movements with a high likelihood of infection.

In England, 163 incidents (23%) with WGS data available did not have any evidence of local transmission of infection, nor any cattle movements with a high likelihood of infection identified with the TB incident. This source was attributed to 129 incidents (25%) in the HRA, 30 incidents (20%) in the Edge Area and 4 incidents (12%) in the LRA. The source of TB infection in the cattle remains unclear for these incidents.

For 56 incidents in England (8% of those with WGS data available), there was no local transmission event identified, despite WGS data being available, but had cattle movements associated with a high likelihood of infection. This suggests that these incidents were most likely due to the introduction of TB through cattle movements. This applied to 7% incidents in the HRA, 10% in the Edge Area and 9% in the LRA.

Most (1,739 incidents, 72%) TB incidents (OTF-W and OTF-S) in England did not have any WGS data available and therefore could not be assessed for evidence of local transmission of infection. This applied to 1,341 (72%) new TB incidents in the HRA, 297 (67%) in the Edge Area and 101 (75%) in the LRA. The 1,739 incidents were still assessed for the likelihood of being associated to infected cattle movements.

Of these 1,739 incidents, most (n=1,552, 89%) also did not have any cattle movements associated with a high likelihood of infection. As WGS data was not available in these incidents, not further assessment on the presence of local transmission of infection could be investigated. This represented 1,200 incidents (65%) in the HRA, 267 incidents (60%) in the Edge Area and 85 incidents (63%) in the LRA.

A further 187 incidents in England without WGS data had cattle movements with a high likelihood of infection. Of these, 8% (141 incidents) were in the HRA, 7% (30 incidents) in the Edge Area and 12% (16 incidents) in the LRA. In these cases, there is a strong indication that cattle movements may have played a part in introducing infection to these herds (including OTF-S incidents), but no WGS data was available to explore the possibility of local transmission of infection.

Figure 3.2.8: Risk pathway combinations identified by the WGS local transmission event and cattle movement algorithm for all new TB incidents with WGS data in the HRA in 2023

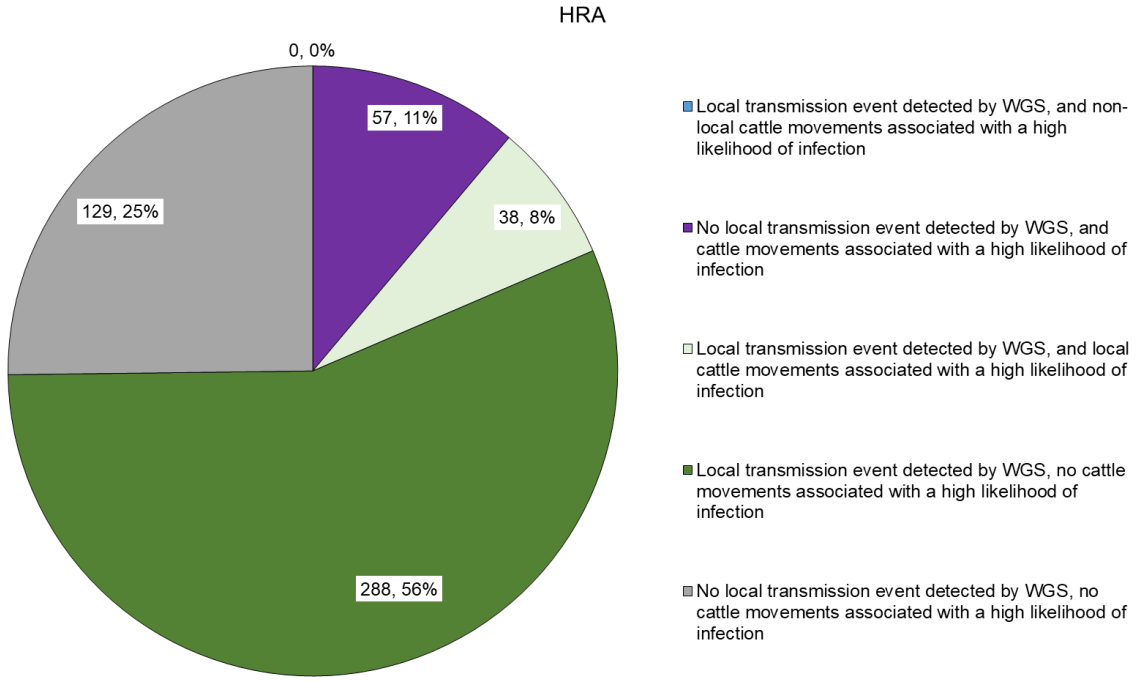


Figure 3.2.8 description: Pie chart showing the risk pathway combinations identified by the WGS local transmission event and cattle movement algorithm for all new TB incidents with WGS data in the HRA in 2023. Combinations and proportions described in the text.

Figure 3.2.9: Risk pathway combinations identified by the WGS local transmission event and cattle movement algorithm for all new TB incidents with WGS data in the Edge Area in 2023

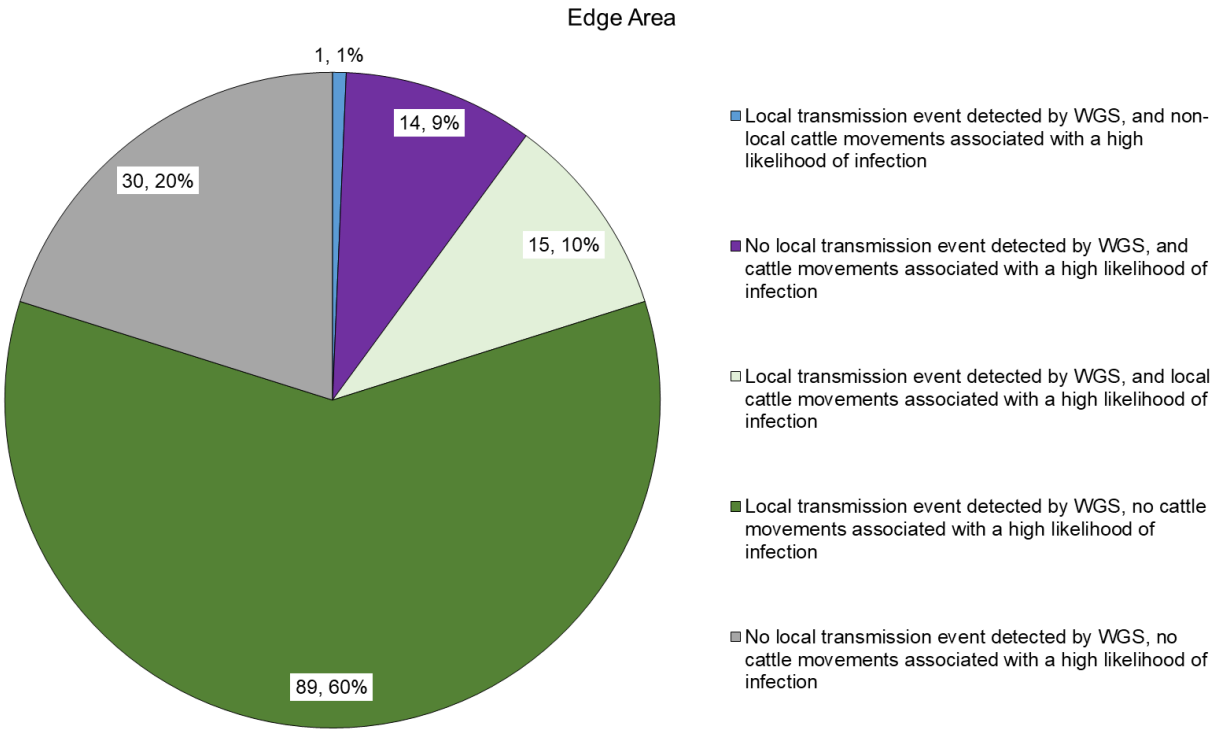


Figure 3.2.9 description: Pie chart showing the risk pathway combinations identified by the WGS local transmission event and cattle movement algorithm for all new TB incidents with WGS data in the Edge Area in 2023. Combinations and proportions described in the text.

Figure 3.2.10 Risk pathway combinations identified by the WGS local transmission event and cattle movement algorithm for all new TB incidents with WGS data in the LRA in 2023

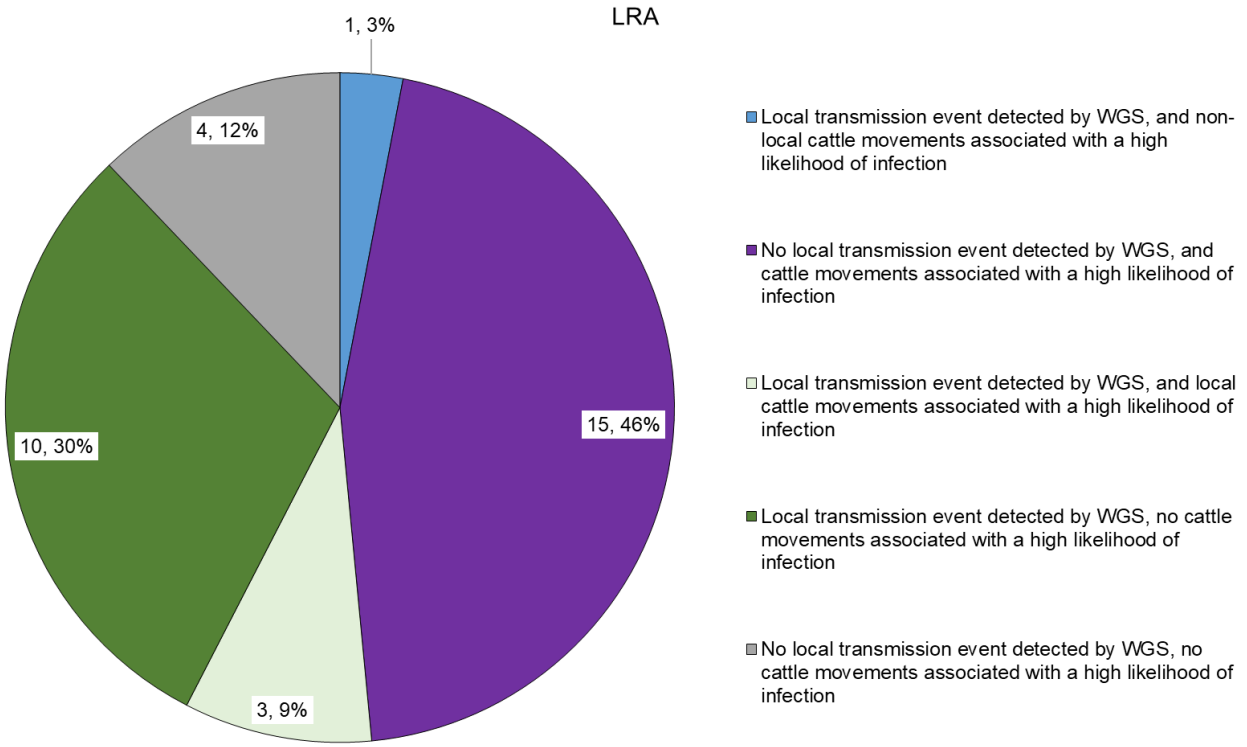


Figure 3.2.10 description: Pie chart showing the risk pathway combinations identified by the WGS local transmission event and cattle movement algorithm for all new TB incidents with WGS data in the LRA in 2023. Combinations and proportions described in the text.

The spatial distribution of the risk pathway combinations for each new TB incident in 2023 are indicated in Figure 3.2.11. TB incidents where a local transmission of infection event was identified were mostly located within the HRA or Edge Area counties bordering the HRA.

Figure 3.2.11. Map of the available evidence for risk pathways of TB infection into the herd, for all TB incidents with WGS data that started in 2023.

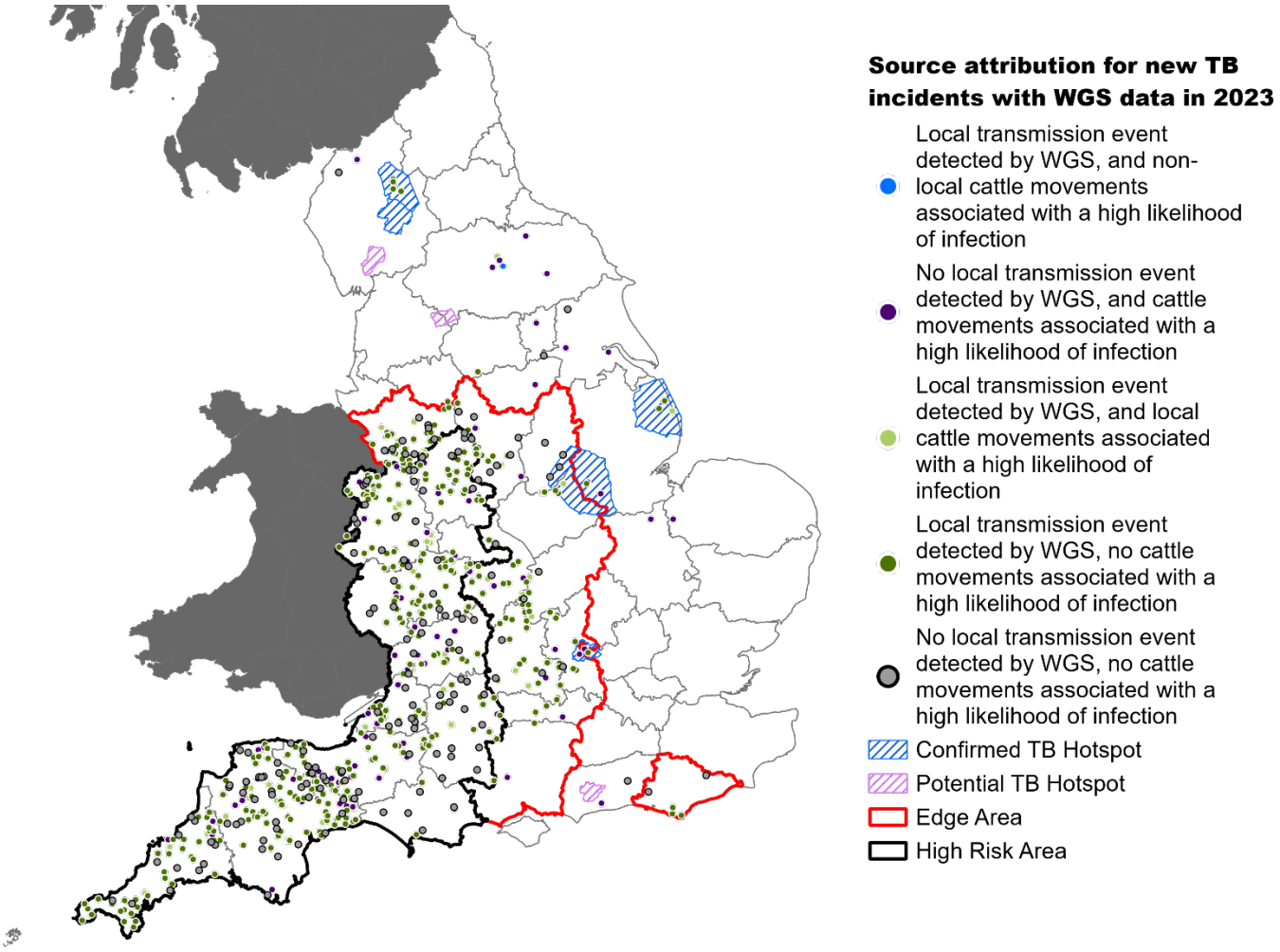


Figure 3.2.11. Map of England, showing the risk pathway combinations of TB infection into the herd, for all TB incidents with WGS data that started in 2023. Most incidents with WGS data are located in the HRA in the west and southwest of England and in the central Edge Area. Further breakdown of risk pathways in each risk area is provided in the text in this and chapters 4.1 to 4.3.

3.3 Finding infected herds: effectiveness of different TB surveillance streams

- TB surveillance activities in this report are categorised into 4 different streams: Routine, Area and Herd risk, Slaughterhouse and Trade and Other.
- In 2023, 5.2 million TB skin tests and 72,008 herd tests were carried out in bovine animals (domestic cattle, water buffalo and farmed bison) in England, over half of which were in the HRA.
- Additionally, over 1.2 million carcases of commercially slaughtered, non-reactor cattle underwent post-mortem meat inspection (PMMI) in abattoirs for pathological evidence (gross lesions) of TB, among other conditions.
- In the HRA and Edge Area, TB incidents were most often disclosed by the Routine surveillance testing stream (66% in the HRA and 61% in the Edge Area). In the LRA, most TB incidents and OTF-W incidents were detected by the Area and Herd Risk surveillance testing stream (54% and 55%, respectively).
- The total number of new TB incidents disclosed by slaughterhouse surveillance in England decreased non-significantly between 2022 (290) and 2023 (216). By contrast, the percentage of all new OTF-W incidents detected in 2023 through slaughterhouse surveillance was the same as in 2022, at 21%.
- In both the Edge Area and the HRA, the percentage of all TB incidents detected through slaughterhouse surveillance decreased non-significantly from 10% (47 and 231 TB incidents, respectively) in 2022 to 9% (40 and 169 TB incidents, respectively) in 2023 in both risk areas. The LRA also saw a non-significant decrease from 8% (12 TB incidents) in 2022 to 5% (7 TB incidents) in 2023.
- Within the Area and Herd Risk surveillance stream, 94% (357 TB incidents) of all TB incidents in the HRA and 85% (93 TB incidents) in the Edge Area were detected by six or 12-month post-incident resolution tests; compared to 10% (7 TB incidents) in the LRA.
- Radial testing continued to detect most of all 67 new TB incidents, within the Area and Herd Risk surveillance stream, in the LRA (60%) in 2023, a small decrease compared to 65% in 2022.
- In the HRA, 39% of OTF herds that only disclosed inconclusive reactors (IR) went on to have a TB incident (OTF-W or OTF-S) within the following 15 months. The equivalent percentages for the Edge Area and LRA were 32% and 23% respectively.
- Trade and other surveillance tests (primarily bespoke pre-movement tuberculin skin tests of individual animals) disclosed only 5% of TB incidents in 2023 compared to 4% in 2022.
- A total of 105 new TB incidents were detected in 2023 by pre-movement tests, of which 73% occurred in the HRA, 23% in the Edge Area and 4% in the LRA.

Surveillance overview

Bovine tuberculosis (TB) is typically a slowly progressing disease in which infected individuals rarely display clinical signs, although they can spread infection when subclinically infected. In England, TB surveillance is performed:

- in live cattle using antemortem tests that measure immunological markers of M. bovis infection, and
- in dead animals by inspecting carcases for pathological evidence of infection (visible lesions characteristic of TB).

The TB surveillance programme thus involves both active surveillance (TB testing of live farm animals) and passive surveillance (post-mortem meat inspection of cattle carcases for TB and other notifiable diseases in the slaughterhouse).

References to ‘cattle’ include domestic cattle (*Bos taurus*), farmed water buffalo (*Bubalus bubalis*) and farmed bison (*Bison spp*.). A total of 5,085,576 cattle were kept in 41,562 active holdings in England in 2023, with the total number of animals representing a 1% decrease compared to 2022, and the total number of active holdings a 2% decrease compared to 2022.

Slaughterhouse surveillance is carried out by meat inspectors and veterinarians employed by, or working on behalf of, the Food Standards Agency (FSA).

On-farm testing is usually performed by Official Veterinarians appointed by APHA, or occasionally by APHA veterinarians and trained Animal Health Officers. The primary surveillance test is the Single Intradermal Comparative Cervical Tuberculin (SICCT) test. Commonly referred to as the ‘skin test’, this measures the presence of a delayed-type hypersensitivity (allergic) response to an injection of bovine tuberculin into the deep layer of the animal’s skin in the neck, which is compared to the response to a simultaneous injection of avian tuberculin in an adjacent site. The comparative nature of the SICCT test is to account for animals that may have been sensitised to other mycobacteria present in the farm environment, which can confound the animal’s reaction to bovine tuberculin.

As in previous years, TB surveillance activities in England were categorised into 4 different streams for the purpose of this report (see detailed description of the surveillance streams and associated tests in the TB Explanatory Supplement):

- Routine: active surveillance through systematic herd level skin testing of all or the majority of animals in OTF herds at a pre-defined interval of 6, 12 or 48 months.
- Area and Herd Risk: more targeted active surveillance with additional skin testing of OTF herds, or individual cattle that are deemed to be at an increased risk of infection; including contiguous herd, radial, hotspot and tracing tests, permanently restricted herds (Approved Finishing Units (AFUs)) and check tests conducted a few months after the conclusion of a TB incident.

- Slaughterhouse: passive surveillance via *post-mortem* meat inspection (PMMI) of all cattle commercially slaughtered for human consumption, as well as cattle that die on farm and are disposed of at an animal by-products processing facility.
- Trade and Other: active targeted surveillance through skin tests of individual animals moved between OTF herds. These are generally conducted to reduce the risk of inadvertently moving infected cattle between herds, such as: compulsory pre- and post-movement skin testing (statutory tests that are privately arranged and funded by cattle farmers), other private TB tests requested and funded by farmers, and tests at artificial insemination centres. This surveillance stream was referred to as ‘proactive surveillance’ in earlier reports.

A total of 5,208,264 individual TB skin tests were carried out on live animals in OTF herds (5,000,541 in 2022). Though this was higher than previous years, when around 4 million skin tests were carried out, this increase reflects the impact of moving most herds in the HRA from annual TB testing onto a six-monthly testing regime, with the first additional routine tests taking place in the HRA in January 2022.

Over 1.2 million animals from cattle holdings in England underwent PMMI in 2023 (over 1.9 million in 2022).

The 72,008 testing events in OTF herds, which led to the detection of 2,435 new TB incidents (including both OTF-S and OTF-W) in 2023, with some herds tested more than once.

The relative proportions of animals and herds tested, and the relative proportion of individual test reactors and herd occurring under each surveillance stream in OTF herds in 2023 is shown in Figure 3.3.1 and Tables 3.3.1a-c. For the purposes of this report, testing events are reported at the herd-level. This means that multiple animal-level tests occurring in the same herd at the same time are counted just once, e.g., in the case of tracing tests or pre-movement tests.

Figure 3.3.1. The percentage of OTF-W herd TB incidents, TB incidents, herd tests, reactors detected and individual cattle tests by surveillance stream in 2023. The total numbers of OTF-W TB incidents, TB incidents, herd tests, reactors detected and individual cattle tests are indicated in brackets.

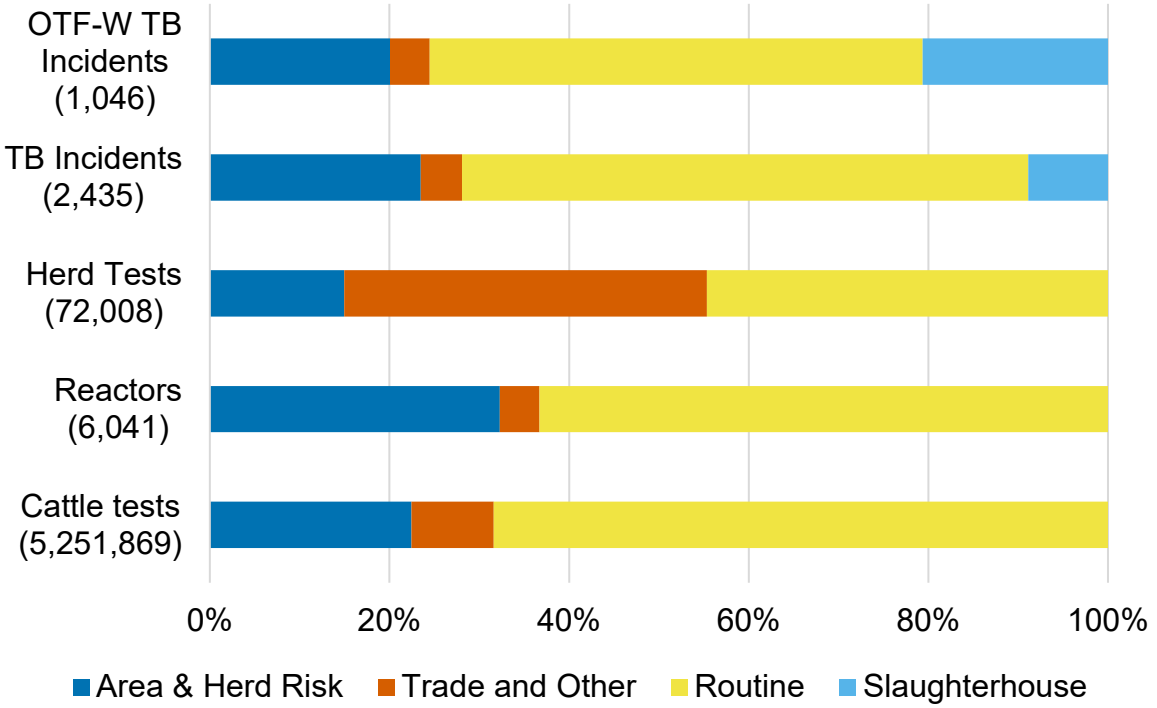


Figure 3.3.1. description: Bar chart showing the percentage of OTF-W herd TB incidents, TB incidents, herd tests, reactors detected and individual cattle tests by surveillance stream in 2023. There were over 5 million cattle tests conducted in England in 2023, and 68% under the routine surveillance stream. Most TB incidents (including OTF-W) and reactors were disclosed by the routine surveillance stream. This was followed by Area & Herd risk stream for these test types. For Herd tests, most tests were disclosed by routine and Trade and Other tests (45% and 40% respectively).

Most common surveillance streams to disclose new TB incidents per risk area

Over the past five years, the annual proportions of new TB incidents disclosed by each surveillance stream has varied more in the LRA compared to the HRA and Edge Area. This is due in part to the low number of TB incidents (small denominator) in the LRA. In the HRA, recent surveillance policy changes are also likely to be a contributing factor in the fluctuation in the proportion of TB incidents detected by different surveillance streams in 2021, 2022 and 2023 (Figure 3.3.2).

Table 3.3.1.a Total number of tests, reactors, and TB incidents in OTF cattle herds by surveillance stream in 2023 in the High Risk Area of England.

Surveillance Stream	Herd tests N (%)	TB incidents N (%)	OTF-W incidents N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Routine	21,483 (50.7)	1,220 (65.8)	465 (57.8)	5.7	1.3
Area and Herd Risk	5,440 (12.8)	389 (21.0)	144 (17.8)	7.2	2.0
Slaughterhouse	NA	169 (9.1)	169 (21.0)	NA	NA
Trade and other	15,429 (36.4)	77 (4.2)	27 (3.4)	0.5	0.9
HRA Total	42,352 (58.8)	1,855(76.2)	805 (77.0)	3.3	1.0
England Total	72,008	2,435	1,046	1.4	1.1

Table 3.3.1.b Total number of tests, reactors, and TB incidents in OTF cattle herds by surveillance stream in 2023 in the Edge Area of England.

Surveillance Stream	Herd tests N (%)	TB incidents N (%)	OTF-W incidents N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Routine	7,325 (43.3)	271 (60.6)	102 (51.3)	3.7	0.8
Area and Herd Risk	2,225 (13.2)	111 (24.8)	43 (21.6)	5.0	2.2
Slaughterhouse	NA	40 (8.9)	40 (20.1)	NA	NA
Trade and other	7,349 (43.5)	25 (5.6)	14 (7.0)	0.3	0.3
Edge Total	16,899 (23.5)	447 (23.5)	199 (19.0)	2.3	0.8
England Total	72,008	2,435	1,046	1.4	1.1

Table 3.3.1.c Total number of tests, reactors, and TB incidents in OTF cattle herds by surveillance stream in 2023 in the Low Risk Area of England.

Surveillance Stream	Herd tests N (%)	TB incidents N (%)	OTF-W incidents N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Routine	3,357 (26.3)	44 (33.1)	7 (16.7)	1.3	0.2
Area and Herd Risk	3,110 (24.4)	72 (54.1)	23 (54.8)	2.3	0.5
Slaughterhouse	NA	7 (5.3)	7 (16.7)	NA	NA
Trade and other	6,290 (49.3)	10 (7.5)	5 (11.9)	0.2	0.1
LRA total	12,757 (17.7)	133 (5.5)	42 (4.0)	0.9	0.2
England total	72,008	2,435	1,046	1.4	1.1

In addition to the tests in Tables 3.3.1, a further 2,425 cattle herds underwent short-interval skin testing, supplemented in some instances by blood tests (primarily interferon gamma [IFN-γ] tests). These skin and blood tests are excluded from Tables 3.3.1a-c-, as they are not routinely used to detect new infection in OTF herds, but control and eradicate infection from epidemiologically linked premises whereby they are under restrictions due to another linked TB incident and are used to regain OTF herd status. These include short interval (SI) tests, inconclusive reactor (IR) re-tests, IFN-γ blood tests, and tests occasionally used on an approved segregated group (ASG) of a herd, often during a TB incident. A total of 17 new TB incidents were disclosed by these test types, mostly through the testing of cattle at epidemiologically linked premises during IFN-γ testing (9 incidents).

In England overall, the Routine surveillance stream contributed to a significantly higher proportion of overall cattle tests than Area and Herd Risk surveillance in 2023 (3,591,876 and 1,178,635, respectively) (Figure 3.3.1). This surveillance stream also detected the most reactors, TB incidents and OTF-W incidents in England overall in 2023, followed closely by Area and Herd Risk surveillance stream (Figure 3.3.1).

In the HRA, two-thirds (66%) of all incidents were detected by Routine surveillance, followed by Area and Herd Risk surveillance (21%, Table 3.3.1a). In the Edge Area, most (61%) TB incidents were detected by Routine (six-monthly or annual) surveillance (Table 3.3.1b): 65% in the six-monthly testing portion of the Edge Area and 51% in the annual testing part of the Edge Area. This was followed by Area and Herd Risk tests, which detected 25% of TB incidents in the Edge Area (20% of TB incidents in the six-monthly testing part and 36% in the annual testing part).

In the LRA, 54% (one in 2) of all new TB and 55% of new OTF-W TB incidents were detected by Area and Herd Risk surveillance stream (Table 3.3.1c). A further 33% of all TB incidents were detected by Routine surveillance, which reflects a higher proportion compared to the proportion of tests of this type conducted in this risk area (26%). Routine testing is conducted every four years in the majority of LRA herds because of the lower force of infection compared to elsewhere in England. As in previous years the proportion of

incidents detected through the Trade and other surveillance stream was higher in the LRA compared to the other TB risk areas (Figure 3.3.2). This highlights the importance of pre- and post-movement testing of cattle moving into the LRA from higher TB risk areas of GB.

Surveillance trends over time

The annual proportions of all new TB incidents detected by each surveillance stream in each TB risk area of England from 2019 to 2023 are shown in Figure 3.3.2.

In England, the proportion of new TB incidents detected by Routine surveillance has remained fairly stable over recent years, 55% in 2019 and 2020, 56% in 2021 and 2022 and 61% in 2023.

The proportion of new incidents detected by Routine surveillance in the HRA has been gradually increasing since 2017 (see previous reports), but grew to a greater extent between 2020 (35%) and 2023 (66%), following the rollout of six-monthly testing for most herds in the HRA in 2021 and 2022.

The annual proportion of new incidents detected by Routine surveillance in the Edge Area remained stable between 2019 and 2022 (55% in both 2019 and 2020, and 56% in both 2021 and 2022), with a slight increase in 2023 (61%).

The annual testing part of the Edge Area saw the proportion almost halve between 2017 (68%) and 2020 (39%), remaining stable at 39% during 2021, before increasing to 42% in 2022 and 51% in 2023.

The proportion of new incidents detected by the Routine surveillance stream in the part of the Edge area now subject to six-monthly testing rose from 56% in 2017 to 65% in 2021. This is not unexpected given the introduction of six-monthly testing in this region in 2018. The proportion of new incidents detected by this surveillance stream has remained stable since then, with 64% in 2022 and 65% in 2023.

In the LRA, the proportion of new incidents detected by Routine surveillance fell between 2019 and 2020 (from 37% to 27%, respectively) then rose to 37% in 2021 before falling again in 2022 (33%) and remained stable in 2023 (33%).

In England, the proportion of new TB incidents detected by Area and Herd Risk surveillance has remained stable in recent years between 30 and 32%, however decreased to 25% in 2023. The proportion of new incidents detected by Area and herd risk surveillance in the HRA in 2023 (21%) has decreased by more than half since 2019 (45%).

The annual proportion of new incidents detected by Area and Herd Risk surveillance in the Edge Area has remained stable over recent years but saw an overall decline in 2023 (25%) compared 2019 (31%). The six-monthly testing part of the Edge Area saw the proportion fall over recent years from 26% in 2019 to 20% in 2023. The proportion of new

incidents detected by the Area and Herd Risk surveillance stream in the annual testing part of the Edge Area rose between 2019 (44%) and 2021 (50%) before falling to 36% in 2023.

In the LRA, the proportion of incidents has fluctuated in recent years, however an overall rise was seen between in 2019 (45%) and 2023 (54%).

In England, the proportion of new TB incidents detected by Trade and other surveillance has fluctuated in recent years, the lowest proportion seen in 2022 (3%) and the highest seen in 2020 (8%). The proportion of TB incidents was similar in 2019 (5%) compared to 2023 (6%). The proportion of new incidents detected by Trade and other surveillance in the HRA in 2023 (4%) has dropped by half since 2019 (8%).

The proportion of new incidents detected by Trade and other surveillance in the Edge Area rose between 2019 and 2020 (from 5% to 8%, respectively) then fell to 4% in 2021 and 3% in 2022 before rising again in 2023 to 6%. This trend was reflected within the six-monthly testing part of the Edge Area which saw a rise from 5% in 2019 to 9% in 2020 followed by a fall in 2021 (3%) and 2022 (2%) before rising to 5% in 2023. In the annual testing part of the Edge Area the proportion of new TB incidents gradually increased between 2019 (5%) and 2023 (8%), with the exception of 2022 where the proportion fell to 4%.

In the LRA, the proportion on new TB incidents has fluctuated in recent years however an overall decrease in the proportion was seen between 2019 (12%) and 2023 (8%).

In England, the annual proportion of new TB incidents detected by Slaughterhouse surveillance has almost halved over the past seven years (16% in 2015 compared to 9% in 2023). This could be explained by the various enhanced on-farm surveillance and control regimes adopted in England since 2013/14, detecting infected cattle at earlier stages of infection on farm and before they reach slaughter age. The overall trend for England is reflected in the HRA, where the annual proportion of new TB incidents detected through Slaughterhouse surveillance has been gradually declining since 2019 (13% in 2019 compared to 9% in 2023). This was also true of the annual testing portion of the Edge Area, where the proportion decreased from 8% in 2020 to 6% in 2021, then remained stable (6% in 2022 and 2023). In contrast, within the six-monthly testing part of the Edge Area, the proportion doubled between 2020 and 2022 (6% and 12%, respectively) but then fell to 10% in 2023. In the LRA, a downward trend was observed between 2015 (14%) and 2020 (6%). The proportion of new TB incidents then increased to 10% in 2021 before falling again in 2022 (8%) and 2023 (5%). It is worth noting that even small changes in the number of TB incidents can produce larger fluctuations in the proportion of new TB incidents, seen especially in the Edge Area and LRA.

Figure 3.3.2 Annual proportions of new TB incidents detected by different surveillance streams within each risk area from 2019 to 2023.

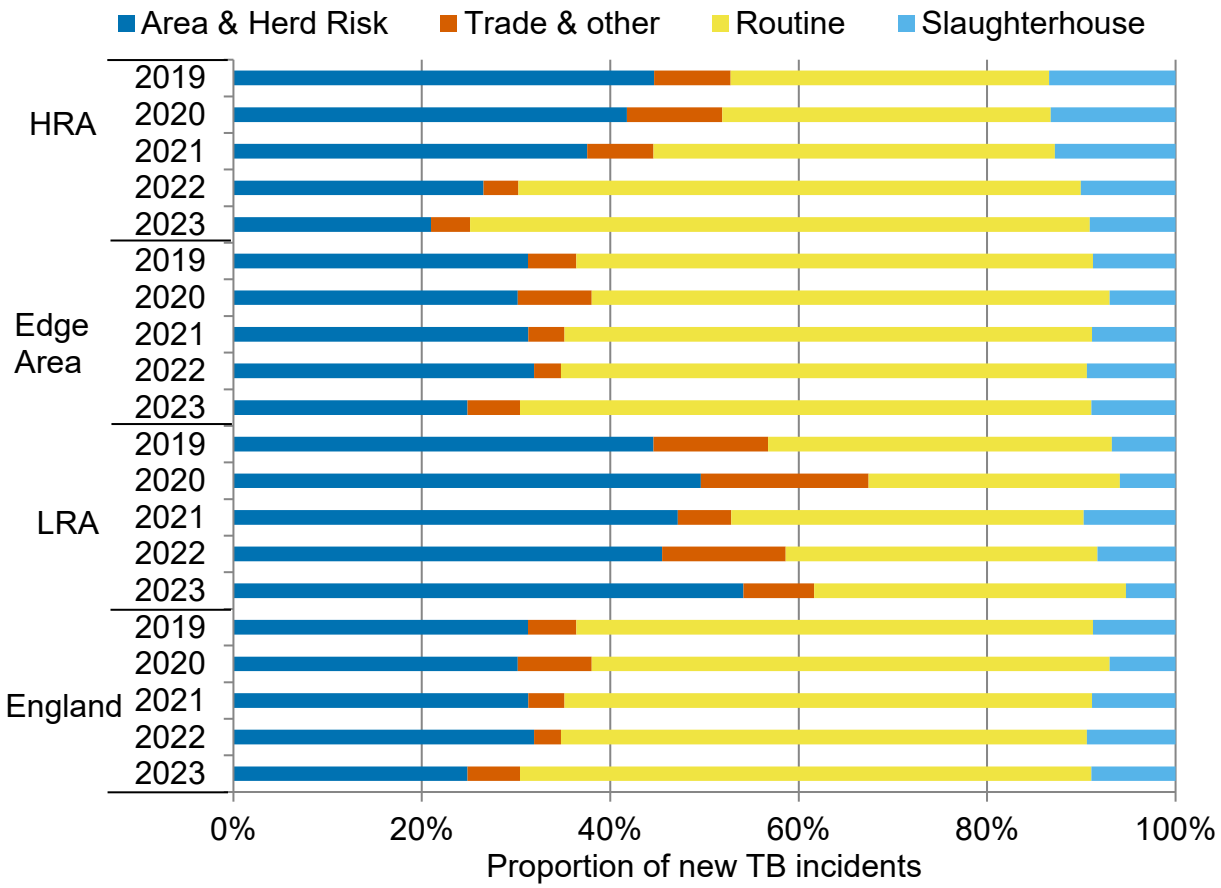


Figure 3.3.2 description: Bar chart showing the annual proportions of new TB incidents detected by different surveillance streams within each risk area from 2019 to 2023. The trends shown over time in the figure are discussed in the main text.

Routine surveillance stream

The Routine surveillance stream includes Whole Herd Tests (WHTs) and Routine Herd Tests (RHTs) conducted in OTF herds and tests conducted in new herds (NH). These 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 (annually) in a small proportion of high-risk herds (see Bovine TB testing intervals) in the LRA. RHTs in the LRA are conducted mainly in breeding stock and younger replacements for the breeding stock. The default TB testing intervals for cattle herds in England are: four years in the LRA, six or 12 months in the Edge Area, and six months in the HRA.

Proportionally, more TB incidents were disclosed per 100 herd tests in the HRA than in the Edge Area and LRA, by both NHTs and WH tests (3.0 and 5.7 in the HRA, 0.4 and 3.8 in

the Edge Area and 0.5 and 1.6 in the LRA, respectively). This is likely to be due to a higher background force of infection in the HRA (Tables 3.3.2 a, b and c).

In the LRA, most herds receive RHTs at four-yearly intervals; with only 7% of herds receiving WHTs in 2023. Most incidents disclosed in the LRA under Routine surveillance were via RHTs (86%). In contrast, WHTs disclosed just 9% of incidents, of which one of these incidents was OTF-W, and NH tests disclosed 5% of incidents in the LRA. Slightly more TB incidents per 100 herd tests were detected by WHTs (1.6) compared to RHTs (1.4), as herds receiving WHTs in the LRA are higher risk (Table 3.3.2d).

Table 3.3.2.a Performance of main test types within the Routine surveillance stream in the HRA in 2023

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 herd test events	Reactors per 1000 cattle tested
NHTs	532 (2.5)	16 (1.3)	5 (1.1)	15 (0.5)	3.0	0.9
WHTs	20,945 (97.5)	1,204 (98.7)	460 (98.9)	3,123 (99.5)	5.7	1.3
RHTs	6 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Total	21,483	1,220	465	3,138	5.7	1.3

Table 3.3.2.b Performance of main test types within the Routine surveillance stream in the Edge Area in 2023

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 herd test events	Reactors per 1000 cattle tested
NHTs	244 (3.3)	1 (0.4)	0 (0.0)	0 (0.0)	0.4	0.0
WHTs	7,081 (96.9)	270 (99.6)	102 (100.0)	644 (100.0)	3.8	0.8
Total	7,325	271	102	644	3.7	1.8

Table 3.3.2.c Performance of main test types within the Routine surveillance stream in the LRA in 2023

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 herd test events	Reactors per 1000 cattle tested
NHTs	414 (12.3)	2 (4.5)	0 (0.0)	2 (4.8)	0.5	0.2
WHTs	245 (7.3)	4 (9.1)	1 (14.3)	3 (7.1)	1.6	0.1
RHTs	2,698 (80.4)	38 (86.4)	6 (85.7)	37 (88.1)	1.4	0.2
Total	3,357	44	7	42	1.3	0.2

In all tables above, the test codes are taken from Sam database. For Whole Herd Tests, data is split between the 6 monthly (6M) and annual (12M) regions of the Edge Area. 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 includes tests in OTF herds deemed to be at higher risk of infection, such as herds subject to check testing several months after the resolution of a TB incident, and tests in permanently restricted Approved Finishing Units (AFUs). It also includes tests for assessing potential source and spread following the detection of a TB incident, for example tracing, contiguous herds, hotspot, and radial tests.

In the HRA, most TB incidents and OTF-W incidents initiated by Area and Herd Risk surveillance in 2023 were detected by post-incident resolution check tests (94% and 93%, respectively), followed by contiguous herd tests (2% and 3%, respectively) (Table 3.3.3a). This is the same trend as in the previous four years. Few source tracing tests were carried out in the HRA, with this test type accounting for less than one per cent of tests under the Area and Herd risk surveillance stream in 2023. However, they detected the second highest number of incidents per 100 herd tests (12.9) after post-incident tests (15.0) (Table 3.3.3a).

In the Edge Area, 85% of TB incidents and 84% of OTF-W incidents were detected by post-incident resolution check tests in this surveillance stream, which is higher than in 2022 (61% and 52%, respectively) (Table 3.3.3b). Post-incident tests also detected the highest number of TB incidents per 100 test events (15.4), compared to 12.5 in 2022. Within the annual testing part of the Edge Area 62% of TB incidents and 42% of OTF-W incidents were detected by post-incident tests compared to 98% and 96%, respectively, within the six-monthly portion of the Edge Area. The number of TB incidents per 100 test

events detected by post-incident tests was highest in the annual (14.0) and six-monthly testing (16.5) parts of the Edge Area.

In the LRA, 58% of the Area and Herd Risk herd tests carried out in 2023 were radial tests, and they disclosed a higher proportion of all OTF-W incidents under this surveillance stream (64%) compared to proportion of TB incidents overall (60%) (Table 3.3.3c). This higher rate of OTF-W incident detection makes sense because radial tests enable the early detection of any local spread of infection from the index OTF-W incident herd or a common local wildlife source, though the incidents they disclosed were not necessarily confirmed as being caused by the same WGS clade of M. bovis as the index case. Radial tests also provide evidence for the presence or absence of endemic disease around OTF-W incidents in the LRA. The highest number of TB incidents disclosed per 100 test events in the LRA resulted from check tests (12.5) despite this type of test representing less than 1% of all test events under this surveillance stream.

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

TB Hotspot tests are conducted in the LRA in response to an OTF-W incident (or cluster of incidents) of obscure or uncertain origin. These are applied to herds within areas defined by APHA, comprising at least a 3 km radius around the farm boundary of the index OTF-W herd. A total of 370 herd hotspot tests were carried out in the LRA in 2023 (62,137 individual cattle tests) with 35 reactors disclosed from 10 TB incidents, one of which was OTF-W (Table 3.3.3c). There were also 138 hotspot herd tests in the annual testing part of the Edge Area due to hotspot areas in an adjoining LRA county spanning the LRA/Edge area boundary (e.g. hotspot HS23 straddling Lincolnshire, Leicestershire and Nottinghamshire). Eight reactors were disclosed from three TB incidents, all of which were OTF-W (Table 3.3.3b).

Table 3.3.3.a Performance of main test types within the Area and Herd Risk surveillance stream in the HRA in 2023

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
Contiguous tests	203 (5.6)	9 (2.4)	4 (2.8)	17 (1.3)	4.4	0.9
Spread tracing tests	957 (26.4)	2 (0.5)	2 (1.4)	2 (0.1)	0.2	0.5
Source tracing tests	31 (0.9)	4 (1.1)	3 (2.1)	6 (0.4)	12.9	0.8
Post-incident tests	2,376 (65.5)	357 (94.4)	131 (92.9)	1,313 (96.9)	15.0	2.2
Check tests	54 (1.5)	6 (1.6)	1 (0.7)	17 (1.3)	11.1	1.0
AFU tests	4 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Total	3,625	378	141	1,355	10.4	0.7

Table 3.3.3.b Performance of main test types within the Area and Herd Risk surveillance stream in the Edge Area in 2023

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
Contiguous tests	69 (3.8)	2 (1.8)	1 (2.3)	4 (1.0)	2.9	0.4
Radial tests	156 (8.6)	11 (10.0)	3 (7.0)	11 (2.6)	7.1	0.6
Hotspot tests	138 (7.6)	3 (2.7)	3 (7.0)	8 (1.9)	2.2	0.5
Spread tracing tests	813 (44.9)	0 (0.0)	0 (0.0)	0 (0.0)	0	0
Source tracing tests	14 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	0	0
Post-incident tests	604 (33.3)	93 (84.5)	36 (83.7)	393 (94.0)	15.4	3.0
Check tests	18 (1.0)	1 (0.9)	0 (0.0)	2 (0.5)	5.6	0.6
Total	1,812	110	43	418	6.1	0.7

Table 3.3.3.c Performance of main test types within the Area and Herd Risk surveillance stream in the LRA in 2023

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 test events	Reactors per 1000 cattle tested
Radial tests	1,674 (57.5)	40 (59.7)	14 (63.6)	84 (56.8)	2.4	0.4
Hotspot tests	370 (12.7)	10 (14.9)	1 (4.5)	35 (23.6)	2.7	0.6
Spread tracing tests	721 (24.8)	8 (11.9)	5 (22.7)	13 (8.8)	1.1	3.5
Source tracing tests	9 (0.3)	1 (1.5)	1 (4.5)	2 (1.4)	11.1	0.8
Post-incident tests	130 (4.5)	7 (10.4)	1 (4.5)	13 (8.8)	5.4	0.5
Check tests	8 (0.3)	1 (1.5)	0 (0.0)	1 (0.7)	12.5	0.8
Total	2,912	67	22	148	2.3	1.1

Test types in the tables 3.3.3 a to c above include: Contiguous tests (VE-CON, VE-CON12), Radial tests (VE-RAD, VE-RAD6, VE-RAD12), Hotspot tests (VE-HS1, VE-HS2), Spread Tracing tests (VE-TR), Source 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 that were detected by each of the main test types within the Area and Herd Risk surveillance stream by surveillance risk area in 2023. Total number of herd tests is shown in brackets.

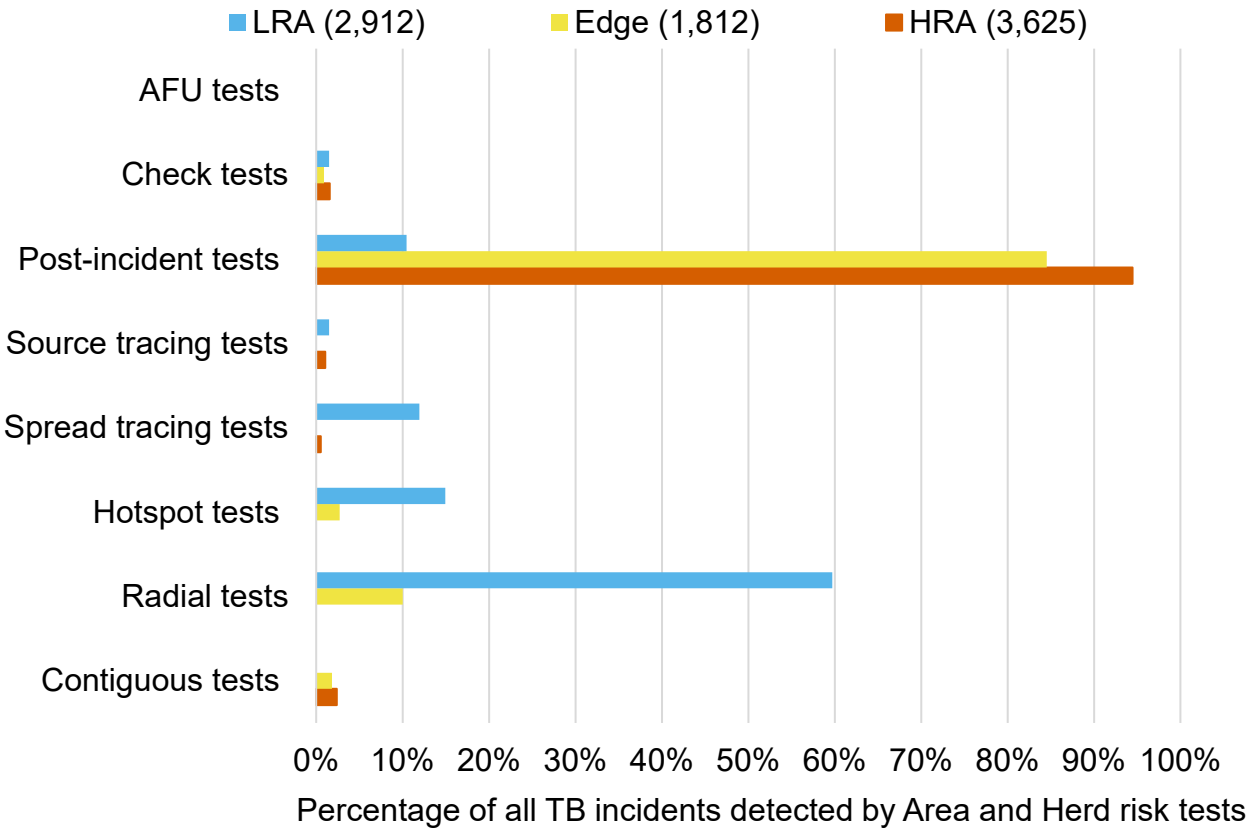


Figure 3.3.3 description: Percentage of TB incidents that were detected by each of the main test types within the Area and Herd Risk surveillance stream by surveillance risk area in 2023. Total number of herd tests was 2,912 in the LRA; 1,812 in the Edge; and 3,625 in the HRA. A breakdown by test type for each risk area is described in the text.

Slaughterhouse Surveillance Stream

Slaughterhouse surveillance for TB is provided by compulsory PMMI (visual inspection of carcases with palpation and incision of lymph nodes) of all cattle slaughtered for human consumption. Any suspicious lesions of TB must be notified to APHA, who will in turn arrange for suitable tissue samples to be submitted to one of our TB reference laboratories for PCR testing and, if positive for M. bovis, bacteriological culture and whole-genome sequencing (WGS) of the bacterial isolate. It is an ongoing, supplementary TB surveillance stream that helps detect infected cattle missed by active surveillance or that became infected since their last skin test.

The probability of detecting TB incidents by slaughterhouse surveillance depends on the background prevalence of infection and frequency and efficacy of active surveillance testing in cattle herds. Further analysis of the efficacy and contribution of slaughterhouse surveillance and monitoring performance may be found in the latest Slaughterhouse surveillance report for GB (2019 to 2022). Herds are skin tested more frequently in the Edge Area and HRA than in the LRA. Therefore, a higher proportion (but lower number) of TB-infected herds is expected to be detected at routine slaughter of cattle in the LRA. However, in 2023, the proportion of TB incidents disclosed by slaughterhouse surveillance was highest in the HRA and Edge Area, both 9%, followed by the LRA (5%) (Table 3.3.1a-c). The proportion of TB incidents disclosed by slaughterhouse surveillance was 10% in the 6-monthly testing part of the Edge Area and 6% in the annual testing part of the Edge Area (data not shown).

Slaughterhouse surveillance primarily detects OTF-W incidents because, by definition, the identification of visible lesions of TB at routine slaughter must be confirmed by positive laboratory test results. Slaughterhouse cases that prove negative on PCR testing in OTF herds trigger temporary movement restrictions (suspension of the OTF status) in the herd of origin pending the completion of laboratory tests, but do not normally generate a new TB incident. However, each year a very small number of OTF-S incidents are usually also reported that were initially triggered at the slaughterhouse. These are cases where visible lesions detected in the slaughterhouse were negative by laboratory testing, but a skin check test in the source herd identified reactors without visible lesions. Even so, no such incidents arose in 2023; all incidents disclosed by Slaughterhouse surveillance were OTF-W in all risk areas.

Figure 3.3.4 shows how the annual proportion of new OTF-W incidents disclosed by slaughterhouse surveillance has changed over time since 2013 in each risk area. In the HRA, the proportion has remained relatively stable; it was 21% in 2023, like recent previous years, and following the same trend as England overall. In the Edge Area and LRA, by contrast, there has been greater annual fluctuation (Figure 3.3.4).

The proportion of OTF-W incidents disclosed by slaughterhouse surveillance in the Edge Area increased from 12% in 2020 to 20% in 2023. The proportion disclosed remains lower than that observed in 2013 (22%). Despite the increase in the proportion of OTF-W incidents disclosed by slaughterhouse surveillance in the Edge Area,there has been a reduction in slaughterhouse cases in this area since 2011 which is most likely due to the increased frequency of routine herd surveillance. For the six-monthly testing part of the Edge Area the proportion of OTF-W incidents disclosed by slaughterhouse surveillance increased from 11% in 2020 to 22% in 2022 and then decreased to 21% in 2023, whereas in the annual testing part it decreased from 17% in 2020 to 14% in 2022 then increased to 18% in 2023 (data not shown).

In the LRA, the proportion of OTF-W incidents disclosed by slaughterhouse surveillance has been falling since 2021 (29%) and was 28% in 2022 and 17% in 2023, which was the

lowest proportion disclosed for all risk areas. This followed a sharp increase observed from 2020 (16%) to 2021 (29%), which had reversed a generally declining trend since around 2015. Comparing the risk areas, the highest proportion of OTF-W incidents initiated by slaughterhouse surveillance in 2023 was in the HRA (21%) and the lowest proportion was in the LRA (17%). This differs from the two previous years (2021 and 2022) when the proportion in the LRA exceeded that in the HRA and Edge Area (Figure 3.3.4).

Figure 3.3.4 Annual proportion of new OTF-W incidents in each risk area that were disclosed by slaughterhouse surveillance from 2013 to 2023

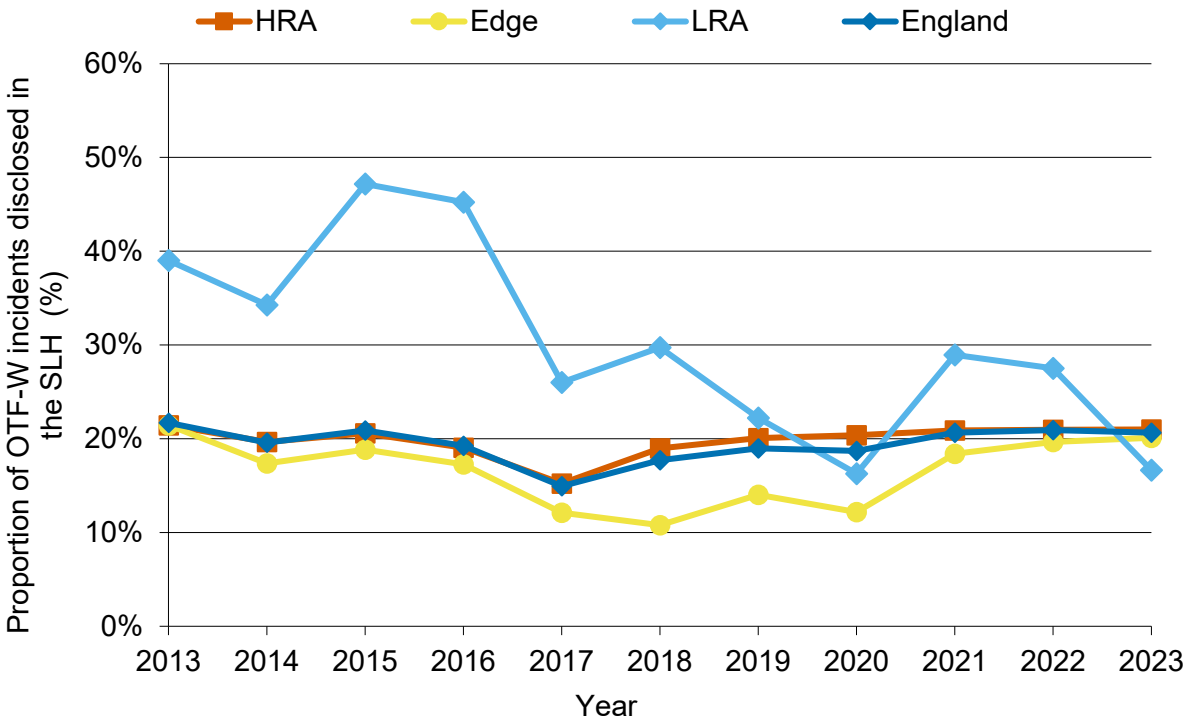


Figure 3.3.4 Line chart showing the annual proportion of new OTF-W incidents in each risk area that were disclosed by slaughterhouse surveillance from 2013 to 2023. The trends shown in the figure are discussed in the main body of the text.

Trade and other surveillance stream

Trade surveillance includes pre-export and post-import tests, private skin or interferon-gamma tests, tests at semen collection centres and statutory (but privately-funded) pre- and post-movement skin tests. Typically, only single animals or a batch of animals in a herd are included in such tests and so these are referred to as ‘animal’ tests rather than herd tests.

Large numbers of cattle movements take place across the country, but not all require a bespoke pre-movement (PrMT) or post-movement (PoMT) test. A government-funded TB herd test completed with negative results within the required timeframe (i.e., 60 days before the date of movement, or 60-120 after movement into an LRA herd) can also qualify as a pre- or post-movement test, respectively, so that a bespoke privately-funded TB movement test is not required for such animals. Therefore, the number of PrMTs (or PoMTs) cannot be accurately counted within surveillance data. The primary purpose of Trade and other tests is to reduce the risk of spreading TB via movements of undetected infected cattle between herds. A secondary objective of pre-movement testing in particular is the additional detection of TB-infected herds missed by routine surveillance.

As expected, the majority of Trade and other surveillance tests were conducted in the HRA (53%) compared to 25% in the Edge Area (14% in the 6-monthly testing part and 11% in the annual testing part of the Edge Area) and LRA (22%). In the HRA and Edge Area, virtually all Trade and other surveillance stream tests in 2023 were PrMTs (Table 3.3.4a-b), whereas in the LRA, the proportion of PoMT tests and PrMTs were more evenly split (Table 3.3.4c). In April 2016, it became compulsory for cattle farmers in the LRA to post-movement test animals entering their herds from higher risk areas of GB, if not slaughtered within 120 days of arrival in the Post-movement TB testing became compulsory in April 2016 for cattle moved into LRA herds from higher risk areas, if not slaughtered within 120 days of arrival in the LRA, and in August 2023 for cattle moved to the annual surveillance testing parts of the Edge Area from higher TB incidence areas of England and Wales.

Trade and other tests detected the lowest proportion of TB incidents of all the surveillance streams in England (5% in 2023 compared to 4% in 2022). The number of reactors per 1,000 tests disclosed by Trade and other tests was 0.9 in the HRA, where most tests in this stream are conducted, and 0.3 in the Edge Area (0.8 in the 6-monthly testing part and 0.6 in the 12-monthly testing part of the Edge Area). This rate increased in the HRA in 2023 (0.9) compared to 2022 (0.5), but previously had been decreasing between 2020 (1.4) and 2022 (0.5). This increase in the HRA can be attributed to the number of reactors identified following pre-movement testing nearly doubling compared to 2022 (128 in 2022 vs 225 in 2023) whereas the number of herd tests only increased by 4%. The fall in previous years could have been due to the large amount of IFN-γ testing in the HRA overall, which could have reduced the animal level prevalence.

In 2023, private tests represented less than 1% of cattle tests within this surveillance stream in the HRA and Edge Area and 3% of cattle tests in the LRA. This is the same trend as in 2022 and 2021. Private tests disclosed one TB incident (OTF-S) in 2023; this was in the annual-testing part of the Edge Area. International trade tests (pre-export and post-import tests) and voluntary pre-sale check tests resulted in the disclosure of no incidents in 2023 (Table 3.3.4).

Table 3.3.4.a Performance of main test types within the Trade and other surveillance stream in the HRA in 2023. NB: 46 skin tests mis-recorded as post-movement, instead of pre-movement, skin tests in the HRA in 2023. These have been added to the Pre-movement test events total but they did not disclose any new TB incidents in 2023.

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Pre-export	4 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Post-import	29 (0.2)	0 (0.0)	0 (0.0)	1 (0.4)	0.0	1.2
Pre-movement	15,383 (99.7)	77 (100.0)	27 (100.0)	225 (99.6)	0.5	0.9
Private	13 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Total	15,429	77	27	226	0.1	0.4

Table 3.3.4.b Performance of main test types within the Trade and other surveillance stream in the Edge area in 2023.

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Pre-export	8 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Post-import	15 (0.2)	0 (0.0)	0 (0.0)	1 (3.1)	0.0	7.9
Post-movement	206 (2.8)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Pre-movement	7,093 (96.5)	24 (96.0)	14 (100.0)	31 (96.9)	0.3	0.3
Private	27 (0.4)	1 (4.0)	0 (0.0)	0 (0.0)	3.7	0.0
Total	7,349	25	14	32	0.8	1.6

Table 3.3.4c Performance of main test types within the Trade and other surveillance stream in the LRA in 2023

Test type	Test events N (%)	TB incidents N (%)	OTF-W incidents N (%)	Reactors N (%)	TB incidents per 100 herd tests	Reactors per 1000 cattle tested
Pre-export	40 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Post-import	51 (0.8)	0 (0.0)	0 (0.0)	1 (11.1)	0.0	1.6
Post-movement	2,277 (36.2)	6 (60.0)	5 (100.0)	5 (55.6)	0.3	0.1
Pre-movement	3,765 (59.9)	4 (40.0)	0 (0.0)	3 (33.3)	0.1	0.1
Pre-sale check	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Private	157 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)	0.0	0.0
Total	6,290	10	5	9	0.1	0.3

Test types in the tables 3.3.4 a to c above includ e: Pre-export (VE-EX), Post-import (VE-PII, VE-PIO), Post-movement (VE-POSTMT, POSTMOVNC, VE-POSTMOVOV), Pre-movement (VE-PRMT, VE-AI), Private (VE-PRI), Pre-sale check LRA (VE-CT-LRA-SA).

Pre-movement testing (PrMT)

Pre-movement testing accounted for most testing under the Trade and other surveillance stream in all risk areas in 2023 (Table 3.3.4a-c). There were over 2.8 million cattle movements within GB in 2023 (Table 3.3.5), excluding direct and indirect movements to slaughter, for example via slaughter markets and AFUs. There was an increase of 60,382 movements compared to 2022. In general, in all TB risk areas, farms move more cattle within their risk area than out with their risk area.

Further, there are more cattle movements 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 cattle moved within the Edge Area. Over 1.2 million cattle movements in 2023 originated in the HRA or Edge Area, similar to 2018 to 2022.

Table 3.3.5 Summary of number of cattle movements between risk areas and countries, 2023. This table doesn't include transitory moves e.g. via a market.

Cattle movements in 2023	To HRA	To Edge Area	To LRA	To Scotland	To Wales	Total
From HRA	679,211	54,380	42,074	1,649	37,720	853,019
From Edge Area	71,279	209,499	45,630	1,061	20,972	348,441
From LRA	16,183	16,892	637,239	29,067	7,728	732,397
From Scotland	1,985	960	60,858	440,745	1,803	510,993
From Wales	86,153	27,513	32,058	862	271,186	427,834
Total	854,811	387,221	817,859	473,384	339,409	2,872,684

Figure 3.3.5 shows how the annual proportion of total new TB incidents disclosed by bespoke, privately funded PrMTs has changed over time since 2013 for each risk area and for England as a whole. Overall, reactors detected at PrMTs triggered 4.5% of all new TB incidents recorded in England in 2023. In the HRA (and England) this proportion was stable between 2011 and 2019 (around 8%) but increased to 10% in 2020. It then dropped to 7% in 2021 and to 4% in 2022 and 2023 following the rollout of six-monthly TB surveillance testing for most cattle herds in the HRA (Figure 3.3.5). In contrast, there has been more variability in the Edge Area and LRA over this 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, increasing the number of eligible herds. In the Edge Area, PrMT disclosure was 8% in 2020, but decreased to 4% in 2021 and 3% in 2022 before increasing to 5% (5% in the 6-monthly testing part and 7% in the 12-monthly testing part of the Edge Area) in 2023. The proportion of TB incidents detected by PrMTs in the LRA has been more variable, from lows of 2% to highs of 8% over the last 10 years. In more recent years it decreased from a peak of 6% in 2019 to 2% in 2020 and 2021. There was a slight increase to 4% in 2022 before decreasing to 3% in 2023.

Figure 3.3.5 Annual proportion of total TB incidents disclosed by pre-movement testing between 2013 and 2023, by risk area. Presented data refer to tests categorised as (bespoke) PrMT, but does not include other (government-funded) tests that can qualify as a PrMT.

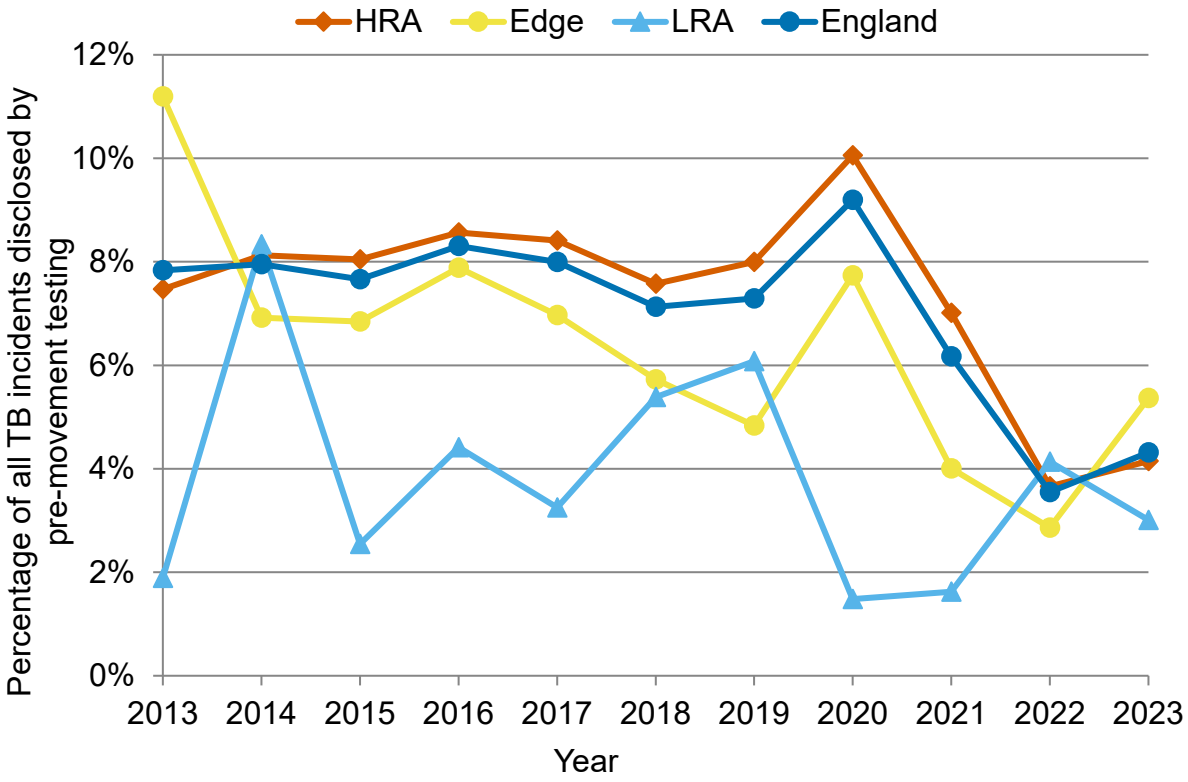


Figure 3.3.5 description: Line chart showing the annual proportion of total TB incidents disclosed by pre-movement testing between 2013 and 2023, by risk area. The trends in each area are described in the text above.

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 must remain isolated from their herd while awaiting the results of a retest at 60 days. iRs that do not give a negative result at the retest are removed as test reactors (2xIR), thus triggering a new incident if their herd was OTF.

As expected, most IR-only herds (herds that had only iRs at the initial test, with no concurrent reactors) were detected in the HRA (72%). Similarly, most iRs were identified in the HRA (76%) (Table 3.3.6).

Between 2022 and 2023, there was a rise in the number of IR-only herds and iRs disclosed in the HRA and LRA but a fall in the Edge Area. This is the opposite trend to that seen between 2021 and 2022 for the HRA and Edge Area where the numbers fell in the HRA and rose in the Edge Area. In the LRA the fall in the number of IR-only herds and iRs disclosed was the same as seen between 2021 and 2022. (Table 3.3.6).

Table 3.3.6 Number (and percentage) of IR-only herds in 2023, and IR animals in these herds by risk area, and percentage change between 2022 and 2023.

Region	IR-only herds (% of all IR-only herds) (% change 2022-23)	iRs disclosed (% of all iRs disclosed) in IR only herds (% change 2022-23)
HRA	1,740 (72%) (+14%)	3,658 (76%) (+8%)
Edge Area	443 (18%) (-22%)	764 (16%) (-31%)
LRA	221 (9%) (+10%)	388 (8%) (+11%)
England total	2,404 (+5%)	4,810 (-1%)

In 2023, 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 in the LRA 23% (Figure 3.3.6).

Figure 3.3.6 Fate of IR-only herds in the 15 months following disclosure of IRs in 2023, by risk area. The fate of some herds is recorded as unknown due to reasons such as ceasing trading and not having a retest.

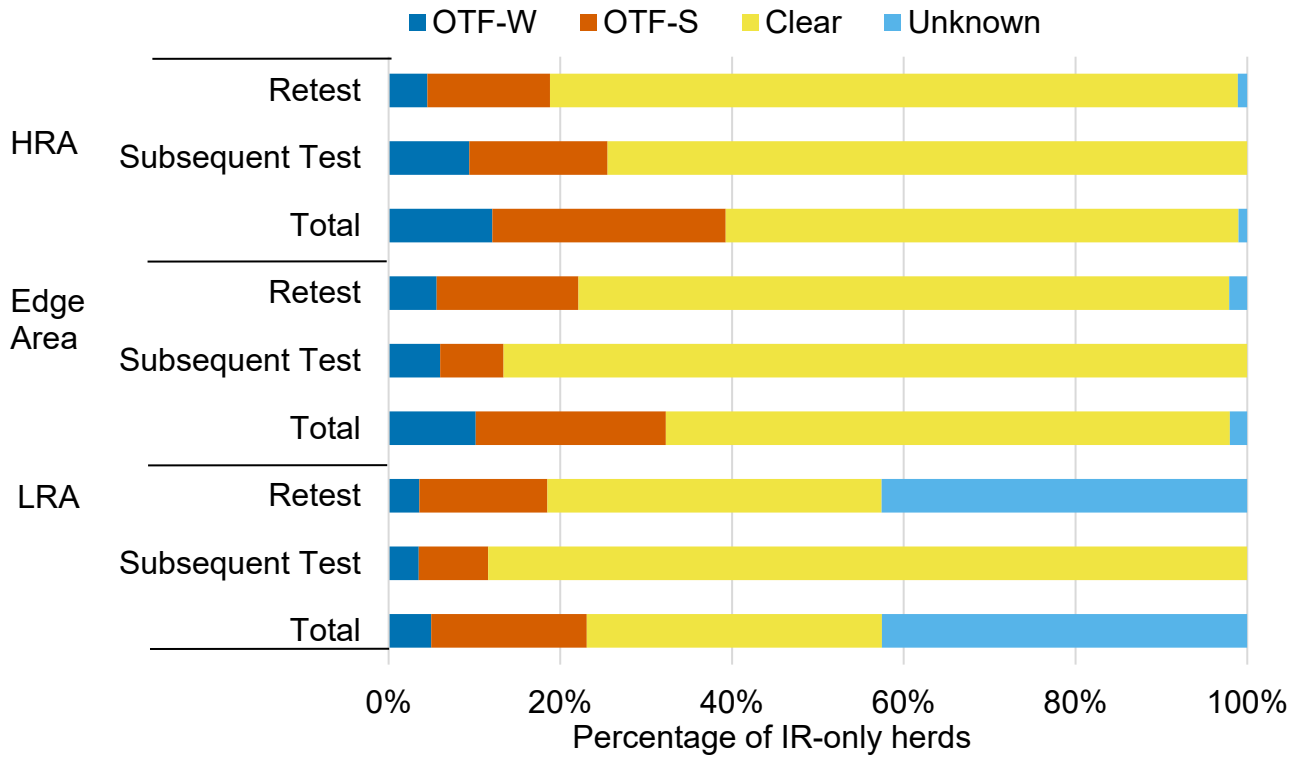


Figure 3.3.6 description: Fate of IR-only herds in the 15 months following disclosure of IRs in 2023, by risk area. The trends by risk area are described in the text.

In 2023, in the Edge Area and LRA, most IR-only herds were those without a recent history of an OTF-W incident (76% and 96%, respectively). The proportion of such herds in the HRA was lower (65%). In the HRA, just under half of the IRs in IR-only herds that went on to have a TB incident (OTF-S or OTF-W) were detected by the IR retests (48%) as opposed to subsequent herd tests. In contrast, most IR-only herds that went on to have a TB incident in the LRA and Edge area were detected at an IR retest (80% and 68%, respectively).

Figure 3.3.7 suggests that IR-only herds in the HRA and Edge Area have an increased likelihood of a TB incident at a subsequent test (rather than a retest) and if they have a history of TB. In contrast, IR-only herds in the LRA had greatest likelihood of disclosing a TB incident at a retest (rather than at a subsequent herd test) and if they had no history of TB. A multivariable analysis (Brunton et al. (2018)) showed that the risk posed by IRs in the HRA and Edge Area was substantially reduced if those animals become reactors or 2xIRs at the 60 day retest and are 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. Retesting IRs after 60 days mitigates much of the risk posed by those animals. In England, the policy to permanently restrict all

resolved IRs (i.e., animals identified as an IR which then tests clear at the 60-day retest) in the HRA, Edge Area and incident herds in the LRA to the herd in which they are disclosed reduces the risk further.

Figure 3.3.7 Proportion of IR-only herds which disclosed a TB incident in 2023 at either the IR retest 60 days later, or a subsequent test (within 15 months after IR test), by surveillance risk area and TB history. The denominator is the number of IR only herds and totals above each column represent the number of herds with a TB incident.

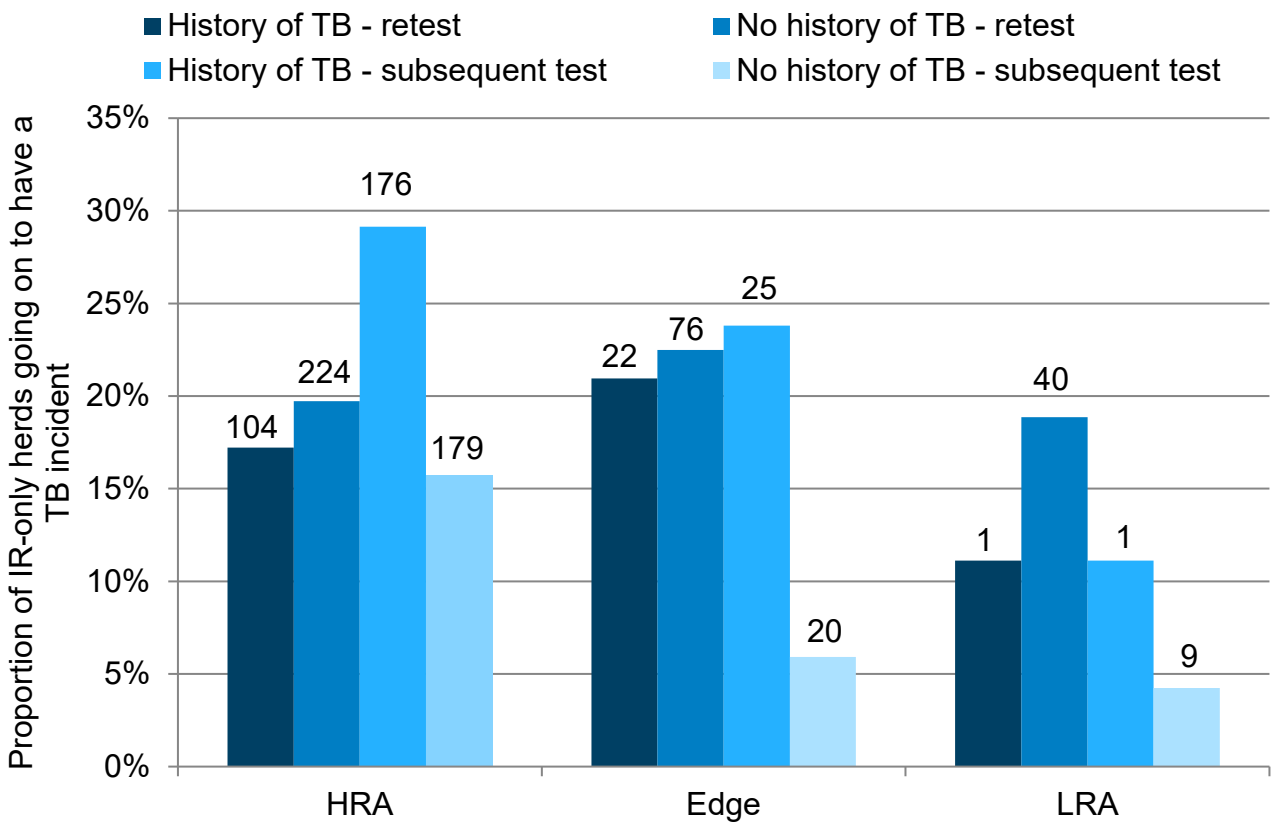


Figure 3.3.7 description: Bar chart showing the proportion of IR-only herds which disclosed a TB incident in 2023 at either the IR retest 60 days later, or a subsequent test (within 15 months after IR test), by surveillance risk area and TB history. For each county, the bar shows the proportion of herds that had an IR and had a history of TB and had a TB retest; had a history of TB and had a subsequent TB test; had no history of TB and had a TB retest; or had no history of TB and had a subsequent TB test in 2023. The numbers of herds which had a TB incident for each category are shown above the bar.

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

- During 2023, a monthly average of 1,890 herds in England (4% of 45,758 herds) were under movement restrictions due to a TB incident.
- The end-of-year point prevalence for England was also 4%, with 1,855 (of 45,006) herds under restrictions on 31st December 2023. Most of these herds (78%) were in the HRA.
- In 2023, the monthly average herd level prevalence in the HRA was 8%, a statistically significant decrease on 2022 (9%, z-test $p<0.001$).
- Average monthly herd prevalence in the Edge Area overall and in both its six-monthly and annual surveillance testing sections, decreased non-significantly in 2023 to 4%, 5%, and 3%, respectively.
- Average monthly herd prevalence in the LRA remained very low and stable in 2023 (0.4%).
- End of year prevalence in 2023 was highest in the six-monthly testing Edge Area county of Oxfordshire (12%), followed by the HRA counties of Gloucestershire (10%), Wiltshire (10%) and Avon (9%).
- TB infected herds remained under movement restrictions for a median of six months in the HRA and the Edge Area, and for a median of five months in the LRA.
- TB incident herds with more than 200 animals or with more than one TB test reactor disclosed were under movement restrictions for longer periods.
- In the HRA, the percentage of TB incidents still open at the end of the reporting year which were classified as persistent (93 incidents, 5%), remained similar to 2022 (98 incidents, 7%).
- The number of persistent TB incidents open at the end of the reporting year in the Edge Area in 2023 (13) was also similar to 2022 (11). There were only two persistent incidents open at the end of the year in the LRA, one more than in 2022.
- Overall, 128 persistent TB incidents were resolved in England during 2023, 87% of which were in the HRA.
- 20,428 cattle were slaughtered for TB control reasons in England, with a median of two and a mean of eight test reactors removed per TB incident that ended in 2023.
- In 2023, a mean of eight reactors were removed per TB incident in the HRA, seven in the Edge Area, and almost three in the LRA.
- Across England, 4.6% of the 136,963 cattle that were IFN-γ tested in 2023, were positive; a slight increase from 2022 (3.9% of animals positive out of 143, 310 tested).
- 68% of the 1,010 herds tested with IFN-γ disclosed at least one IFN-γ test positive animal.

Herd prevalence

Herd prevalence is the proportion of cattle, water buffalo and farmed bison herds (henceforth termed ‘cattle herds’ for simplicity) in a country, risk area or another spatial unit classified as infected with TB at a given point in time. In Figure 3.4.1 below, 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. However, the map in Figure 3.4.2 gives the percentages of herds under TB restrictions at the end of the year for each county (i.e. the point prevalence). The magnitude of the herd prevalence of TB depends on both:

- how many TB-infected herds are newly detected (incidence), and
- how long each TB incident herd remains under movement restrictions (incident duration).

Stricter TB control policies, in particular the number and types of tests with negative results needed for a TB incident herd to regain its OTF status, can increase the duration of TB movement restrictions. Less stringent controls may lead to a swifter resolution of the TB incident, but risks leaving undetected infection in the herd if controls are removed too soon.

Prevalence provides an indication of the impact the epidemic is having on the cattle farming sector.

During 2023, an average of just over 4% of all cattle herds in England were kept under movement restrictions due to a TB incident. This was a significant decrease in average monthly prevalence of 1% compared to 2022 (5%, z-test $p<0.001$). This decrease occurred despite a 2% reduction in the average monthly number of active cattle herds in England between 2022 (n=46,819) and 2023 (n=45,758) and was driven by a 16% fall in the average monthly number of herds under restriction, from 2,191 in 2022 to 1,890 in 2023.

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 in OTF herds in GB (i.e. October to April). Average monthly herd prevalence in the HRA decreased significantly in 2023 (8%, $p<0.001$, z-test) compared to 2022 (9%), to the lowest level seen in the previous 10 years and continuing the decreasing trend that started in 2018.

In the Edge Area, herd prevalence rose steadily since 2007 with a marked upward trend seen between 2013 (when all herds in the area were placed on routine annual testing) and the peak in 2018-2019. Since then, average monthly prevalence has shown a tendency to decrease, fluctuating between just over 3.5% and just over 6%, and plateauing at around

4% throughout 2023. These fluctuations in previous years, and the plateau in 2023 are consistent with the trend seen in the 6-monthly testing Edge Area. Conversely, in the 12-monthly testing Edge Area, average monthly herd prevalence has remained more stable, between 2% and 4% since 2016, a slight increase compared to 2014 to 2016 where it remained below 2%. The increase in prevalence in the Edge Area between 2013 and 2018-2019, followed by a fall, reflects both the earlier detection of infected herds and the more stringent controls that those herds are subject to. In the LRA, average monthly prevalence has remained consistently low for the past ten years.

Figure 3.4.1 Percentage of live English herds under TB movement restrictions (prevalence) as a result of any TB incident, by month, between January 2014 and December 2023.

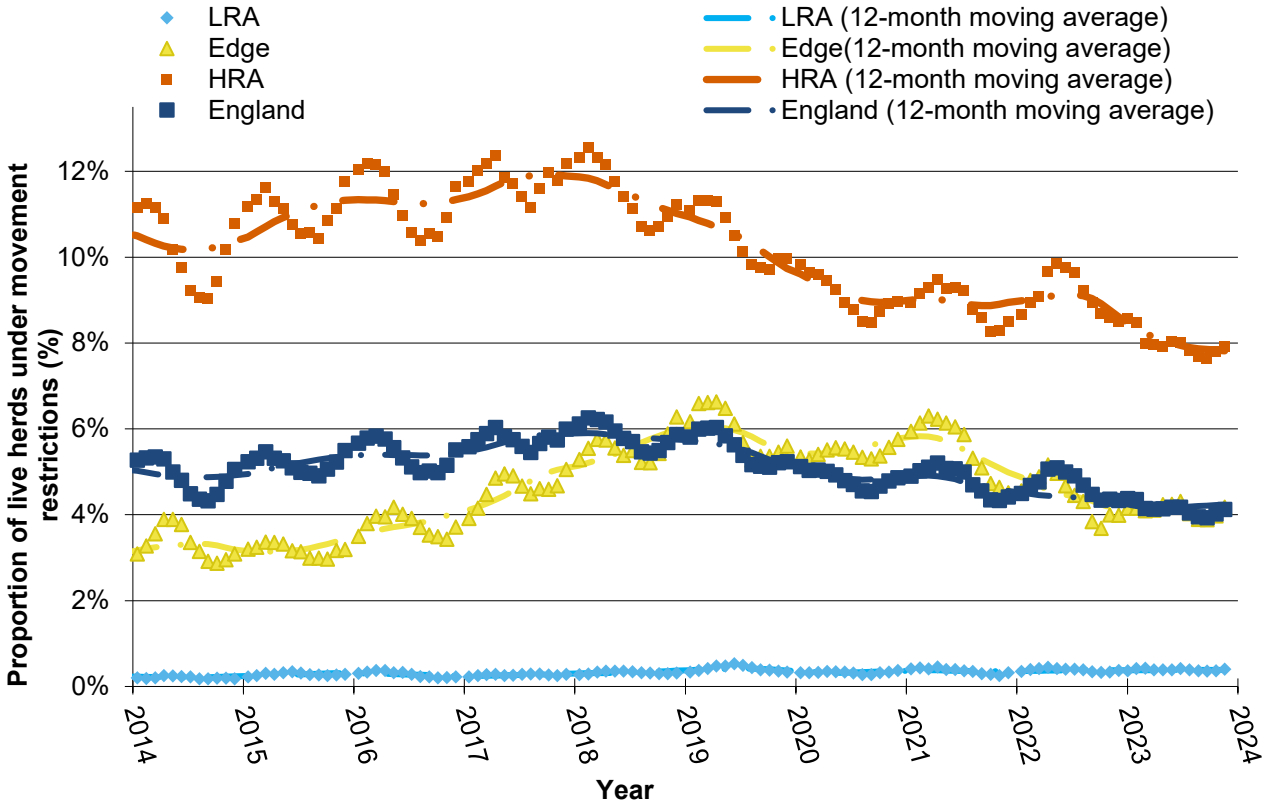


Figure 3.4.1 description: Chart showing the monthly percentage of live English herds under TB movement restrictions (prevalence) as a result of any TB incident, by month, between January 2014 and December 2023. Monthly prevalence in the HRA remained stable, at around 8% in the HRA throughout 2023. Prevalence in the HRA has been following an overall significant decreasing trend since 2018 (linear regression $p<0.001$). In the Edge Area, prevalence peaked between 2018 and 2019, but has shown a tendency to decrease since, plateauing in 2023.

In 2023, as in previous years, there was wide variation in the end of year herd prevalence of TB across the counties of England (Figure 3.4.2). Oxfordshire (six-monthly testing Edge Area) experienced the highest herd prevalence (11.5%), followed by the HRA counties of Gloucestershire (10.4%), Wiltshire (10.1%) and Avon (9.2%). The lowest prevalence was seen in counties in the LRA, and in the annual testing Edge Area. Further details about prevalence at county level are presented in Chapter 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 of England that were under restrictions due to an ongoing TB incident on 31st December 2023

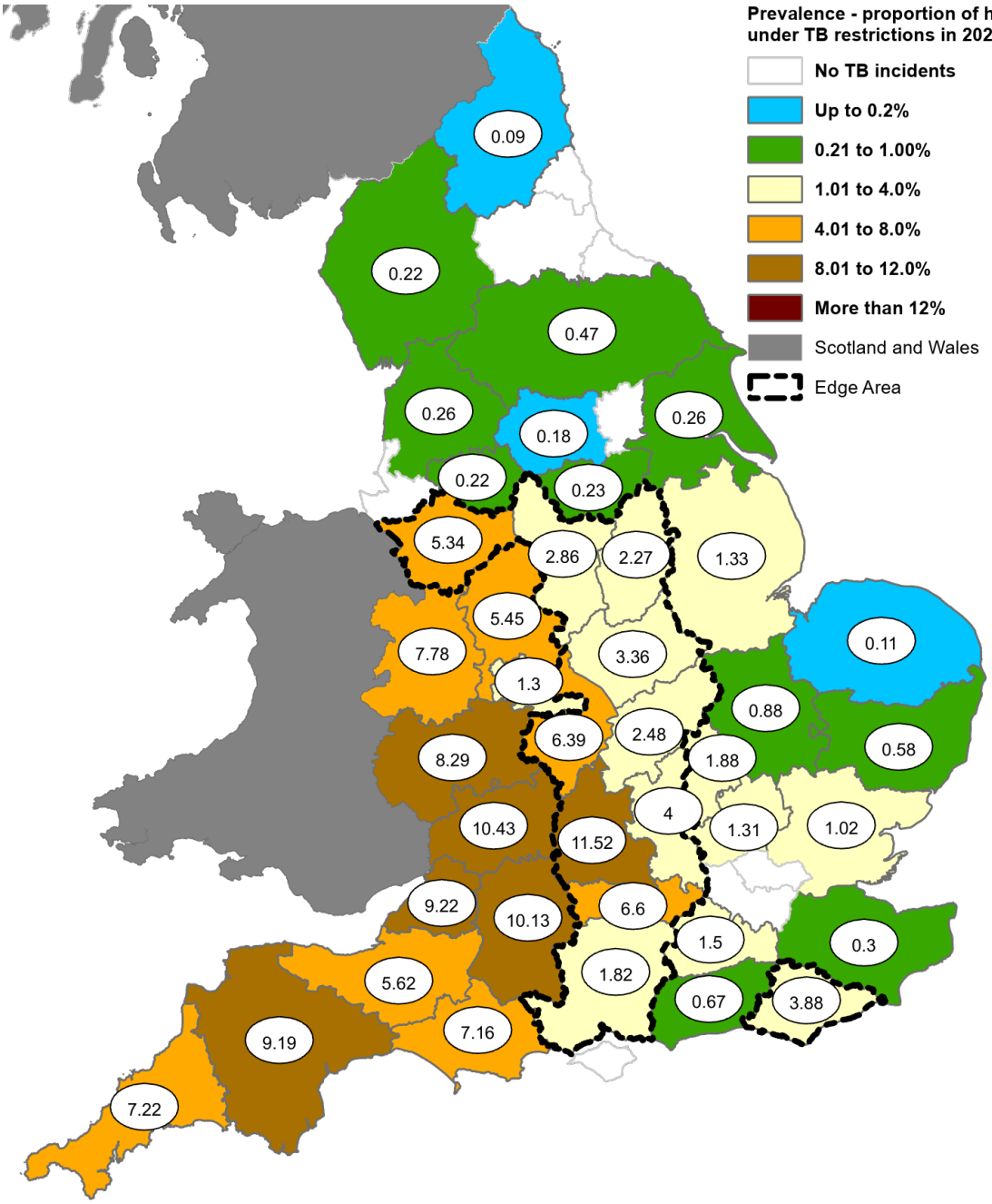


Figure 3.4.2 description: Map of England showing the herd prevalence in each county in England. Herd prevalence was generally greatest in the HRA counties. However, as in previous years, Oxfordshire (one of the counties in the six-monthly surveillance testing section of the Edge Area) sustained the highest herd prevalence of TB in England in 2023.

Duration of TB incidents

Herds affected by TB incidents lose their OTF status and are thus prevented from moving cattle to other herds while incident control measures (such as more frequent and supplementary testing) are in place to limit the risk of spreading TB and eradicate the infection. Limited exceptions, including direct movements to slaughter, slaughter markets or finishing units approved by APHA (AFUs), may be permitted under licence.

TB incident duration affects the cost of TB to both farmers and taxpayers because movement restrictions disrupt the normal management of the herd and trigger more frequent herd testing. Longer TB 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 (residual) M. bovis infection in the herd (and further spread of disease) if restrictions are removed prematurely.

A total of 2,596 herds in England regained OTF status in 2023 after sustaining a TB incident. Of those, 14 were non-grazing AFUs (12 in the HRA and two in the Edge Area). Due to differences in the management of TB in AFUs, which remain under permanent TB movement restrictions, they have been excluded from the following duration figures, unless stated otherwise.

Herds with a TB incident that closed in 2023 were under restriction in the HRA, Edge Area, and both testing regions of the Edge Area for a median period of six months. This was significantly longer than in the LRA (median incident duration of five months, $p<0.001$, K-sample equality of medians test; K-test) (Figure 3.4.3). The shorter median duration in the LRA 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. The median and interquartile range (IQR) for herds in the HRA, Edge Area and LRA are shown in Figure 3.4.3. Median duration in England was slightly higher in 2023 than 2022 (187 days) due to small increases in median duration in the HRA and Edge Area (189 and 183 days in 2022, compared to 203 and 188 in 2023, respectively).

Figure 3.4.3 Median duration and interquartile range of all TB incidents that closed in 2023, by risk area

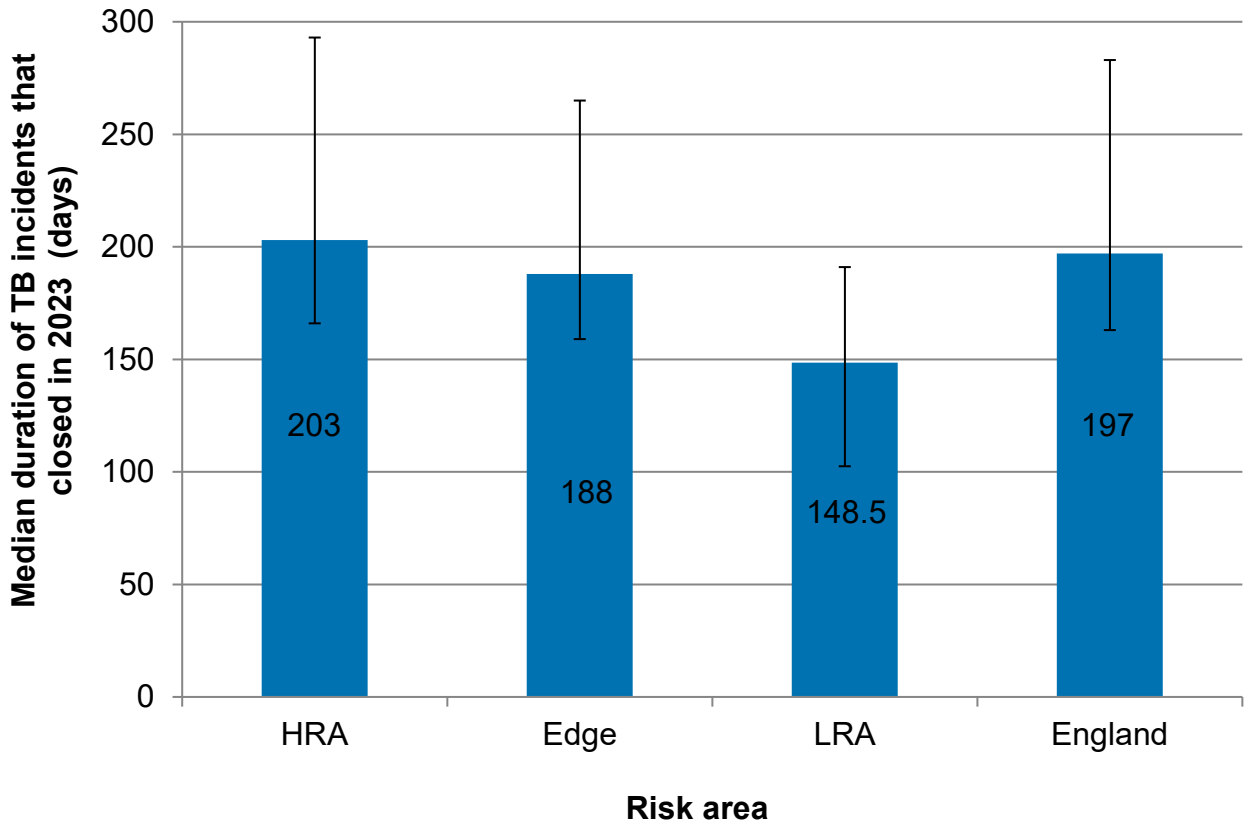


Figure 3.4.3 description: Bar chart showing the median duration of TB incidents that closed in 2023 by risk area and in England overall. Herds with TB incidents were under restriction for similar lengths of time (median) in the HRA and Edge Area, but the duration of TB incidents was shorter in the LRA. However, there is wide county-to-county variation within each risk area (data not shown).

Factors significantly associated with long incident durations 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 TB risk areas (Figure 3.4.4). Further details on the regression analysis used to look at the association between herd size, TB risk area and incident duration is available in the Great Britain surveillance data report (Tab D7).

In 2023, it took longer for restrictions to be lifted in large herds (more than 200 animals) than in smaller herds. This can be seen by the increasing percentage of such herds (green shading) in the longer duration categories. A greater percentage of medium (between 51

and 200 animals) and small herds (between 1 and 50 animals) are restricted for shorter periods in the HRA, Edge Area and LRA (Figure 3.4.4).

Figure 3.4.4 Comparative duration of TB incidents that ended in 2023, by risk area and herd size

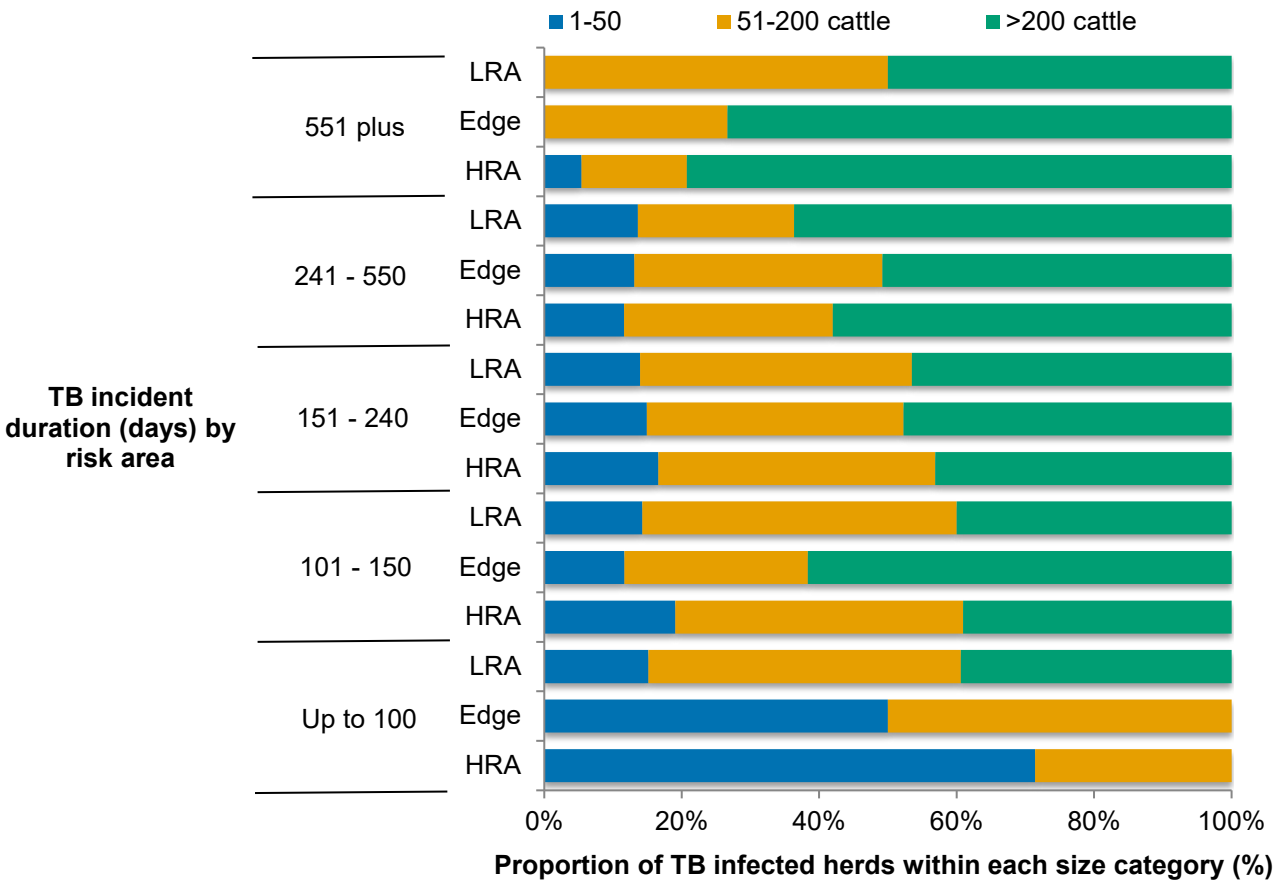


Figure 3.4.4 description: Bar chart showing the comparative duration of TB incidents that ended in 2023, by risk area and herd size. Smaller herds of up to 50 animals came off movement restrictions more quickly than herds with 51-200 animals, which also resolved more quickly than those with over 200 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 several factors that can interfere with efforts to eradicate infection from a herd, such as:

- The limitations of the existing ante-mortem diagnostic tests (imperfect sensitivity and specificity of the skin and IFN-γ tests). This can lead, respectively, to false negative results and missed infected animals at one round of testing (some of which

emerge as TB reactors in subsequent herd tests) and, less commonly, false positive test results that trigger further follow-up tests and artificially prolong the duration of a TB incident.
- Intense cattle-to-cattle transmission (high within-herd infection prevalence).
- Re-introduction from continued or new exposure to a local infection source (e.g. from local wildlife reservoirs of TB, or infected contiguous cattle herds).
- Introduction, under licence, of undetected infected animals (replacements) from other herds.

Figure 3.4.5 shows the number of short interval tests (SITs) required to resolve a TB incident, comparing risk area and herd size.

In 2023, for all risk areas, most TB incidents required two SITs to restore OTF herd status, as in 2022. Herds in the HRA tended to have longer TB incidents, with 10% of incident herds (209 of 2,016 TB incidents in the HRA that closed in 2023) undergoing five or more SITs in 2023. The equivalent percentage in the Edge Area was 8% of incident herds (33 of 439) requiring five or more SITs to regain OTF status, and in the LRA just one per cent (2 of 136).

In the HRA, two thirds of small herds (1-50 cattle) required two SITs to resolve a TB incident (66%, 196 of 295 TB incidents in such herds that closed in 2023), while 28% (84 of 295) required three or more. Similarly, two thirds of medium size herds (51-200 cattle) ended their TB incident after two SITs (66%, 479 of 721) and a third required three or more SITs (33%, 239 of 721). Large herds (>200 cattle) were split equally between needing two SITs (50%, 497 of 1,000) or three or more SITs (50%, 499 of 1,000).

Figure 3.4.5 Number of SITs to resolve a TB incident, by risk area and herd size (for TB incidents ending in 2023)

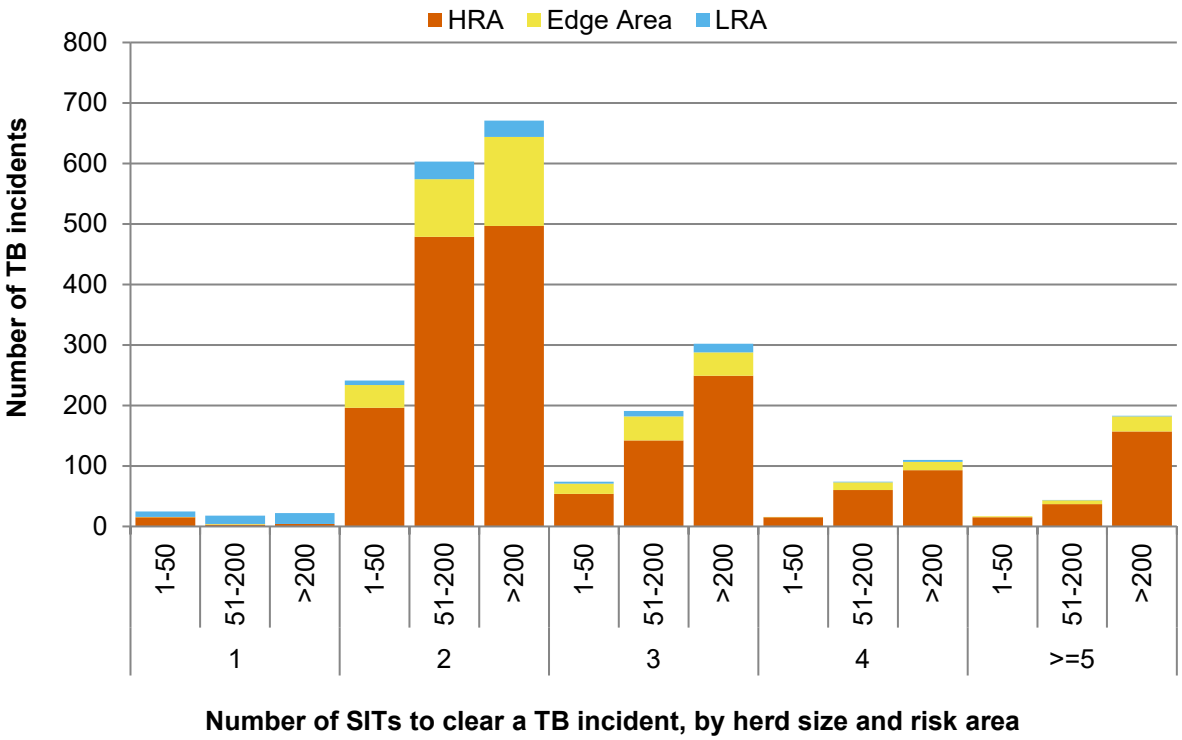


Figure 3.4.5 description: Bar chart showing the number of SITs to resolve a TB incident, by risk area and herd size (for TB incidents ending in 2023). In all three risk areas, most herds required two SITs to end a TB incident. In the HRA, large herds (more than 200 cattle) more often required three or more SITs to end a TB incident compared to the Edge Area and the LRA.

Changes in incident duration over time

Since 2014, TB incidents with more than one reactor have consistently been under movement restrictions for longer than those with only one reactor, across all risk areas (Figure 3.4.6). In 2023, this difference was statistically significant (Pearson's chi square test, $p<0.001$).

Additionally, as in previous years, TB incidents with more than one reactor generally lasted longer in the HRA than in the Edge Area and LRA. In 2023, the median duration of TB incidents with more than one reactor in the HRA was 250 days (236 days in 2022), the longest observed in the HRA since 2019 (251 days).

Previously, the duration of TB incidents with 0-1 reactors in the HRA and Edge Area had been similar to each other since 2014, increasing steadily each year. However, this spiked during 2022 in the HRA to a median duration of 223 days. In 2023, the duration of TB incidents with 0-1 reactors in the HRA has returned to a similar level seen in the Edge Area (174 days and 168 days, respectively). The duration of TB incidents with up to one reactor is largely driven by the required minimum number of SITs. In the LRA, this is often only one as most incidents only have reactors with no visible lesions and a negative PCR or culture results (OTF herd status suspended or OTF-S), rather than lesion and/or PCR/culture-positive animals (OTF herd status withdrawn or OTF-W), hence the lower incident duration in the LRA than in the HRA and Edge Area.

Figure 3.4.6 Median duration of TB incidents that ended in each year, between 2014 and 2023. Note: TB incidents triggered by no reactors were TB incidents initiated by a slaughterhouse case, or by two or more iRs per TB incident, where subsequent testing of the affected herd revealed no reactors

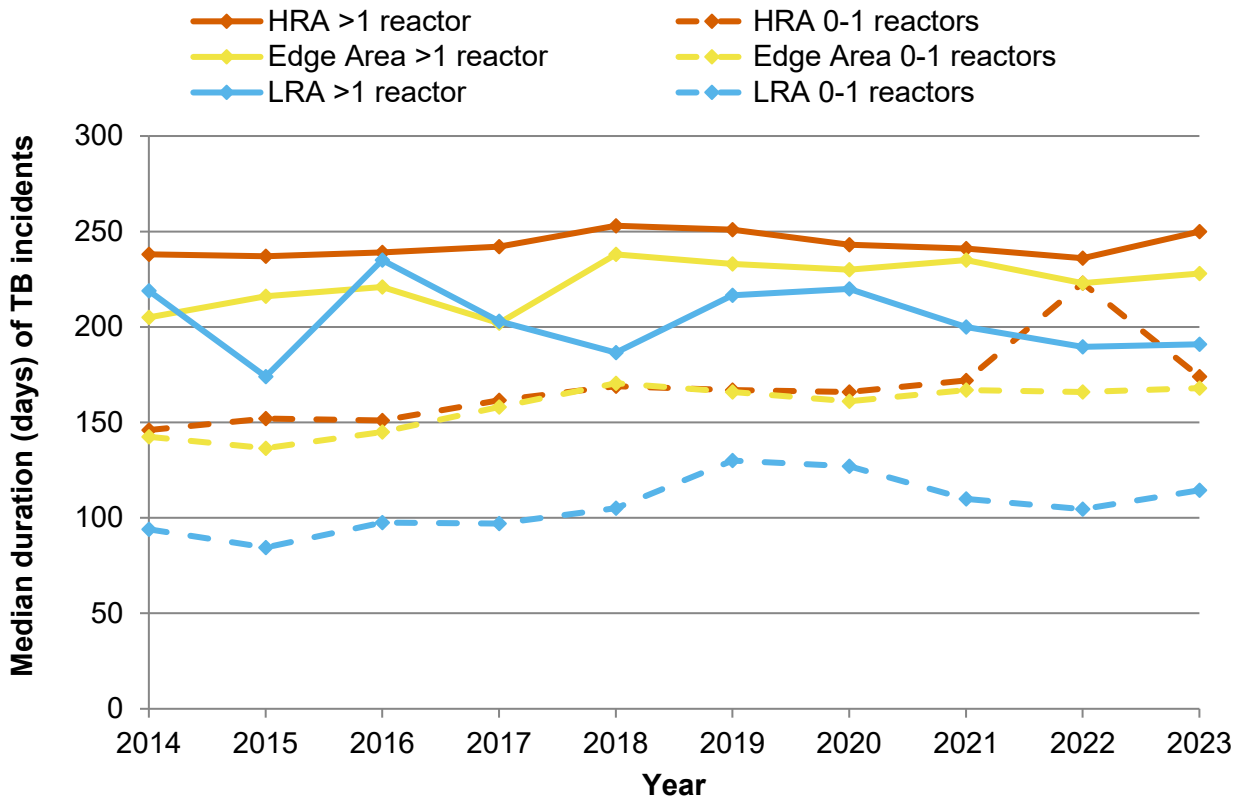


Figure 3.4.6 description: Line chart showing the median duration of TB incidents that ended in each year, between 2014 and 2023. TB incidents that ended in 2023 in the HRA and Edge Area with more than one reactor had a similar duration. In 2023, the median duration of single reactor herds in the HRA returned to a level similar to the Edge Area, as seen in years before 2022. Incidents in the LRA were under restriction for a shorter time compared to the HRA and Edge Area, regardless of the number of reactors.

Persistent TB incidents

TB incidents lasting more than 550 days (about 18 months), are classified by APHA as 'persistent' for management and reporting purposes. The affected herds are then 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 unresolved at the end of each year since 2014, by risk area. In 2023, as in previous years, the vast majority of those (n=93, 86%) were in the HRA.

The number of persistent incidents still open at the end of 2023 in England (n=108) was marginally lower than 2022 (n=110) and was the lowest in the past 10 years. In England and the HRA, the number of persistent TB incidents increased by a fifth between 2015 to 2018 and has since declined, falling by 59% in England between 2018 to 2023. This was largely driven by a 63% decrease in the number of persistent incidents in the HRA, over the same period. However, this declining trend has plateaued over the last two years, as there was very little change in the number of persistent incidents in England, and by risk area, in 2023 compared to 2022. There were 5 fewer persistent incidents in the HRA, with their percentage remaining unchanged, at 7%. The Edge Area and LRA experienced 2 and one more incidents, respectively (Figure 3.4.7).

The number of persistent incidents in the Edge Area was the second lowest in the last 10 years. This has mainly been driven by a fall in the number of persistent incidents in the six-monthly testing section of the Edge Area, falling from a high of 27 incidents in 2019 to just 8 incidents at the end of 2023. Most persistent incidents in the Edge Area have been recorded in this portion over the last ten years (between 75% to 100% from 2014 to 2022, and 63% of persistent incidents in the Edge Area in 2023).

Only two persistent incidents remained unresolved in the LRA (in Bedfordshire and West Sussex) at the end of 2023 (Figures 3.4.7 and 3.4.8).

Figure 3.4.7 Number of persistent TB incidents still open at the end of each year that had lasted more than 550 days.

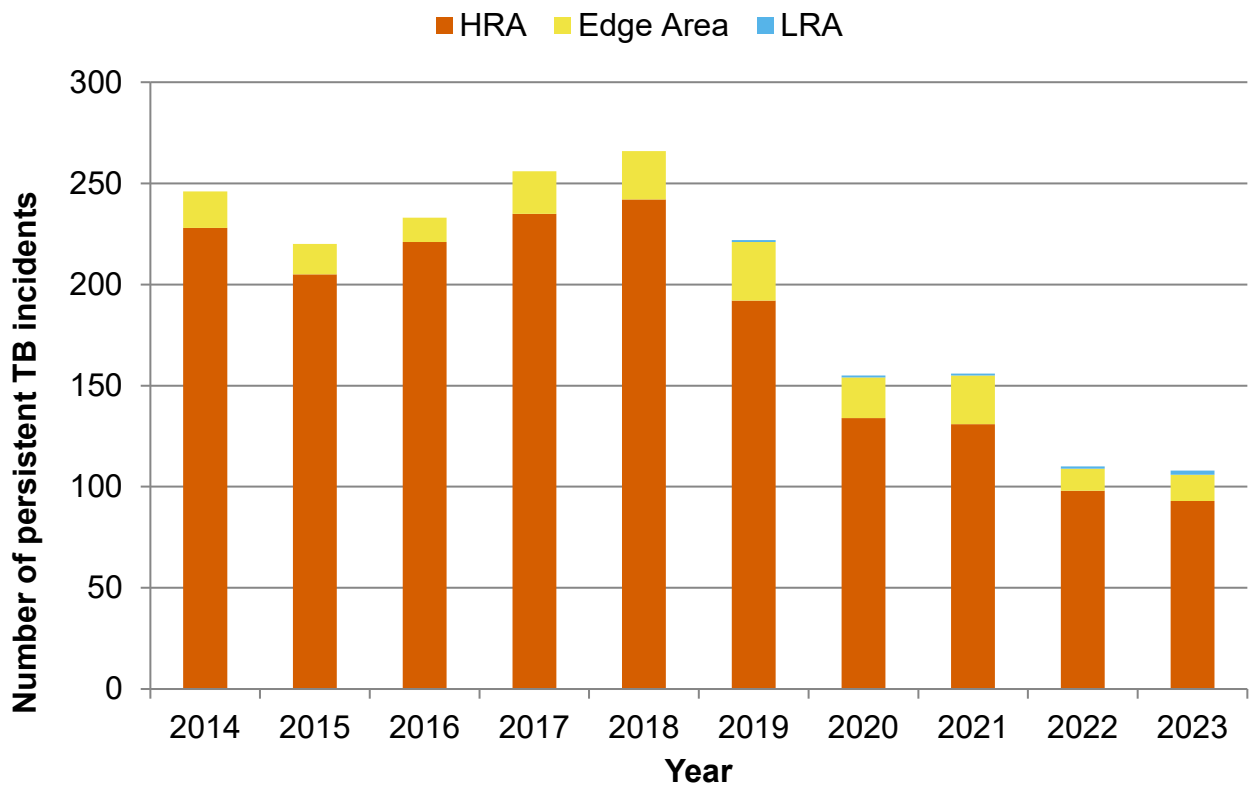


Figure 3.4.7 description: Bar chart showing the number of persistent TB incidents still open at the end of each year that had lasted more than 550 days. During 2023, there were 108 persistent TB incidents in England (93 in the HRA, 13 in the Edge Area and two in the LRA).

There was variation across counties in the percentage of TB incidents still open at the end of 2023 (Figure 3.4.8). Nineteen counties had persistent incidents in 2023 (n=16 in 2022). Aside from the West Midlands, Bedfordshire, and West Sussex, which all had a single persistent incident out of very small total numbers of incidents, the highest percentage of persistent TB incidents open at the end of 2023 were in Berkshire (six-monthly testing Edge Area, 25%), and the HRA counties of Avon (14%), Shropshire and Wiltshire (13% for both). These were four of eight counties where the percentage exceeded 10%, in comparison to just two counties in 2022.

The percentage of persistent incidents in Berkshire remains amongst the highest recorded in England, as it has done over the past three years. This percentage has increased slightly compared to 2022 (23%) and remains considerably higher than before it began increasing in 2018 (14%).

In Avon, the percentage of persistent incidents has been steadily increasing from 8% in 2019 up to 14% in 2023. Nonetheless, the percentage in 2023 for Avon was still considerably lower than its previous highpoint of 27% in 2012. Both Shropshire and Wiltshire have seen the percentage of persistent incidents increase from 8% in 2022 to 13% in 2023. This is the highest percentage recorded in Shropshire over the last ten years, and the highest seen in Wiltshire since 2019 (14%).

Figure 3.4.8 Percentage of persistent TB incidents in each county, open at the end of 2023, that had lasted more than 550 days

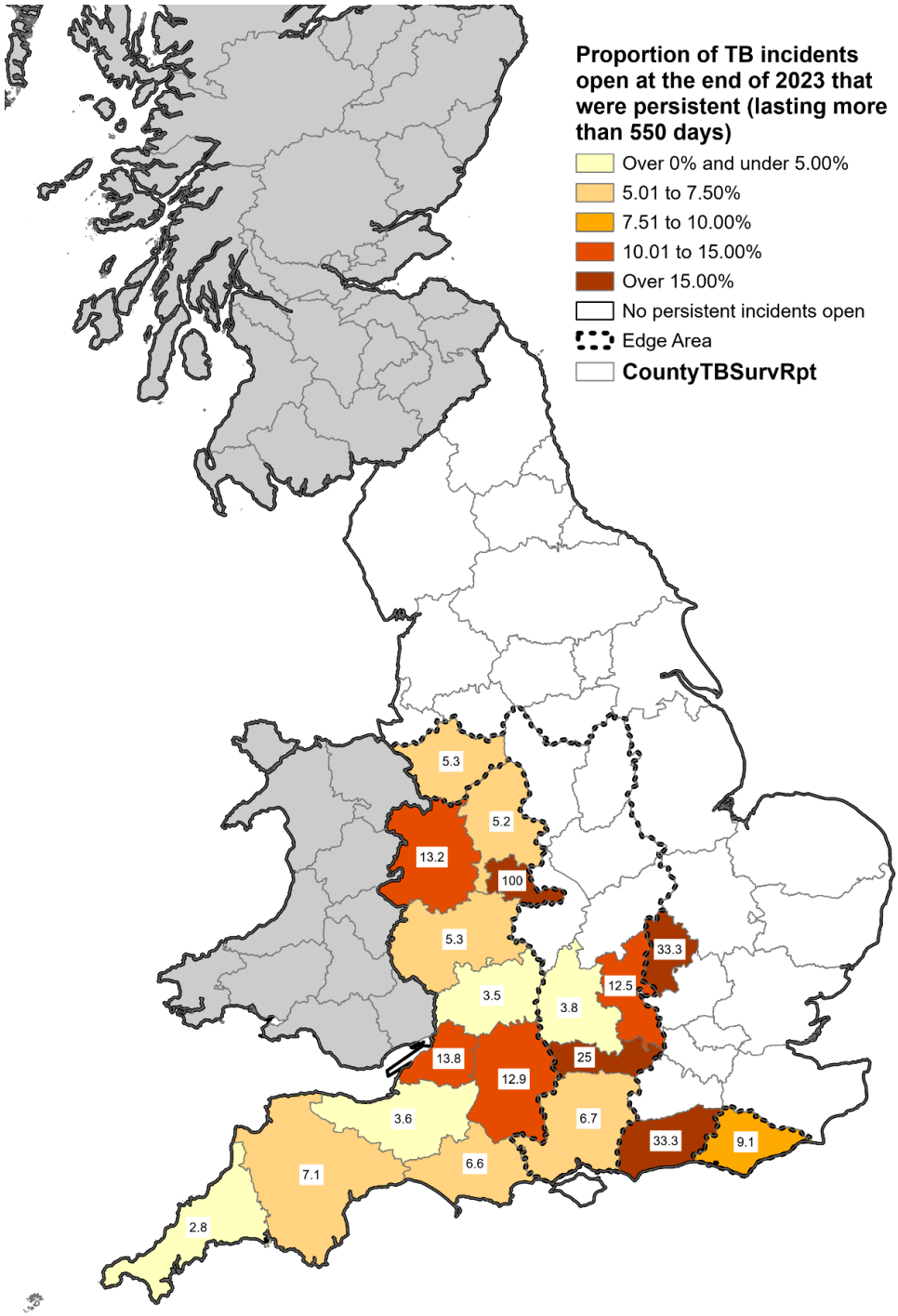


Figure 3.4.8 description: Map of England showing the percentage of persistent TB incidents in each county, open at the end of 2023, that had lasted more than 550 days. In 2023, the percentage of persistent TB incidents that were ongoing at the end of the year rose in all risk areas compared to 2022, and was highest in the HRA (7%), followed by Edge Area (5%, six-monthly testing 4%, 12-monthly testing 5%), and LRA (3%). This was

the highest percentage of persistent TB incidents at the end of the year seen in the LRA since 2012 (6%). Apart from the West Midlands, Bedfordshire, and West Sussex which had one persistent TB incident open at the end of 2023 (100%, 33% and 33%, respectively), the counties with the highest percentage of persistent TB incidents open at the end of 2023 were Avon (14%), Shropshire and Wiltshire (13% for both).

Number of animals removed from TB incident herds

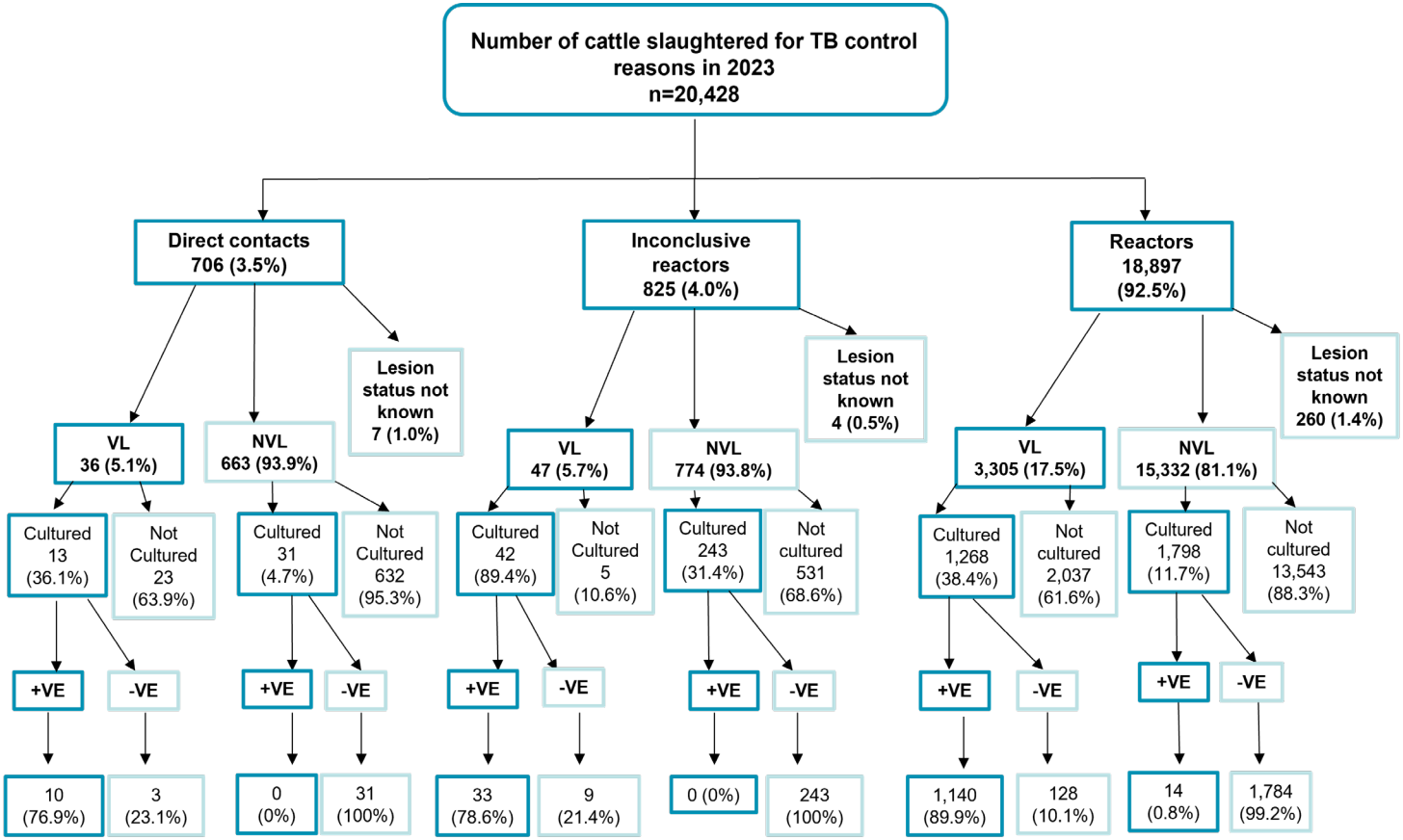
Cattle that test positive for TB must be isolated from the rest of the herd and rapidly removed. In 2023, a total of 20,428 cattle were slaughtered for TB disease control purposes in England, a 9% decline compared to 2022 (n=22,358). Most cattle slaughtered were skin and/ or IFN-γ blood test reactors (92.5%). The remaining 7.5% were removed as inconclusive reactors (iRs) before re-testing, either voluntarily by the keeper (4%), or by APHA as direct contacts (3.5%, Figure 3.4.9a).

Almost all cattle slaughtered for TB control purposes are subjected to *post-mortem* meat inspection (PMMI) in the slaughterhouse, but not every TB-affected animal is sampled at slaughter for laboratory culture and whole-genome sequencing (WGS) of *M. bovis*. For incident control purposes, confirmation of infection with *M. bovis* entails the detection of typical visible lesions of TB at PMMI in at least one slaughtered test reactor ('VL reactors'), or the identification of *M. bovis* by bacteriological culture (or, more recently, by PCR testing) in at least one animal in the affected herd.

Only 89% of VL carcases of cattle removed for TB control reasons (reactors, iRs and DCs) that were sampled for culture yielded a positive result for *M. bovis*, compared to just under 1% of animals with no visible lesions (NVL) sampled for culture (Figure 3.4.9a).This is a small decrease compared to previous years, with 92% of VL carcasses being removed for TB control reasons in 2022 and 2021.

The results of the single intradermal comparative cervical tuberculin (SICCT) test can be read at standard (ST) or severe (SEV) interpretation, depending on the circumstances in which the test is being performed. SEV interpretation is used for most SITs carried out in TB incident herds in England and is also retrospectively applied to the results of the test that disclosed the TB incident. It entails the classification of some ST iRs as skin test reactors and so it is designed to increase the diagnostic sensitivity of the SICCT test, thus reducing the risk of leaving undisclosed infected animals in the herd.

Figure 3.4.9a Diagram showing the number of different categories of cattle that were slaughtered for TB control reasons in 2023, and the number (and percentage) of those in which evidence of infection with *M. bovis* was detected post-mortem.



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

Figure 3.4.9a description: Diagram showing the number of different categories of cattle that were slaughtered for TB control reasons in 2023, and the number (and percentage) of those in which evidence of infection with *M. bovis* was detected post-mortem. Of 20,428 cattle slaughtered for TB control reasons in 2023, most of them (92.5%) were TB reactors. 4% were IRs and 3.5% were inconclusive reactors. Of the 20,428 animals slaughtered, only 3, 388 had visible lesions. Of the 16,769 animals that were NVL, 91% were TB reactors. Finally, 271 animals slaughtered did not have their lesion status known.

In England, most test reactors in 2023 (50%) were removed under the ST interpretation of the skin test (9,357 animals). This was followed by the number of SICCT test-negative animals that were slaughtered because of a positive IFN-γ test result (5,681 animals, 30%), and as SEV-interpretation skin test reactors (3,733 animals, 20%). The number of ST and SEV interpretation skin test reactors both fell in 2023 (10,652 and 4,443 in 2022, respectively). However, the number of animals removed following a positive IFN-γ blood test increased slightly compared to 2022 where 5,567 animals were removed. The decrease in number of reactors removed can be partly explained by the fall in the number of all (and OTF-W) TB incidents, in England compared to 2022.

Despite the slight rise compared to 2022, the number of animals removed after supplementary IFN-γ blood tests in 2023 remained just under half the peak number of animals removed, seen in 2021 (n=11,185). This was due to a number of reasons, including:

- Fewer cattle herds being eligible for mandatory IFN-γ testing due to changes in the policy in 2021.
- Fewer OTF-W incidents disclosed due to decreasing incidence and prevalence in England.
- A proportion of tests which were not booked due to diversion of APHA resources because of the avian influenza outbreak and (later in the year) the cases of bluetongue disease virus in the southeast of England.

The pattern of reactor cattle slaughtered in the HRA was similar to England overall, with over half the cattle slaughtered under a ST interpretation of the skin-test (7,589 animals, 50%). Just under a third (29%) of animals in the HRA were removed because of a positive IFN-γ test (4,437 animals). Similarly, most animals were also removed under a ST interpretation of the skin test in 2023 in the Edge Area (49%, 1,481 animals), followed by removals following a positive IFN-γ test (31%, 935 animals). Conversely, in the LRA, most animals were removed due to positive IFN-γ tests (46%, 306 animals), followed by ST interpretation of the skin-test (43%, 287 animals). This is different to 2022, where 53% were removed under a ST interpretation of the skin test, and 34% after a positive IFN-γ test. This is largely attributable to increases in the number of animals removed after positive IFN-γ tests in Cumbria and South East England. Further information on the number of reactors removed in these areas can be found in the LRA reports.

Of all the cattle in England that were slaughtered for TB control reasons and had visible lesions of TB at PMMI or were *M. bovis* positive on culture, 73% were removed as ST-interpretation reactors. Moreover, In England, 26% of ST-interpretation reactors had visible lesions of TB, *M. bovis* positive culture results, or both (30% in 2022). For IFN-γ test-positive animals, the equivalent percentage was 11%, followed by 8% for SEV-interpretation reactors.

As expected, these percentages varied by TB risk area. The LRA has the highest percentage of ST-interpretation skin test reactors with visible lesions and/or positive culture results (37%), followed by the Edge Area (26% in the six-monthly testing part, and 23% in the annual testing part 32%), and was lowest in the HRA (25%). This was the same for SEV-interpretation reactors (14%, 9%, and 7% in the LRA, Edge Area and HRA, respectively). This is different to previous years, where the HRA has had the highest percentage of ST and SEV test interpretation skin test reactors with visible lesions. The change could be a result of the increased frequency of testing in the HRA (which is now on six-monthly routine testing since 2022), leading to earlier detection of disease and less time for lesion formation.

For IFN-γ test-positive animals, the equivalent percentage was highest in the HRA (11%) followed by the Edge Area (10%, 6-monthly testing 9%, 12-monthly testing 11%) and LRA (5%). In the HRA, the percentage of IFN-γ test positive animals with VLs or culture-positive results decreased slightly from 12% in 2022 to 11% in 2023. ST-interpretation reactors dropped from 29% to 25%, as did SEV-interpretation reactors (8% to 7%) (Figure 3.4.9b).

Figure 3.4.9b Number of reactors and other animals removed for TB control reasons in 2023 with *post-mortem* evidence of *M. bovis* infection (VL reactors and/or culture-positive animals), by reactor type (IFN-γ test positives, ST and SEV interpretation reactors to the skin test) and risk area. Stacked bars labelled with the percentage of reactors that had visible lesions of TB (VL) and/or positive culture results.

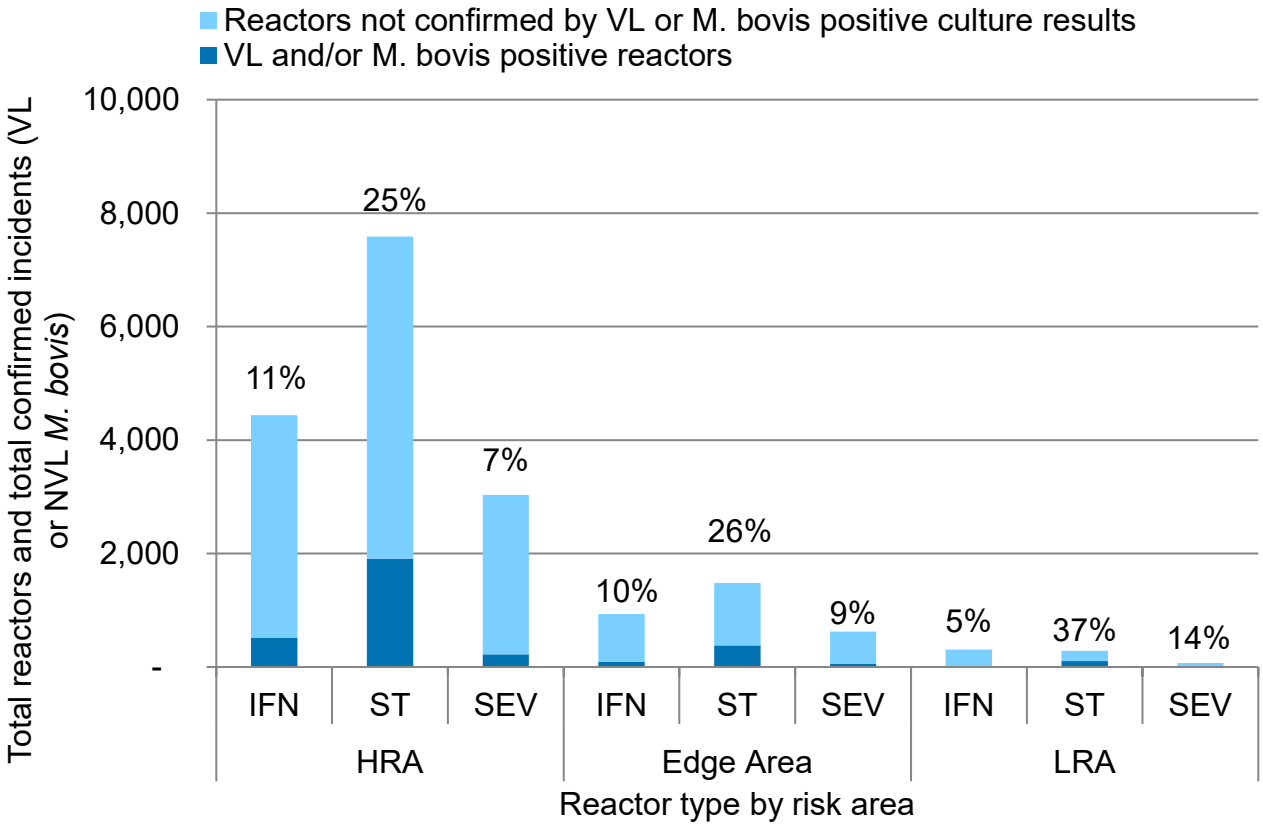


Figure 3.4.9b description: Number of reactors and other animals removed for TB control reasons in 2023 with *post-mortem* evidence of *M. bovis* infection (VL reactors and/or culture-positive animals), by reactor type (IFN-γ test positives, ST and SEV interpretation reactors to the skin test) and risk area. The figure shows Stacked bars labelled with the percentage of reactors that had visible lesions of TB (VL) and/or positive culture results.

Unsurprisingly, the majority of the 20,428 cattle removed from herds were reactors taken from the HRA (n=16,115, 79%), which has been a consistent feature over the last ten years. However, the number of reactors removed in the HRA has been declining over the last six years, falling by 39% since the peak in 2017 (n=25,057, Figure 3.4.10a). Substantial numbers of cattle were also removed as 1xIRs or DCs, and 2xIRs, the majority again taken from the HRA, as seen over the previous ten years (n=458, 54% and n=492, 75% in the HRA, respectively).

After a steep increase in the number of reactors removed from herds in the Edge Area between 2014 and 2018, the number of reactors has been decreasing since 2019, falling by 58% from the peak of 7,254 in 2018 to 3,067 reactors removed in 2023. This was largely driven by a 68% decline in the number of reactors removed in the six-monthly testing part of the Edge Area over the same time period (Figure 3.4.10b). Increases seen

since 2014 were due to the adoption of more frequent routine herd testing and more stringent TB incident control protocols in the Edge Area.

Two consecutive skin herd tests with negative results at SEV interpretation are required before restrictions can be lifted from any TB incident herd in the HRA (since April 2016) and the Edge Area (since 2013). Furthermore, compulsory IFN-γ testing in all herds with OTF-W incidents in the Edge Area was rolled out from 2014, but then partially rolled back from July 2021, when mandatory IFN-γ testing was restricted to recurrent and persistent OTF-W TB incidents in the six-monthly testing part of the Edge Area.

In the LRA, the number of reactors and 1xIR or DCs has fluctuated over the years but remains less than a tenth of the value seen in the HRA and a fifth of that seen in the Edge Area. The number of 2xIRs has been stable, remaining under 60 since 2015 (Figure 3.4.10c). The much lower number of cattle removed for TB control reasons in the LRA means that it is more susceptible to sudden annual rises caused by occasional explosive TB incidents affecting one or two large herds. This was the case in 2023 where a single explosive TB incident in Cumbria produced 18% of the total reactors removed in the LRA.

Figure 3.4.10a Number of reactors, inconclusive reactors and direct contacts removed from herds between 2014 and 2023, in the HRA.

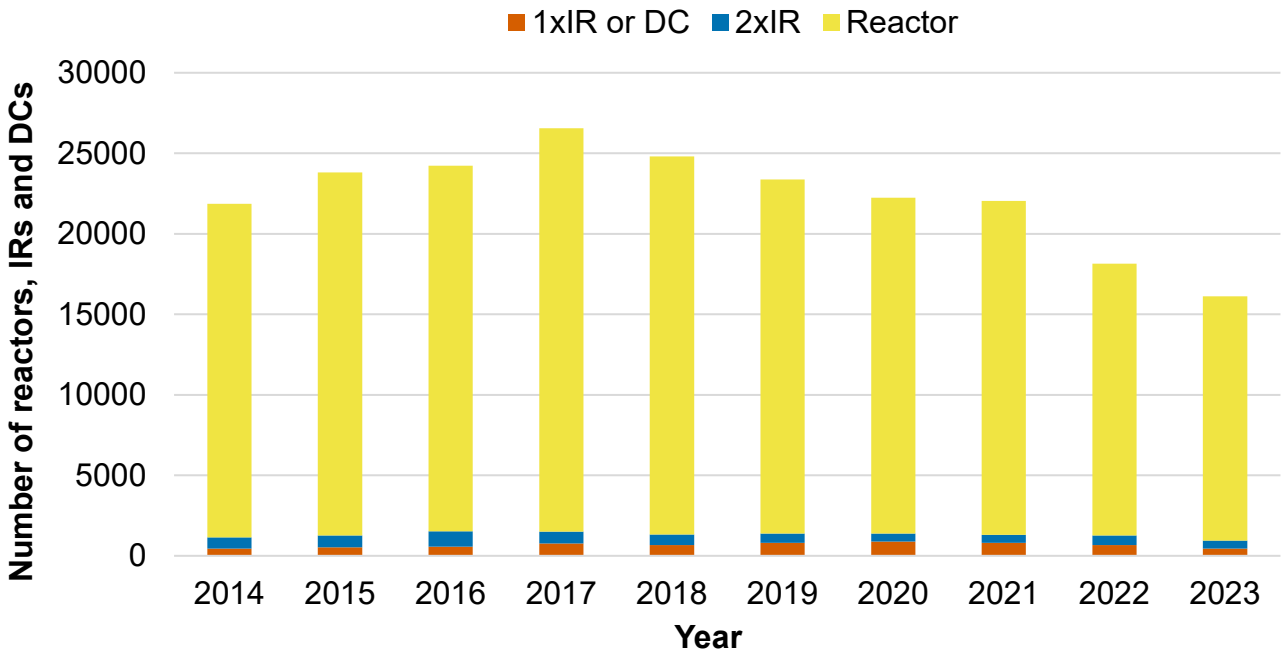


Figure 3.4.10a description: Bar chart showing the number of reactors, inconclusive reactors and direct contacts removed from herds between 2014 and 2023, in the HRA. Most cattle removed over the past ten years are reactors taken from the HRA, with substantial numbers also removed as DCs or IRs. The number of reactors removed has fallen by 39% in the HRA since 2017.

Figure 3.4.10b Number of reactors, inconclusive reactors and direct contacts removed from herds between 2014 and 2023, in the Edge Area.

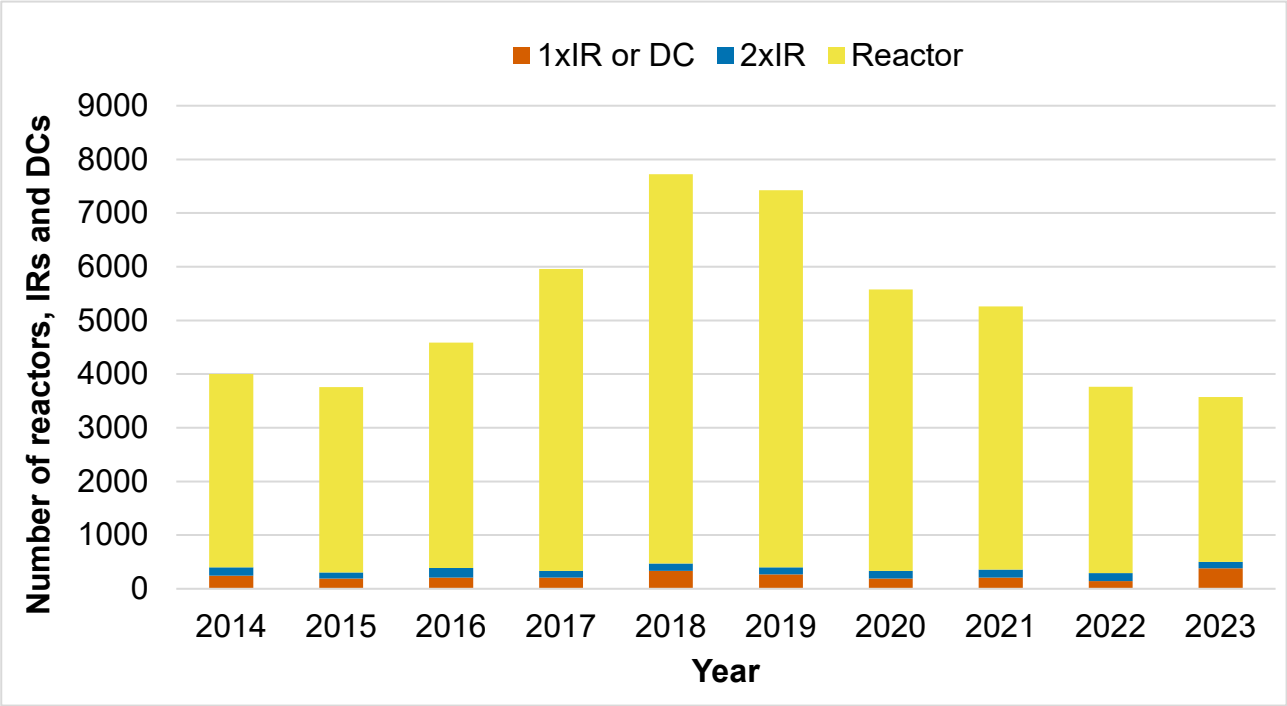


Figure 3.4.10b description: Bar chart showing the number of reactors, inconclusive reactors and direct contacts removed from herds between 2014 and 2023, in the Edge Area. The number of cattle removed as reactors in the Edge Area increased substantially since 2013, when more stringent controls were introduced, but has fallen by 58% compared to 2018.

Figure 3.4.10c Number of reactors, inconclusive reactors and direct contacts removed from herds between 2014 and 2023, in the LRA.

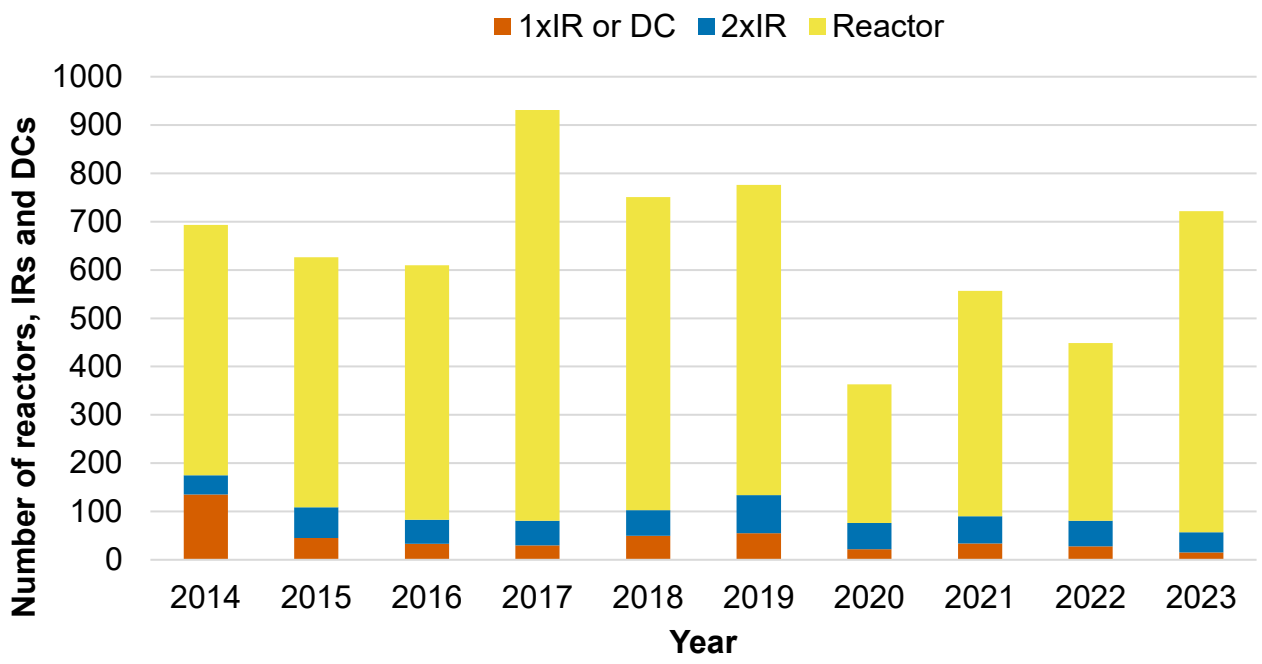


Figure 3.4.10c description: Bar chart showing the number of reactors, inconclusive reactors and direct contacts removed from herds between 2014 and 2023, in the LRA. The number of animals removed as reactors, 1xIR or DC, and 2xIR has remained substantially lower in the LRA relative to the Edge Area and HRA.

In 2023, in England, the median number of reactors removed per incident (including IFN-γ test positive animals) was two, one lower than previous years. The average (mean) number of test reactors removed in the HRA per TB incident was around six from 2009 to 2014. It then increased to almost 10, by the end of 2020, and has since dropped to 8 in 2023. Figure 3.4.11a shows the moving average number of reactors removed in each risk area. There has been greater fluctuation in the Edge Area, with peaks in both 2015 (7) and 2019 (11) but decreased to a mean value of 7 in 2023. This trend is mirrored in the six-monthly testing part of the Edge Area, where the number of reactors peaked at 9 in 2015, and 13 in 2019, but has decreased to a mean of 8 reactors in 2023. The trend in the annual testing section of the Edge Area has fluctuated, but to a lesser extent than the six-monthly testing section of the Edge Area, with a peak of 8 reactors removed in 2019, and a tendency to decrease since then, to a mean of 5 reactors in 2023.

The fall in the number of reactors taken per new TB incident in the HRA and Edge Area may have been associated with changes in the use of the IFN-y test in recent years, as previously explained. Furthermore, the fall in number of reactors in the HRA and Edge Area is also attributable to fewer new OTF-W incidents disclosed due to decreasing incidence and prevalence in these risk areas.

Of the TB incidents that closed in 2023, 288 had no reactors (Figure 3.4.11b). These were either incidents initiated by a slaughterhouse case, or by two-times inconclusive reactors,

where subsequent testing in the herd revealed no reactors. Sixty-three percent of TB incidents in England had two or more reactors, largely driven by the Edge Area and the HRA (60% and 65% respectively). In the LRA, the percentage was 40% (Figure 3.4.11b).

Figure 3.4.11a Monthly rolling mean total number of test reactors taken per TB incident that closed between January 2014 and December 2023, by risk area (12-month moving average)

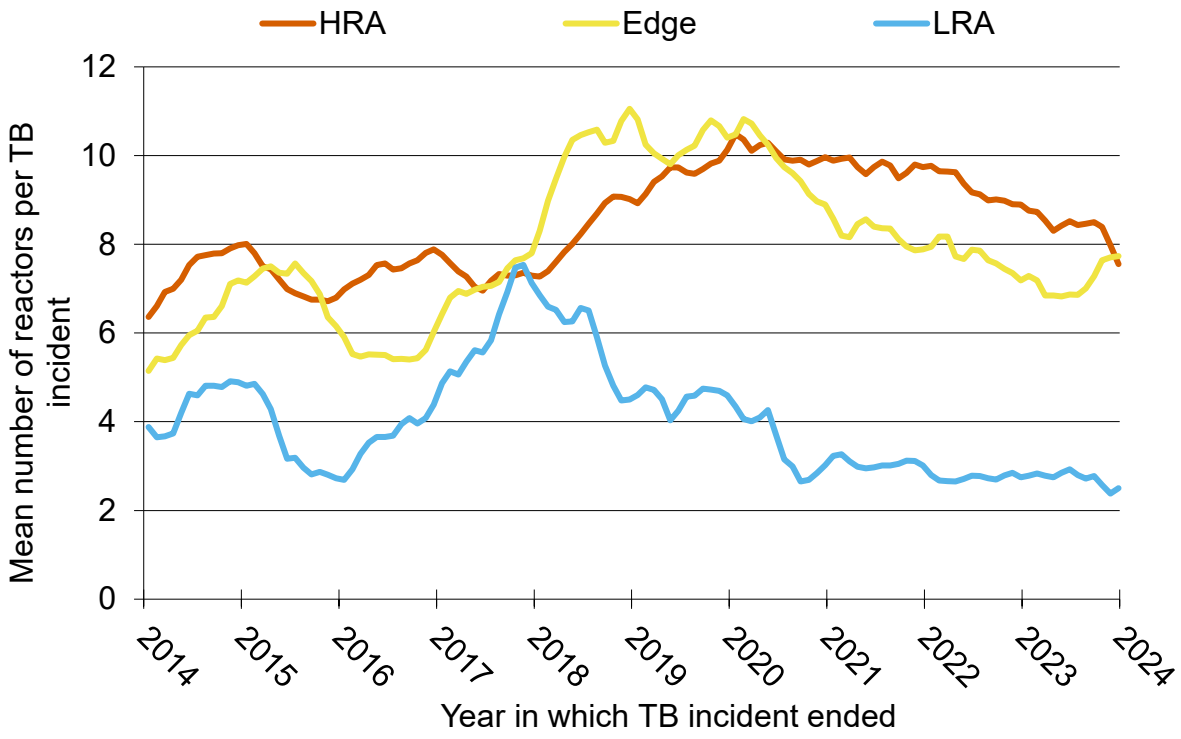


Figure 3.4.11a description: Line chart showing the monthly rolling mean total number of test reactors taken per TB incident that closed between January 2014 and December 2023, by risk area (12-month moving average)**.** The mean total number of test reactors removed in the HRA per TB incident was around six from 2009 to 2014, rose to close to 10 reactors in 2020 and in 2021, and has fallen in 2023 to 8 per incident. 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 below 10 by the end of 2020 and to just over 7 in 2023. There are few incidents in the LRA, so the mean shows greater variability, with a peak of almost 8 reactors in 2018.

Figure 3.4.11b Distribution of the number of TB incidents that finished in 2023, by total number of reactors removed per incident, for each risk area of England.

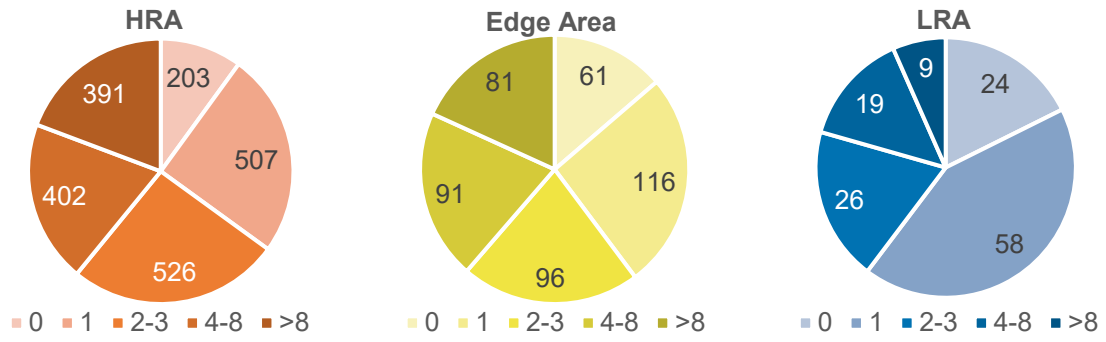


Figure 3.4.11b description: Three pie charts showing distribution of the number of TB incidents that finished in 2023, by total number of reactors removed per incident, for each risk area of England (HRA, Edge Area, and LRA). In the HRA and Edge Area, incident numbers were spread relatively evenly between all reactor number categories, except for incidents with no reactors, which were the least common. In the LRA, incidents with just one reactor were most common.

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

The interferon gamma (IFN-γ) blood test is a supplementary diagnostic test used in specific scenarios alongside the skin test to enhance the sensitivity of TB testing and help resolve TB incidents.

In England, from 1st April 2017 to 11th of July 2021, all herds experiencing a lesion- or laboratory-positive (OTF-W) TB incident in the LRA and Edge Area, as well as those in the HRA where at least two intensive badger culling seasons had been completed, were subjected to mandatory IFN-γ blood testing alongside the skin test. Mandatory IFN-γ tests were also used in herds with persistent TB incidents (under restriction for more than 18 months), herds with explosive incidents and those being considered for whole or partial slaughter.

In July 2021, the IFN-γ testing policy changed for the HRA and the six-monthly surveillance testing part of the Edge Area, where mandatory IFN-γ testing was applied to all herds experiencing a new OTF-W incident within 18 months of the herd regaining OTF status following a previous incident. The test deployment policy was unchanged in the LRA and the annual surveillance testing part of the Edge Area, where all new OTF-W incidents continue to be subjected to mandatory IFN-γ testing. Any chronic and persistent OTF-W incidents across the HRA and Edge Area were also subjected to an IFN-γ test. Outside these scenarios, the deployment of the IFN-γ blood test was at APHA case vets' discretion. This policy continued in 2023.

Table 3.3.7 Number of animals (herds) receiving an IFN-γ test in 2023, by risk area and testing reason. Test types included Miscellaneous (VE-IFN, VE-IFN_ANOM, VE-IFN_BOV_OTH, VE-IFN_FLEX, VE-IFN_NSR, VE-IFN_OTH_SP, VE-IFN_PRI, VE-IFN_PBCP, VE-IFN_NBCP), OTF-W outside HRA (VE-IFN_LOW_IN), Persistent OTF-W (VE-IFN_PERSI), Chronic breakdown management (VE-IFN_CHRONIC), and Recurrent testing (VE-IFN_RECUR). Number of herds tested are given in brackets.

Risk Area	Total	Miscellaneous	OTF-W outside HRA	Persistent OTF-W	Chronic Breakdown Management	Recurrent Incident
HRA	94,216 (642)	7,727 (82)	0 (0)	10,511 (57)	3,411 (26)	72,567 (477)
Edge Area	29,227 (254)	1,586 (19)	14,275 (143)	610 (6)	1,018 (3)	11,738 (83)
Edge 6m	15,422 (113)	1,546 (15)	2,049 (17)	471 (4)	1,018 (3)	10,338 (74)
Edge 12m	13,805 (141)	40 (4)	12,226 (126)	139 (2)	0 (0)	1,400 (9)
LRA	12,910 (114)	766 (12)	12,144 (102)	0 (0)	0 (0)	0 (0)
England	136,353 (10,10)	10,079 (113)	27,029 (245)	11,121 (63)	4,429 (29)	84,305 (560)

A total of 136,353 cattle from 1,010 herds were IFN-γ tested in England in 2023 and 4.5% (6,166) of those were positive. A total of 1,010 herds were tested and 742 (69%) disclosed at least one IFN-γ test positive animal. Both the number of individual animals, and the number of herds receiving IFN-γ tests in 2023 decreased slightly compared to 2022 (143,310 animals and 1,066 herds, with 5,567 test positive animals disclosed).

Due to the serious epidemic of avian influenza affecting poultry farms and other captive birds during 2022 and 2023, APHA could not deliver some mandatory and discretionary IFN-γ tests. For example, second and third rounds of IFN-γ testing were not applied in some of the eligible herds, while in some herds only specific epidemiological groups were tested, rather than all animals over six months of age.

Since 2014, the overall percentage of IFN-γ test positive animals has fluctuated between 4% and 6%. Historically (prior to 2018) there were notable differences between risk areas in the test positive rate, with generally much higher rates in HRA herds compared to the LRA and Edge area (Figure 3.3.8). However, the test positive percentage in the HRA has seen a general decline between 2015 (19%) and 2018 (6%) and since then the rate has been more similar and following a similar temporal trend across all risk areas. In 2023, the percentage of IFN-γ test positive animals was 5% in the HRA, and 3% in both the Edge Area and LRA (Figure 3.3.8). This is likely to reflect the increase in IFN-γ testing in the HRA from 2018 onwards (thus increasing the denominator), largely underpinned by a sharp increase in mandatory IFN-γ testing in BCP areas, which was introduced in 2017.

Figure 3.3.8. Number of animals tested and proportions of animals IFN-γ test positive by risk area, 2013 to 2023.

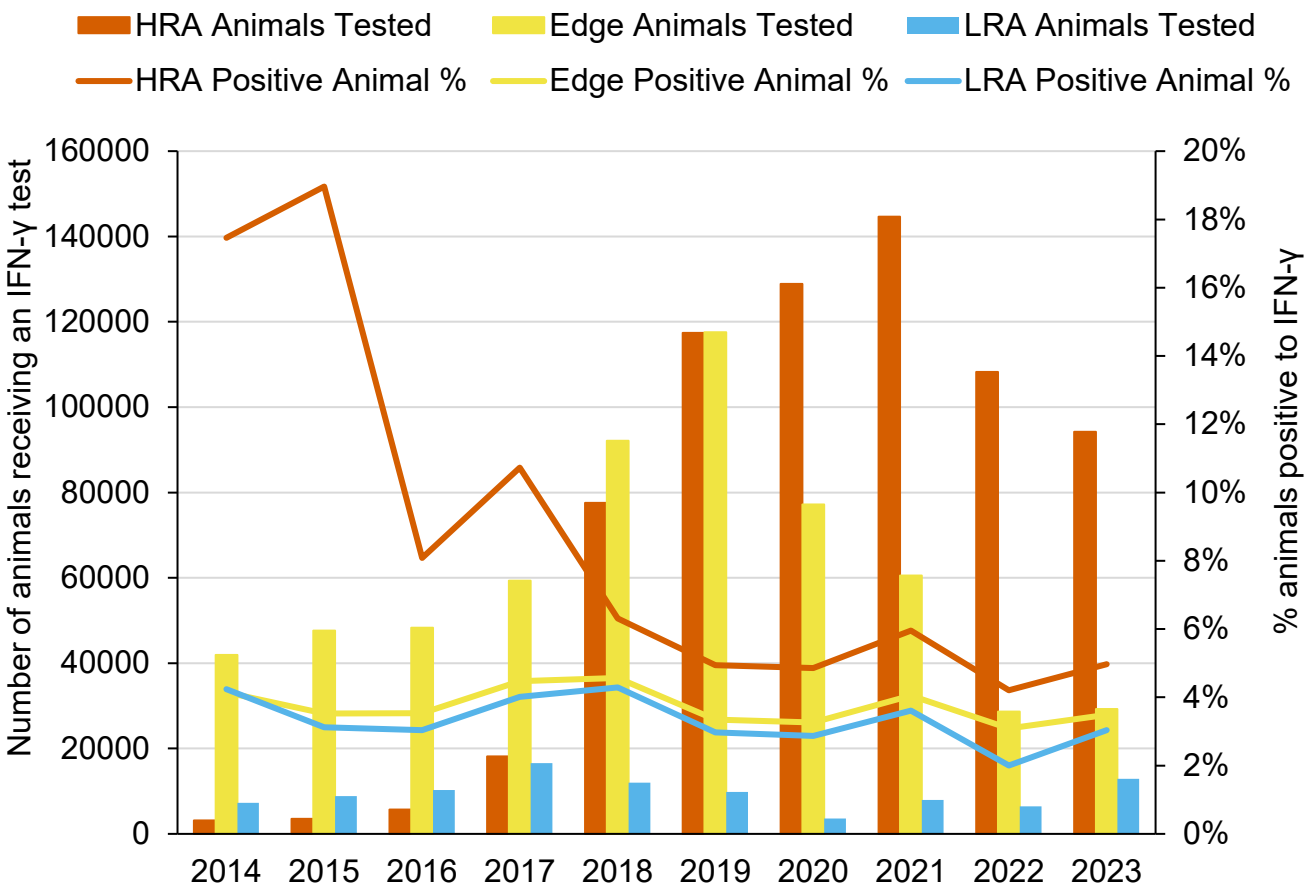


Figure 3.3.8. description: Number of animals tested and proportions of animals IFN-γ test positive by risk area, 2014 to 2023. A dual chart showing the number of animals tested by risk area between 2014 and 2023 as bars on the figure. The proportion of animals that were tested positive is shown as a line for each risk area. A breakdown of the trends shown in the figure are described in the text.

In recent years there continues to be a decline in the number of herds undergoing IFN- γ testing in the HRA, whereas number of herds tested in the Edge Area appears to be increasing slightly, though this is still much lower than within HRA. Despite these trends in the numbers of herds tested, the percentage of test-positive herds seems fairly stable in the Edge Area and HRA. In the LRA, there has been some fluctuation in the percentage of positive herds , where the number of herds being tested remained low and stable (Figure 3.3.9).

Figure 3.3.9. Number of herds tested with IFN-γ and proportion of these herds with at least one IFN-γ positive animal by risk area, 2013 to 2023.

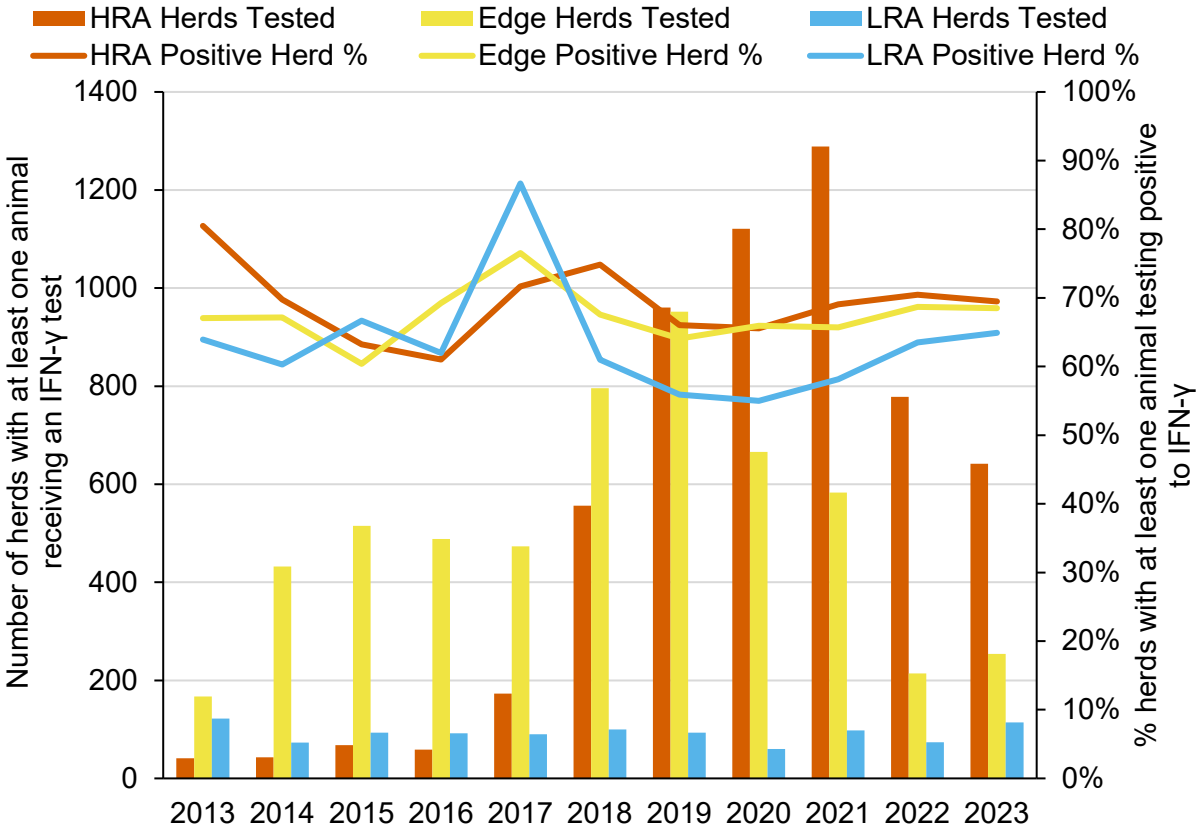


Figure 3.3.9 description: Number of herds tested with IFN-γ and proportion of these herds with at least one IFN-γ positive animal by risk area, 2013 to 2023. A dual chart showing the number of herds tested by risk area between 2014 and 2023 as bars on the figure. The proportion of herds that were tested positive is shown as a line for each risk area. A breakdown of the trends shown in the figure are described in the text.

4. The TB epidemic in the three risk areas of England

4.1 Epidemiology of TB in the High Risk Area

- The High Risk Area (HRA) accounted for 76% of all new TB incidents declared in England in 2023 compared to 78% in 2022.
- The total number of new TB incidents detected in the HRA in 2023 (n=1,855) decreased significantly ($p<0.001$) by 19.1% compared to 2022 (n=2,294).
- Herd incidence rate in the HRA fell from 14.4 TB incidents per 100 herd years at risk (HYR) in 2022, to 13.2 in 2023. This change was statistically significant ($p = 0.003$) and the value for 2023 represented the lowest annual herd incidence rate recorded in the HRA since 2006.
- The herd incidence rate decreased in all but three of the 11 counties of the HRA in 2023 compared to 2022.
- The following counties saw a statistically significant change in incidence rate in 2023 compared to 2022: Shropshire (27% reduction) and Hereford and Worcester (24% reduction).
- The lowest incidence rates in the HRA counties in 2023 were observed in Staffordshire (9.8 TB incidents per 100 HYR), Somerset (11.1), and Dorset (11.7). The highest rates were recorded in Gloucestershire (16.9), Wiltshire (16.2) and Devon (15.6).
- The overall average monthly herd prevalence for the HRA decreased significantly from 9.1% in 2022 to 8.0% in 2023 ($p<0.001$). The end of year herd prevalence also decreased significantly from 8.5% in 2022 to 8.0% in 2023.
- The following counties had the highest end of year herd prevalence in 2023: Gloucestershire (10.4%), Wiltshire (10.1%), Avon (9.2%) and Devon (9.2%), whereas West Midlands (1.3%), Staffordshire (5.5%) and Somerset (5.6%) experienced the lowest herd prevalence.
- Compared to other HRA counties in 2023, Devon had the highest number of herds (24% of all HRA herds) and experienced the highest percentage of all new TB incidents (28%). This was followed by Cornwall, which had 14% of HRA herds and 14% of new TB incidents.
- The median duration of herd TB incidents in the HRA was 203 days in 2023, which was significantly longer than in 2022 (189 days).
- For TB incidents ending in 2023, counties experiencing the longest incidents on average were: Avon (242.5 days), Wiltshire (226 days), and Hereford and Worcester (209.5 days).
- Based on TB incidents still ongoing at the end of 2023, the percentage of TB incidents that were persistent (lasting more than 550 days) increased in the HRA

overall (7.1% in 2023) ($p<0.001$) and in five HRA counties compared to 2022, but decreased in six HRA counties.

- The HRA counties with the highest percentage of persistent TB incidents in 2023 were: Avon (13.8%), Shropshire (13.2%) and Wiltshire (12.9%). The single TB incident recorded in West Midlands in 2023 was also persistent.
- Of all IFN-γ tests carried out in England in 2023, 69% (n=94,216) involved cattle kept in the HRA.
- The number of IFN-γ tests carried out on animals in the HRA in 2023 decreased by 13% from 2022 (n=108,248) and by 35% compared to 2021 (n=144,621).
- The HRA county where the highest number of IFN-γ tests were completed in 2023 was Devon (n=24,726; 26% of HRA tests). This was a 32% increase compared to 2022. The number of tests also increased by 64% in Wiltshire.
- Most incidents (72%, OTF-W and OTF-S) in the HRA did not have WGS data available (n=1,341). The remaining 28% of incidents (OTF-W only by virtue of requiring a culture result) had WGS data available for analysis.
- For 18% of new incidents in the HRA in 2023 (326 incidents, representing 64% of incidents with WGS data available), a local transmission event was identified from WGS data.
- Counties with the highest percentage of incidents associated with a local transmission event were Hereford and Worcester (41 incidents, 26%), Shropshire (41 incidents, 25%), and Staffordshire (34 incidents, 24%).

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 Area. All these counties (Cheshire, Derbyshire, East Sussex, Oxfordshire and Warwickshire) were moved fully into the Edge Area, reducing the size of (and number of cattle herds in) the HRA. Data reported in this chapter are for the 11 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 in parts of counties that were formerly in the HRA but are now fully in the Edge Area.

From July 2021, default six monthly herd testing was rolled out across the HRA (with the first additional tests taking place in January 2022), having been first introduced in Staffordshire and Shropshire in September 2020 (effectively from March 2021). Prior to this change to the TB surveillance regime, all OTF herds in the HRA were tested annually. Even so, cattle herds in the HRA at lower risk of a TB breakdown have the option to remain on annual surveillance testing if they meet one of the ‘earned recognition’ criteria. More information is available on the TB hub (Six-monthly surveillance testing of cattle herds in the High Risk Area–- Bovine TB | TB Hub).

Defra’s overall objective for the HRA is to continue to reduce TB incidence year on year so that all of its counties can be declared officially free from TB in cattle by the end of 2038.

Officially TB Free status is achieved by having 99.8% of herds retaining OTF status for three consecutive years, as defined in the [WOAH Terrestrial Code Article 8.12.4]

Figure 4.1.1 Map of HRA counties in 2023, showing the former HRA sections of five counties that straddled the HRA and Edge Area between 2013 and 2017, and locations of new TB incidents detected in the HRA in 2023.

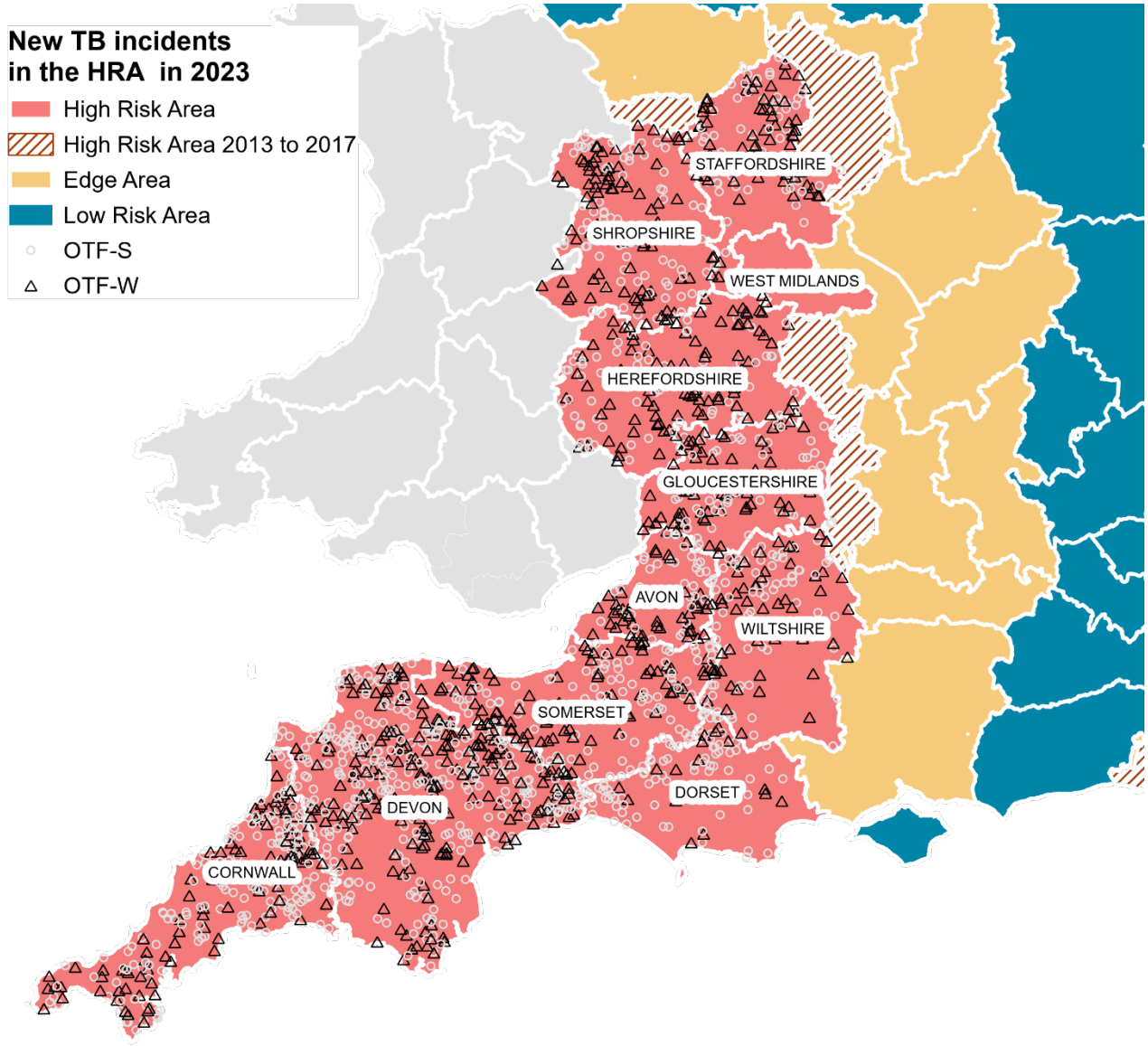


Figure 4.1.1 description: Decorative map of HRA counties in 2023, showing the former HRA sections of five counties that straddled the HRA and Edge Area between 2013 and 2017, and locations of new TB incidents detected in the HRA in 2023. The incidents are spread throughout the HRA.

In this chapter, TB incidents are mostly reported with no distinction between their post-mortem status, i.e. lesion and/or PCR test- or culture-positive incidents (OTF-W), or lesion and PCR test- or culture-negative incidents in which infection with *M. bovis* was strongly suspected (OTF-S). This is due to the high positive predictive value of the comparative

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

The statistical methods used throughout this chapter to compare epidemiological parameters between years and over longer periods of time are described in detail in the Explanatory Supplement. Briefly, the tests used were:

- the chi-squared test to compare changes in number of new TB incidents between years
- the incidence rate ratio (IRR) to assess changes in incidence rate
- the K-sample equality of medians test to evaluate changes in median duration
- the z-test to determine differences in prevalence

The herd TB incidence rate in the HRA in 2023 was 13.2 incidents per 100 HYR, an 8% decrease compared to the rate in 2022 (14.4). This decrease was significant (IRR 0.92, p=0.003) (Table 4.1.1).

Table 4.1.1 Headline TB epidemiological parameters for the HRA in 2023

Year	Total number of new TB incidents (OTF-W incidents)	Herd incidence rate	Median TB incident duration (days) (interquartile range)	Herd prevalence (average monthly)
2023	1,855 (805)	13.2	203 (166 to 293)	8.0
2022	2,294 (1,079)	14.4	189 (163 to 278)	9.1
Change (%)	-19.1%	-8.3%	+7.4%	-12.1%
Statistical significance	p<0.001	p=0.003	p<0.001	p<0.001

Number of new TB incidents

The annual number of new TB incidents is important in terms of disease control resource planning and the number of farm businesses impacted. During 2023, as in 2022, most herds in the HRA received two routine herd tests. This compares to just one routine test in previous years. The increase is due to a change in the TB herd surveillance regime from annual to six monthly testing implemented in Staffordshire and Shropshire from September 2020 and across all other HRA counties from July 2021. Increasing the default testing frequency of cattle herds in the HRA from annual to six monthly enables TB-infected herds to be identified sooner, thus minimising the probability of within and between-herd spread.

The number of new TB incidents disclosed in 2023 was highest in Devon (522), followed by Cornwall (258), and Somerset (186), whilst West Midlands (1), Avon (76) and Dorset (97) recorded the lowest number of incidents (Figure 4.1.2). The number of new TB incidents decreased in all eleven HRA counties in 2023 compared to 2022. This decrease was statistically significant in four counties: Cornwall (258 vs 337 TB incidents in 2023 and

2022 respectively, p=0.002), Devon (522 vs 607, p=0.018), Hereford and Worcester (161 vs 239, p<0.001) and Shropshire (166 vs 231, p=0.001).

Despite some fluctuations over time, all counties saw decreases in the number of new TB incidents in 2023 compared to five years ago, except for the West Midlands (one incident in 2019, one in 2023) (Figure 4.1.2). However, the West Midlands contains very few herds and cattle compared to the other counties (see Figure 4.1.6). Most other counties saw a reduction of at least 15% in the number of new TB incidents over the past five years, except for Gloucestershire where the reduction was more modest (2%). The greatest relative reduction was seen in Staffordshire (51%) and Avon (35%). Over a quarter (28%) of all new TB incidents in the HRA in 2023 were in Devon, but new incidents in this county fell by 16% between 2019 and 2023 (621 vs 522 incidents).

Figure 4.1.2 Annual total number of new TB incidents (OTF-W and OTF-S) by HRA county 2019 to 2023. Counties are ranked by total TB incidents in 2023. Number of TB incidents in 2023 are in parentheses next to the county name.

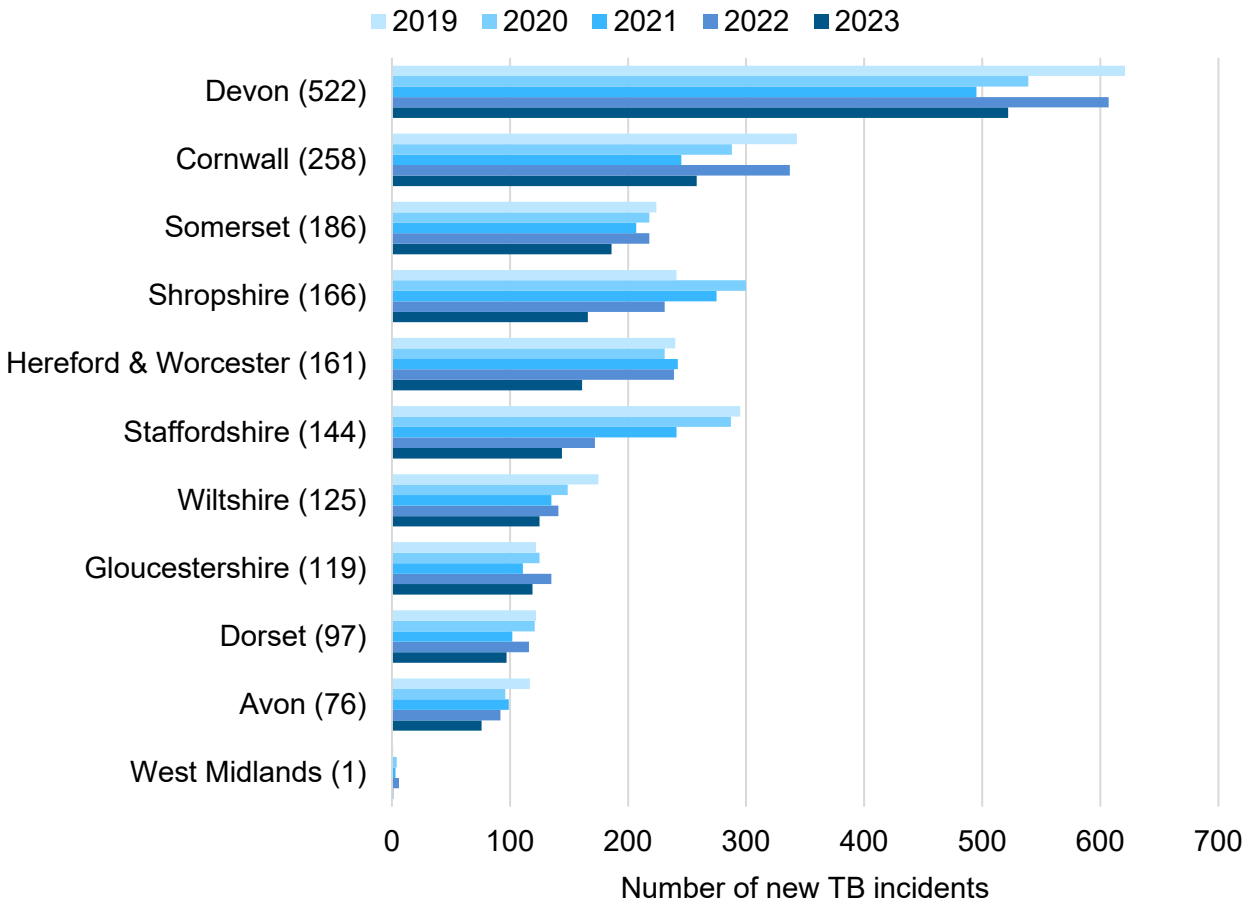


Figure 4.1.2 description: Bar chart showing the annual total number of new TB incidents (OTF-W and OTF-S) by HRA county 2019 to 2023. Counties are ranked by total TB incidents in 2023. In 2023, Devon had the most incidents in 2023 in the HRA.

Across the HRA overall, 43% of new TB incidents in 2023 were OTF-W. This was a reduction compared to 2022 (47%) and continued a declining trend in this parameter over the last five years, which is also evident for most counties individually (Figure 4.1.3). The counties with the highest percentage of OTF-W incidents in 2023 were the West Midlands (100%), Avon (57%) and Hereford and Worcester (57%). The county with the lowest percentage of OTF-W incidents in 2023, by a considerable margin, was Dorset (18%, falling from 30% in 2022). There was also a marked reduction in percentage of OTF-W incidents in Cornwall, from 54% in 2022 to 37% in 2023. Counties where the percentage of OTF-W incidents increased in 2023 compared to 2022 were Hereford & Worcester (54% in 2022, 57% in 2023) and Shropshire (51% in 2022, 52% in 2023).

Figure 4.1.3 Percentage of new TB incidents that were OTF-W in each HRA county, 2019 to 2023. Counties are ranked by total TB incidents in 2023. Percentage of OTF-W in 2023 are in parentheses next to the county name.

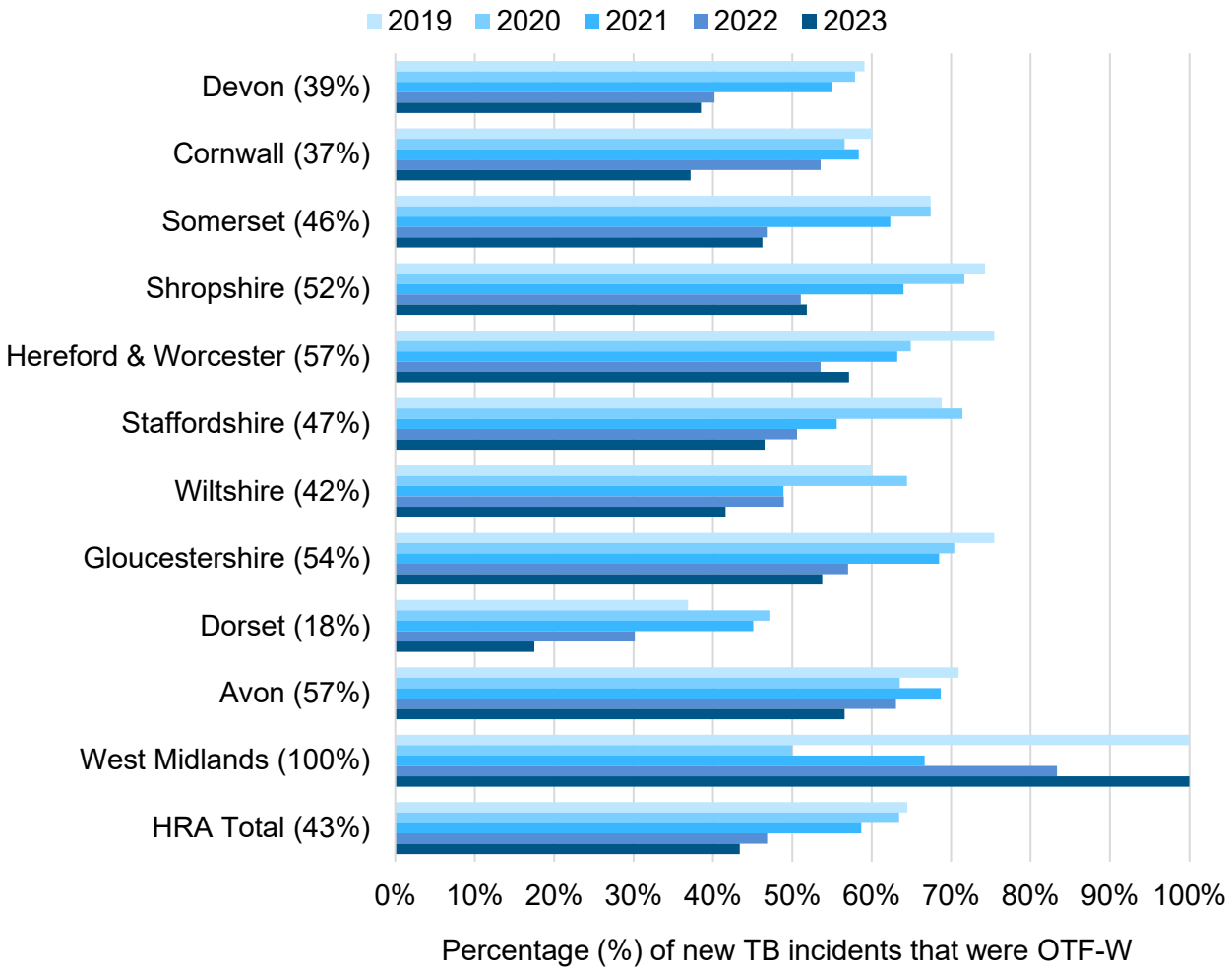


Figure 4.1.3 description: Bar chart showing the percentage of new TB incidents that were OTF-W in each HRA county, 2019 to 2023. In 2023, all incidents (100%) in the West Midlands were OTF-W, followed by 57% of incidents in Avon and 57% in Hereford & Worcester.

TB herd incidence rate by county

The preferred measure of disease occurrence is the number of new TB incidents per 100 HYR, i.e. the rate at which new TB incidents occur in the population of herds at risk. Figure 4.1.4 shows TB incidence rate for each HRA county in 2023 and how this has changed over time since 2019.

In the HRA overall, TB incidence rate in 2023 was 13.2 incidents per 100 HYR, a statistically significant decrease compared to 2022 (14.4) and the lowest recorded level since 2006 (11.0). The highest county-level incidence rates in 2023 were observed in Gloucestershire (16.9), Wiltshire (16.2) and Devon (15.6), and the lowest in Staffordshire (9.8), Somerset (11.1) and Dorset (11.7).

TB incidence rate decreased in 2023 compared to 2022 in eight HRA counties. Most reductions were non-significant, but statistically significant declines occurred in Shropshire (16.7 TB incidents per 100 HYR in 2022 to 12.1 in 2023, 27% reduction, p=0.002) and Hereford and Worcester (16.3 in 2022 to 12.4 in 2023, 24% reduction, p=0.007). Incidence rate fell for the fourth consecutive year or more in Avon and Somerset, the third consecutive year in Staffordshire and Shropshire, and the second consecutive year in Hereford and Worcester (Figure 4.1.4).

By contrast, the TB incidence rate rose in 2023 compared to 2022 in Gloucestershire, Devon, and Wiltshire, but none of these increases were significant. This was the first increase seen in Wiltshire in the past five years, and the second consecutive year of increases in Gloucestershire and Devon.

Figure 4.1.4 TB incidence rate (new TB incidents per 100 HYR) for the HRA overall and each HRA county, 2019 to 2023. Counties are ranked by incidence rate in 2023. Incidence rate estimates for 2023 are in parentheses next to county names

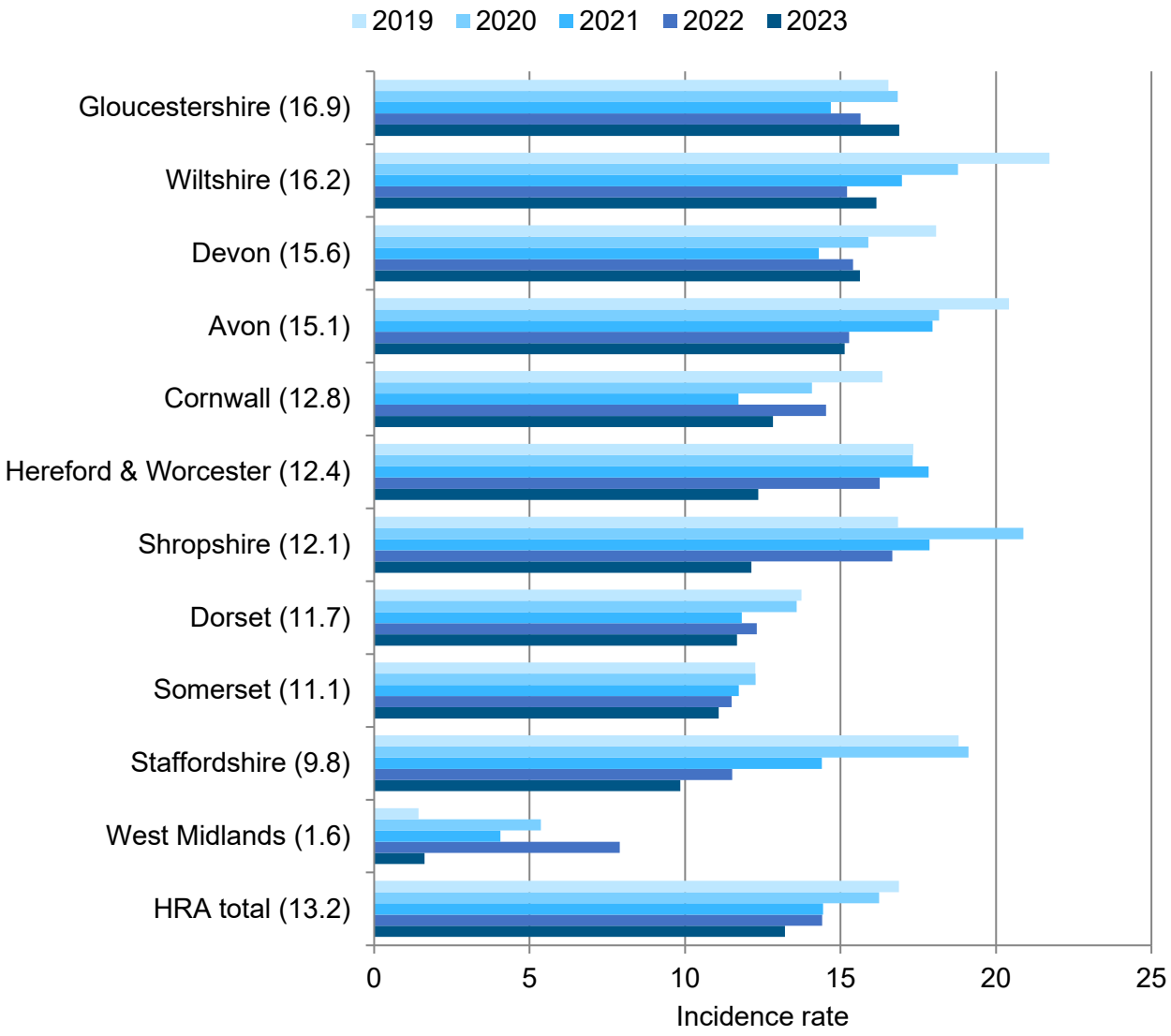


Figure 4.1.4 description: Bar chart showing the TB incidence rate (new TB incidents per 100 HYR) for the HRA overall and each HRA county, 2019 to 2023. The incidence rate was highest in Gloucestershire at 16.9 new TB incidents per 100 HYR. The HRA average was 13.2.

TB herd prevalence by county

Prevalence reflects the percentage of herds that are restricted due to TB at a given point in time. Two different estimates of TB prevalence are reported here. The end of year herd TB prevalence is a point prevalence, reported here for the 31st December in each year. Prevalence values reflect collective variation in the incidence rate, the duration of TB

incidents, and the timing of the start of the incident. Further notes on the methodology of incidence rate and prevalence measures are described in the Explanatory Supplement.

In the HRA overall, the end of year TB prevalence in 2023 was 7.9%. It was significantly lower than in 2022 (8.4%, p=0.034) and represents the sixth consecutive year of decline (Figure 4.1.5).

At the county level, Gloucestershire had the highest end of year prevalence in 2023 (10.4%), whereas the lowest prevalence was seen in Staffordshire (5.5%) and the West Midlands (1.3%) (Figure 4.1.5).

In line with the overall trend in the HRA, end of year prevalence decreased from 2022 to 2023 in eight HRA counties. Most of these county level declines were non-significant, but there was a significant decrease in Shropshire (10.5% in 2022 to 7.8% in 2023, p=0.005). Notably, prevalence continued to fall in Avon, and having previously been the county with highest prevalence (10.8% in 2022 and 12.6% in 2021) it had only the third highest prevalence in 2023 (9.2%). Non-significant increases in end of year prevalence relative to 2022 were seen in Devon (9.1% in 2022 to 9.2% in 2023), Gloucestershire (9.2% to 10.4%), and Dorset (6.2% to 7.2%) (Fig 4.1.5).

Figure 4.1.5 End of year herd TB prevalence for the HRA overall and for each HRA county, 2019 to 2023. Counties are ranked by order of prevalence in 2023. Prevalence estimates for 2023 are in parentheses next to county names.

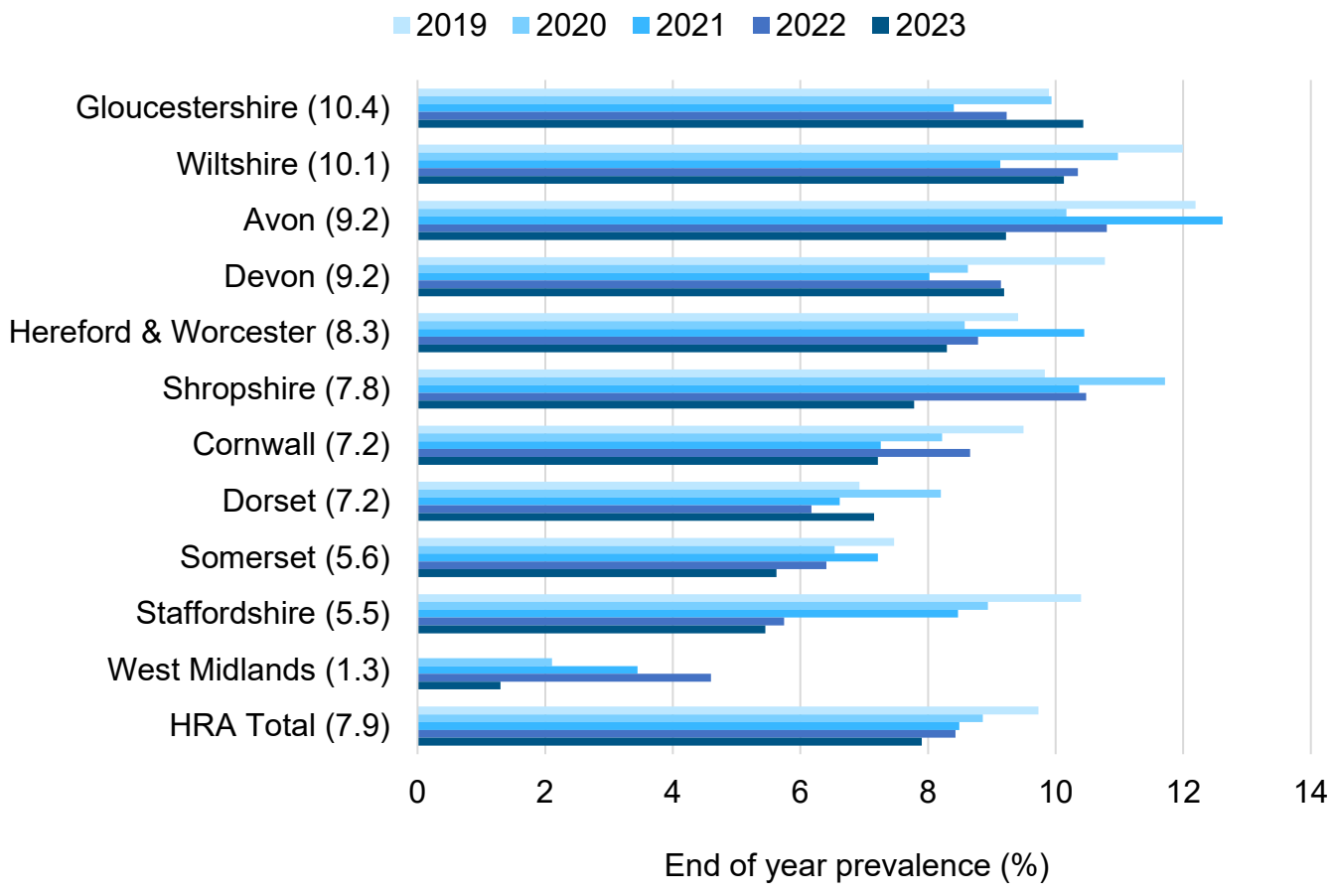


Figure 4.1.5 description: Bar chart showing the end of year herd TB prevalence for the HRA overall and for each HRA county, 2019 to 2023. Gloucestershire had the highest prevalence, at 10.4% of herds under TB restrictions at the end of the year. The HRA average was 7.9%.

Cattle 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 land fragmentation on farms (Broughan et al., 2016). The total number of cattle (i.e., the cattle population) is a crude demographic measure, as the cattle distribution and management within herds can influence the risk of disease.

In 2023, as in previous years, the number of new TB incidents per county in the HRA generally increased with the number of cattle and number of cattle herds (compare Figure 4.1.6 and Figure 4.1.2, and see Figures 3.2.1a and b in Chapter 3.2 ‘Characteristics of herds found infected with TB’). For example, Devon incurred 28% of all new TB incidents in the HRA in 2023, containing 24% of herds and 25% of all cattle in the HRA. Cornwall was the county with the second highest percentage of all TB incidents in the HRA (14%) and contained 14% of herds and 13% of the cattle population in the HRA (Figure 4.1.6).

However, there were exceptions to this pattern. Hereford and Worcester had slightly more new TB incidents in 2023 than would be expected when considering the number of herds and cattle in the county, though this was not as apparent as in 2022. By contrast, both Dorset and Staffordshire had fewer new TB incidents than may have been expected by their respective numbers of registered cattle herds.

Figure 4.1.6 Total Number of cattle (x100) and herds in HRA counties in 2023. Counties ranked by new TB incident totals (in parentheses next to county name)

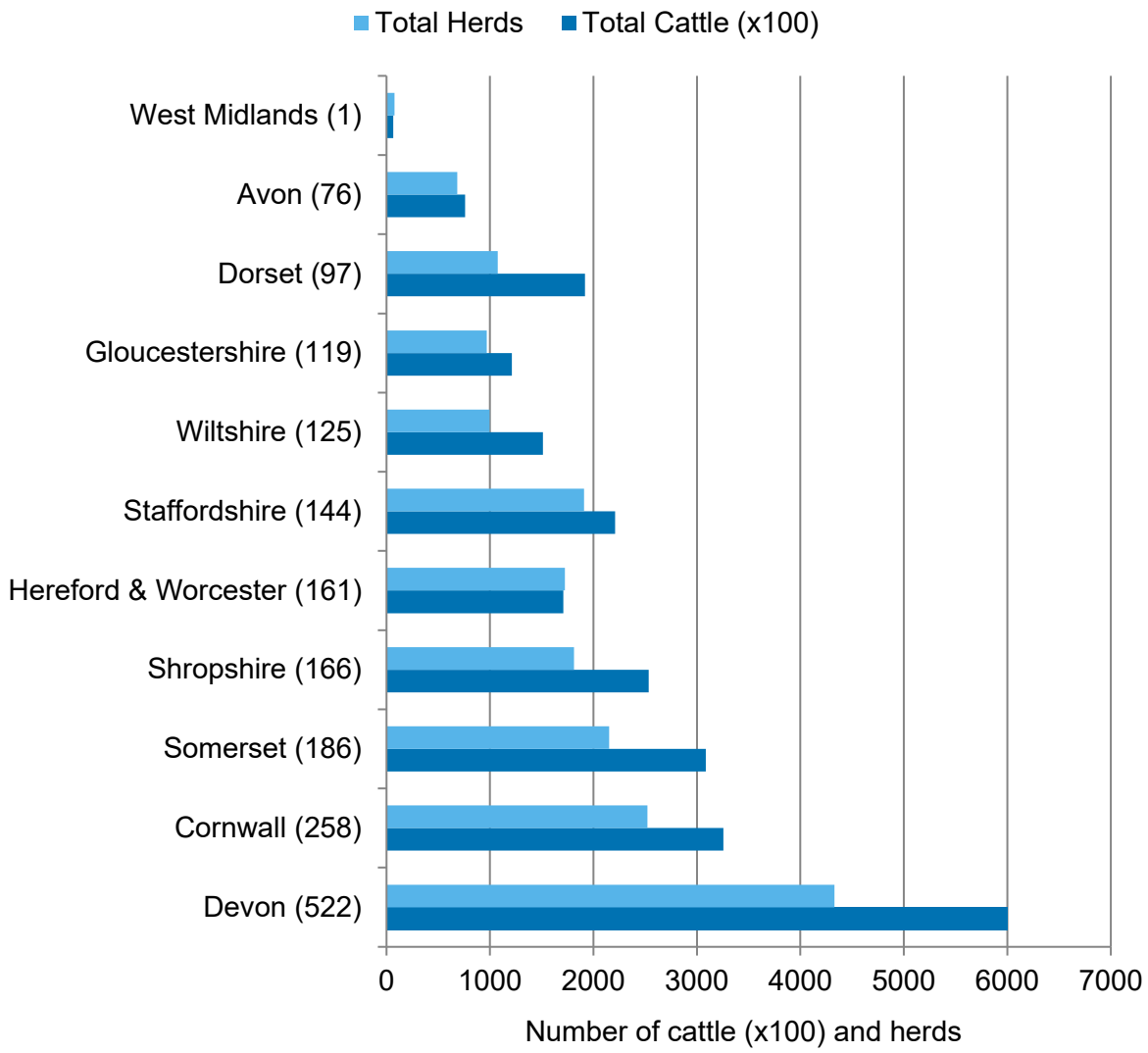


Figure 4.1.6 description: Bar chart showing the total Number of cattle (x100) and herds in HRA counties in 2023. Devon had the highest number of total herds and total cattle in the HRA in 2023.

In 2023, 7.2% of herds in the HRA were considered to be large (herd size of 301-500 animals) and 5.1% were very large (herd size >500 animals). These are very similar to the percentages seen in 2022 (7.2% large and 4.8% very large herds). Wiltshire had the highest percentage of large herds in the HRA in 2023 (8.9%, 89 herds), followed by Dorset (8.6%, 92 herds) (Figure 4.1.7). This differs from 2022, where Dorset had the highest and Wiltshire the second highest percentage of such herds. Hereford and Worcester (4.2%, 73 herds) and West Midlands (3.9%, 3 herds) had the lowest percentage of large herds in 2023, which is consistent with 2022 and 2021.

Although analyses confirm that larger herds are at higher risk of becoming infected, the presence of more large herds alone cannot explain the higher incidence rate in the HRA.

Some HRA counties with a high percentage of large herds had a relatively low incidence rate; for example, Dorset had the second highest percentage of large herds (8.6%) and highest percentage of very large herds (8.1%) (Figure 4.1.7), but was ranked 8th for TB incidence rate per 100 HYR in the HRA in 2023 (Figure 4.1.4).

Figure 4.1.7 Percentage of herds that are large (301-500 animals) and very large (>500 animals), by HRA county, in 2023. Counties ranked by percentage of herds with >300 cattle. Incidence rate is shown in parentheses next to the county name.

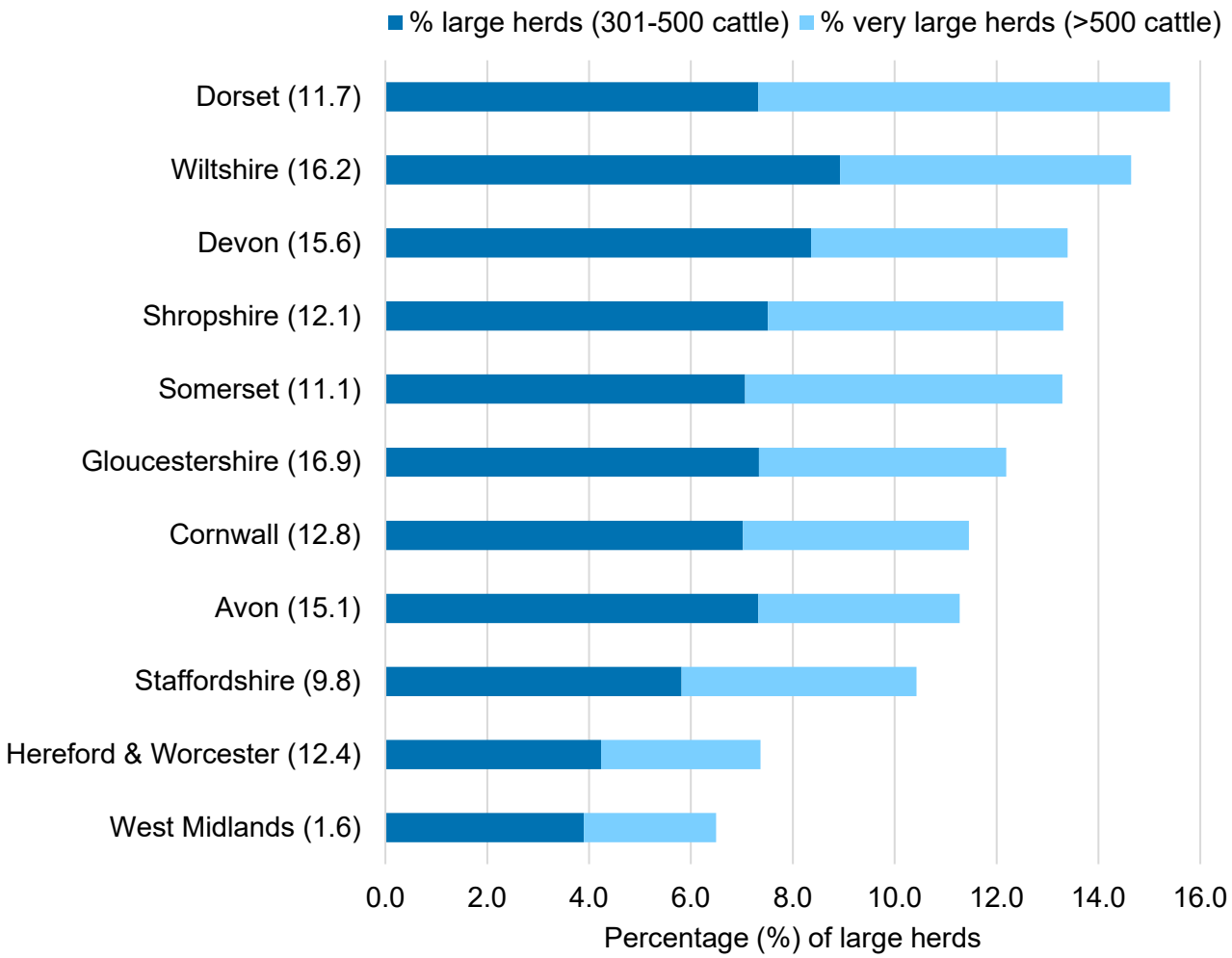


Figure 4.1.7 description: Percentage of herds that are large (301-500 animals) and very large (>500 animals), by HRA county, in 2023.

TB incident duration and persistent TB incidents

A total of 2,029 TB incidents (including OTF-W and OTF-S) ended in the HRA in 2023. Figure 4.1.8 shows the median duration of these incidents by HRA county. Twelve of the 2,029 TB incidents involved approved finishing units (AFUs) and so were excluded from the median duration calculations presented in Figure 4.1.8 due to the unique testing regimes operating in AFUs.

For all TB incidents ending in the HRA in 2023, the median duration was 203 days, 14-days longer than 2022 (189 days). The counties with the longest median duration for all TB incidents were Avon (242.5 days), Wiltshire (226 days), and Hereford and Worcester (209.5 days) (Figure 4.1.8). Avon also had the longest median duration in 2022 and 2021. Moreover, the median duration of incidents in all three of these counties in 2023 increased in relation to 2022.

As in previous years, the median duration of OTF-W TB incidents was longer than for OTF-S TB incidents across all HRA counties in 2023 (Figure 4.1.8). Dorset recorded the longest median duration for OTF-W incidents (272.5 days), whilst (excluding West Midlands, where only one OTF-W TB incident ended in 2023) Gloucestershire had the shortest (229 days). For OTF-S incidents, Avon had the longest median duration (203 days), with Staffordshire recording the shortest (172 days). Avon and Wiltshire ranked in the top three longest median duration for both OTF-W and OTF-S incidents. Conversely, despite having the longest OTF-W median duration, Dorset recorded the fourth lowest OTF-S median duration in 2023.

Figure 4.1.8 Median duration (days) of all TB incidents that ended in 2023 (all TB incidents, OTF-W incidents and OTF-S incidents), by HRA county. Counties ranked by the duration of all TB incidents (number of incidents in parentheses)

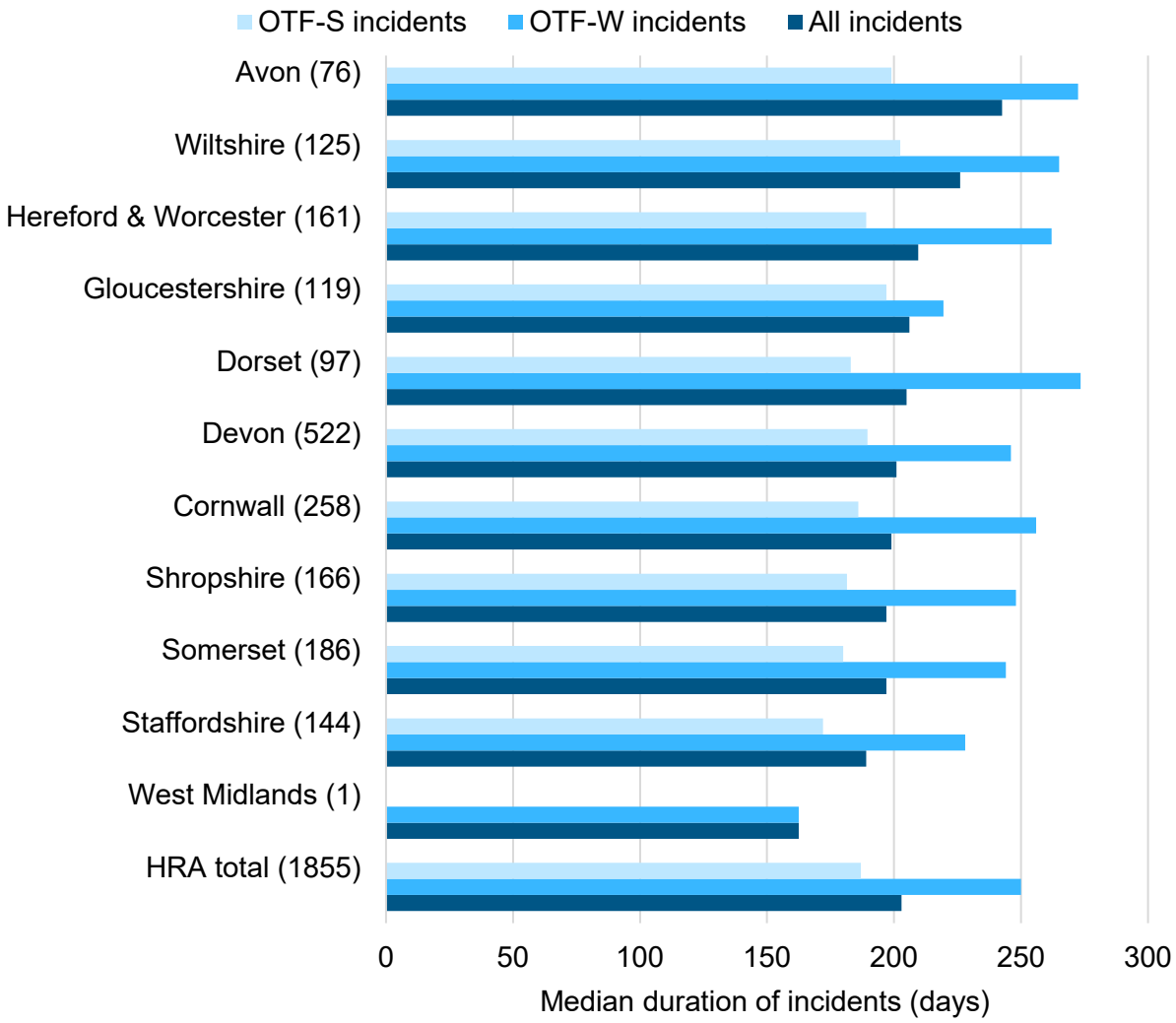


Figure 4.1.8 description: Bar chart showing the median duration (days) of all TB incidents that ended in 2023 (all TB incidents, OTF-W incidents and OTF-S incidents), by HRA county. The county with the highest median duration for all incidents was Avon; Wiltshire had the highest median duration for OTF-S incidents, and Dorset had the highest median duration for OTF-W incidents.

Figure 4.1.9 shows the median duration of all TB incidents (including AFUs) in each county, and how that has changed over time from 2019 to 2023. Over this period, median incident duration in the HRA overall declined by just three days, and for most counties it fluctuated around 200 days. However, there have been notable increases in incident duration over this period in Avon (+45.5 days) and Hereford and Worcester (+29 days), and an overall decline in incident duration in Dorset (-21.5 days). As a result, 2023 was the first year that Dorset did not rank in the top three for median duration since 2016, and the second year that Avon has recorded the highest median duration.

Overall, all counties saw an increase in median duration between 2022 and 2023. This is

despite the percentage of OTF-W incidents declining in the HRA in 2023 relative to 2022 (Figure 4.1.3). The largest county-level increases in median duration compared to 2022 were seen in Wiltshire (+41.5 days), Avon (+31.5 days), and Hereford and Worcester (+20 days) and Devon (+17 days). However, only the increases seen in Wiltshire and Devon were statistically significant (K-sample equality of medians test, p=0.016 and p=0.017, respectively).

Figure 4.1.9 Median duration (in days) of all TB incidents (including AFUs) that ended in each year between 2019 and 2023, by HRA county. Counties are ranked by median duration in 2023, with the 2023 median duration in brackets. Note: The high median duration in the West Midlands in 2019 (587 days) is truncated at 300 days and was due to only two TB incidents in that year, one of which was classified as persistent (>550 days).

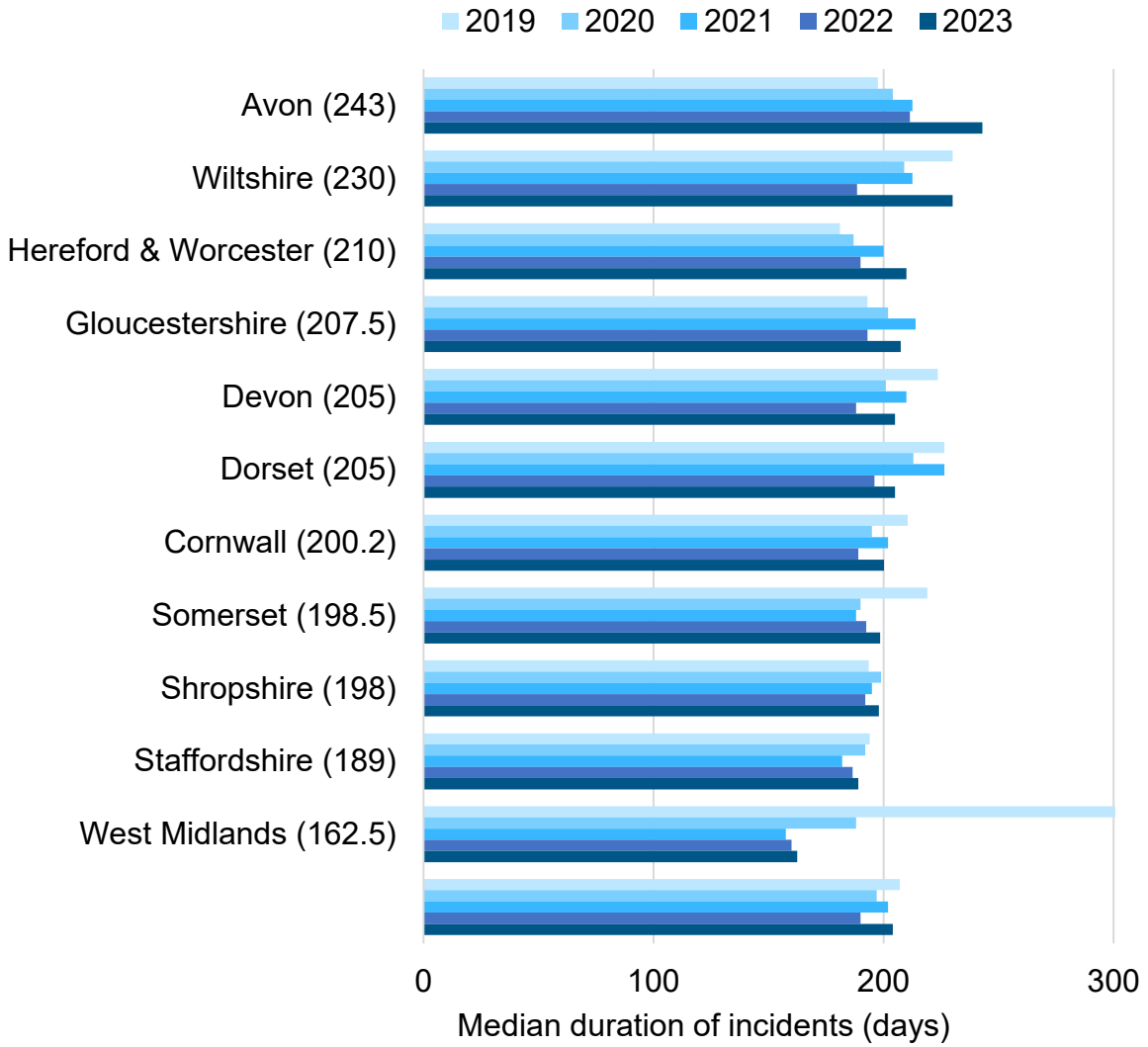


Figure 4.1.9 description: Bar chart showing the median duration (in days) of all TB incidents (including AFUs) that ended in each year between 2019 and 2023, by HRA county. In 2023, Avon had the highest median duration. The average duration in the HRA was 204 days.

TB incidents lasting for more than 550 days are considered to be persistent and affected herds are eligible for enhanced management procedures. During 2023, 111 persistent TB incidents were resolved in the HRA, however 93 were still ongoing at the end of the year. This is slightly lower than 2022, where 131 persistent TB incidents were resolved within the year, and 98 were still ongoing at the end of the year. Notwithstanding, in the HRA overall, 7.1% of all TB incidents that were still ongoing at the end of 2023 were classed as persistent. This was a small increase compared to 2022 (6.6%), although in general there has been a declining trend in the percentage of persistent incidents in the HRA since 2019 (when the percentage exceeded 10%, Figure 4.1.10).

Other than the West Midlands, where the single incident which remained open at the end of 2023 was persistent (i.e., 100% persistent incidents), the counties with the highest percentage of persistent TB incidents still open at the end of 2023 were Avon (13.8%), Shropshire (13.2%) and Wiltshire (12.9%). These were the same three counties that sustained the highest percentage of persistent TB incidents in 2022. In Shropshire and Wiltshire, the percentage of persistent TB incidents increased considerably compared to 2022, by 5.3% and 4.5%, respectively. However, in Avon the increase was smaller (a 1.3% increase compared to 2022). Nonetheless, Avon recorded in 2023 the highest percentage of persistent TB incidents for the previous three years, and persistence has been rising in the county since 2019 (8%).

The counties with the lowest percentage of persistent incidents in 2023 were Cornwall (2.8%), Gloucestershire (3.5%), and Somerset (3.6%). Both Cornwall and Gloucestershire featured in the three counties with the lowest percentage persistent TB incidents in 2022, where the percentage fell by 1.7% and 0.4% in 2023, compared to 2022, respectively. However, greater declines were seen in Somerset and Staffordshire, which experienced a 3.8% and 2.2% drop in percentage persistent TB incidents in 2023 compared to 2022, respectively.

Figure 4.1.10 Percentage of TB incidents still ongoing at the end of 2023 that were persistent (duration over 550 days), out of all TB incidents in each HRA county. Counties are ranked by percentage persistent incidents in 2023 (shown in parentheses). The high percentage of persistent TB incidents in the West Midlands in 2023 is due to a single TB incident still open at the end of the year, which was classified as persistent.

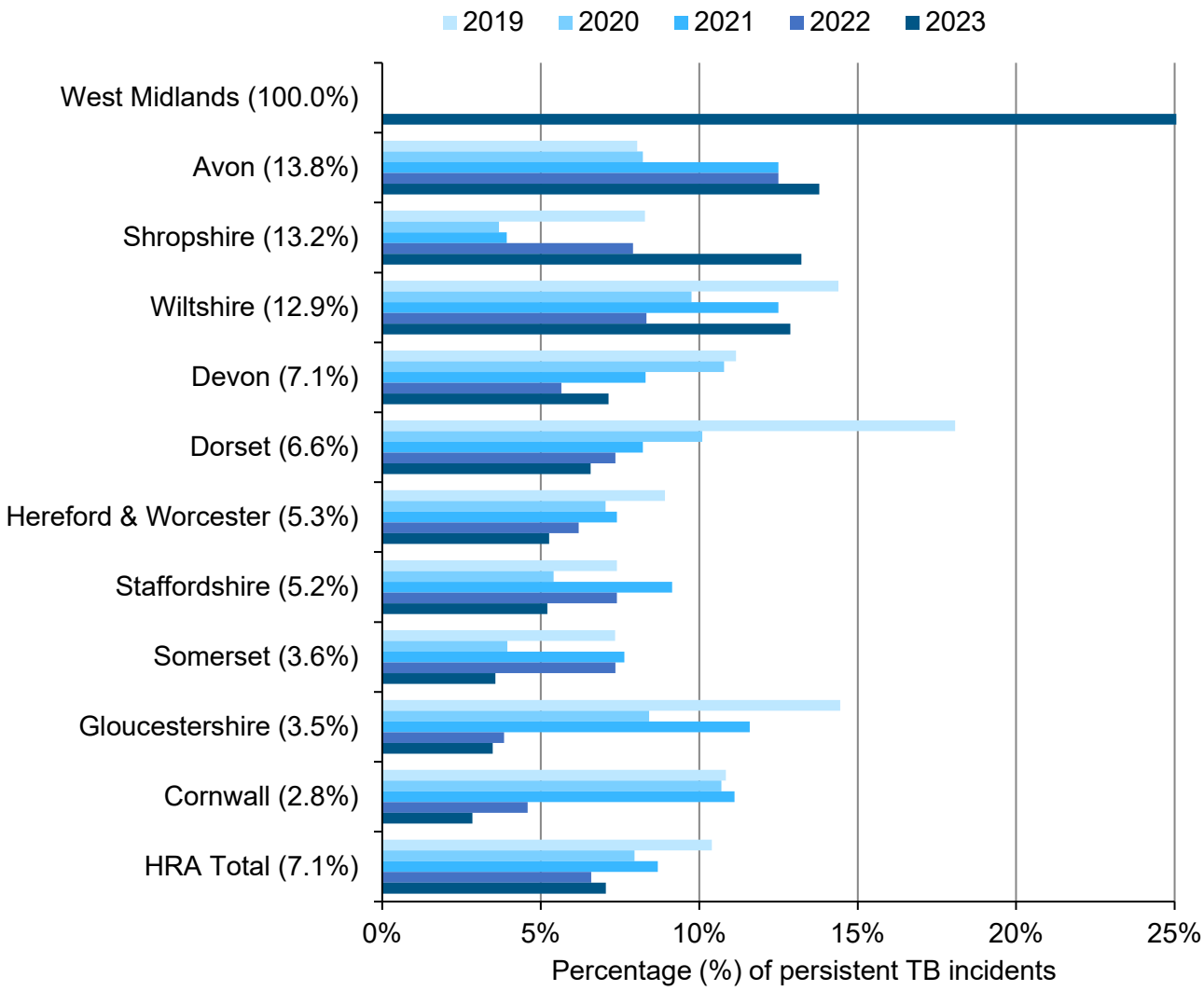


Figure 4.1.10 description: Bar chart showing the percentage of TB incidents still ongoing at the end of 2023 that were persistent (duration over 550 days), out of all TB incidents in each HRA county. The West Midlands had a single TB incident still open at the end of the year, which was classified as persistent, followed by Avon which had 13.8% of incidents classified as persistent.

Recurrence of TB infection

In 2023, 57% of new TB incidents in the HRA occurred in herds that had experienced at least one TB incident in the previous three years, a slight increase compared to 2022 (56%). As in previous years, the percentage of recurrent TB incidents in the HRA in 2023 was higher than in the Edge Area (52%) and LRA (21%).

The percentage of recurrence was highest in Staffordshire (67%), Shropshire (64%) and Dorset (62%), and lowest in Cornwall, Avon, Hereford and Worcester (all 53%) and the West Midlands (0%, none of one incident) (Figure 4.1.11).

Seven counties in the HRA saw an increase in the percentage of recurrent TB incidents in 2023 relative to 2022; increases were seen in Staffordshire, Dorset and Shropshire (8%, 6%, and 2% increase compared to 2022, respectively), where the percentage of recurrent TB incidents has been rising since 2019 (Fig 4.1.11). The remaining four counties experienced decreases or stayed unchanged in 2023 compared to 2022. The largest decline was seen in Avon (14% decrease compared to 2022), ending the increasing trend seen in the county between 2019 and 2022. This is the lowest percentage recurrent TB incidents recorded in Avon over the past five years, with the county previously observing the highest percentage in the HRA in 2021 and 2022.

At a county-level, the number of recurrent herds was highest in Devon (283 herds), Cornwall (128 herds) and Shropshire (101 herds). The number of recurrence herds in 2023 fell across all counties in 2023 compared to 2022, and this follows the trend of overall decline in the number of recurrent herds in the HRA in recent years (Appendix 1 Figure 5).

Figure 4.1.11 Annual percentage of recurrent TB incidents (incidents in herds which had a TB incident in the last three years), per HRA county, 2019 to 2023. Counties are ranked by highest percentage of recurrent incidents in 2023, with the percentage of recurrent incidents in the county in 2023 shown in parentheses.

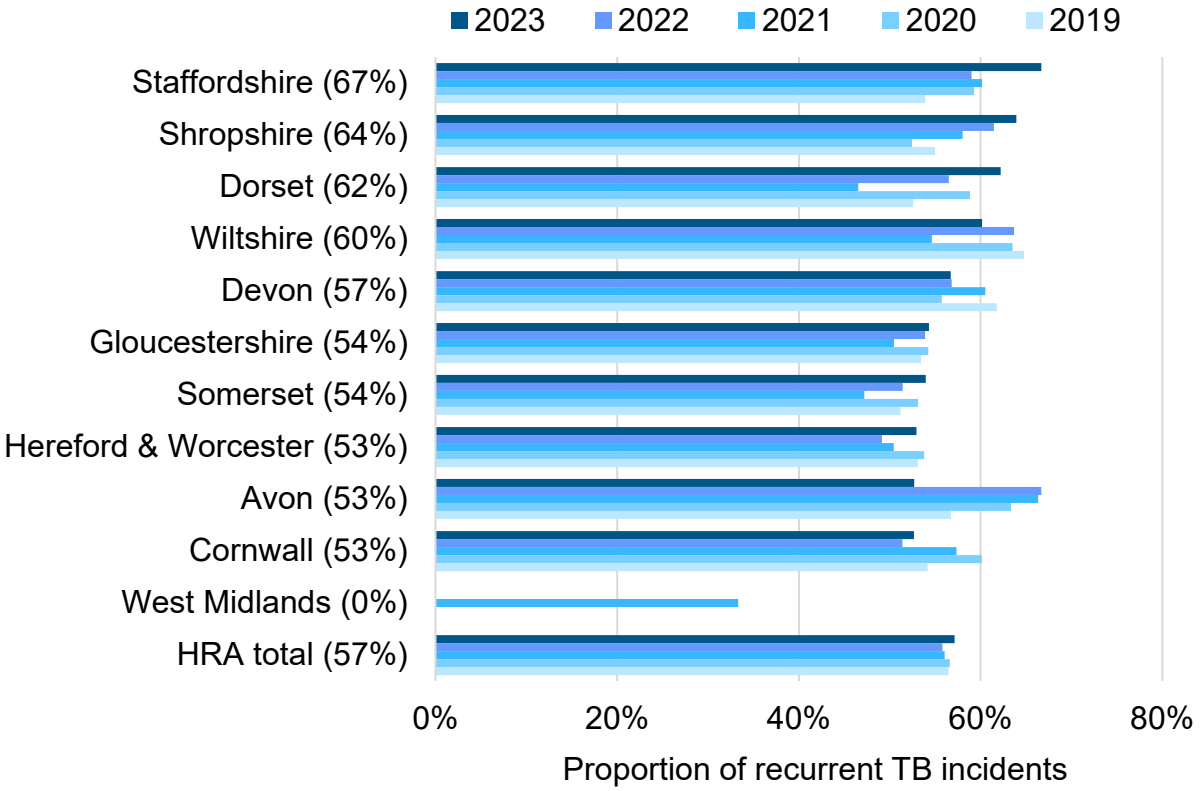


Figure 4.1.11 description: Bar chart showing the annual percentage of recurrent TB incidents (incidents in herds which had a TB incident in the last three years), per HRA county, 2019 to 2023. Staffordshire was ranked highest with 67% of incidents considered recurrent in 2023.

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, has led to additional cattle controls. These include 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 and/or culture results. This, along with the increased use of the IFN-γ blood test in OTF-W TB incidents in the HRA since April 2017, should help reduce recurrence due to residual cattle infection and may also reduce the severity of incidents. Other measures implemented in the HRA during this reporting period that may help reduce incident recurrence include the offer of bespoke farm biosecurity advice and control of the reservoir of infection in badgers through licensed culling and some vaccination (see badger control areas monitoring data).

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 4.1.12 shows the percentage of all TB incidents disclosed by each surveillance stream and county. In the HRA overall, the highest percentage of TB incidents were disclosed by Routine (tuberculin skin) herd tests (65.8%). Routine herd testing (performed every six or 12 months) was also the leading disclosing surveillance stream in all counties in the HRA in 2023, where it triggered over 60% of all TB incidents. Routine herd testing also disclosed the highest percentage of TB incidents in 2022 in the HRA overall (59.7%), and in all HRA counties, though at a slightly lower percentage compared to 2023.

The Area and Herd Risk surveillance stream detected the second highest percentage of TB incidents in the HRA (21.0%), with the highest percentage of TB incidents disclosed via this surveillance stream in Shropshire (29.5%), followed by Dorset (25.8%). Based on the number of TB incidents detected per 100 herd test events, the Area and Herd Risk surveillance stream was the most efficient at detecting TB incidents within the HRA compared to the three other streams, detecting 7.2 TB incidents per 100 herd tests in 2023 (Table 3.3.1a, Chapter 3.3 Finding Infected herds). At a more granular level, post-incident herd tests (carried out at approximately six and 18 months after restoration of OTF herd status) were the most efficient test types within the HRA overall (15.0 TB incidents per 100 herd tests) in 2023, followed by source tracing tests (12.9 TB incidents per 100 herd tests) (Table 3.3.3.a).

Tuberculin skin tests in the Trade and Other surveillance stream led to the fewest detections of TB in the HRA overall in 2023 (4.2%), with this stream finding the highest percentage of TB incidents in Dorset (8.2%) (Figure 4.1.12). This is similar to 2022, where tests in the Area and Herd Risk stream detected the second highest, and those in the Trade and Other surveillance stream the lowest percentage of TB incidents (26.5% and 3.7%, respectively).

Figure 4.1.12 Percentage of all TB incidents detected by each surveillance stream, by HRA county in 2023.

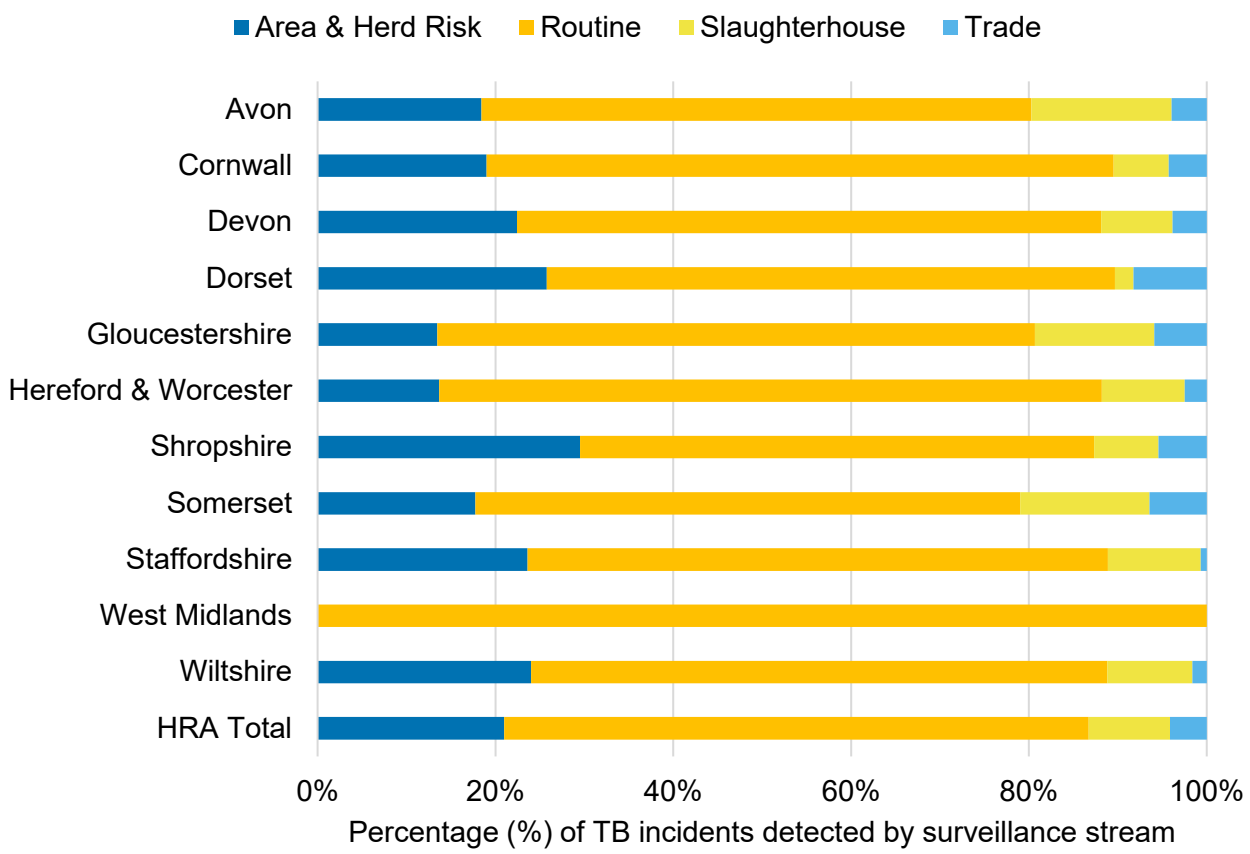


Figure 4.1.12 description: Bar chart showing the percentage of all TB incidents detected by each surveillance stream, by HRA county in 2023. Most incidents across all counties were disclosed by routine surveillance.

In the HRA overall, 9.1% of all TB incidents and 21.0% of OTF-W TB incidents were disclosed through routine post-mortem meat inspection of non-TB test reactor cattle in slaughterhouses in 2023, similar to the situation in 2022. Variation between counties can be seen in Figure 4.1.13. The counties with the highest percentage of OTF-W TB incidents disclosed by slaughterhouse (SLH) surveillance in 2023 were: Somerset (31.4%), Avon (27.9%), and Gloucestershire (25.0%). Both Somerset and Gloucestershire experienced rises in the percentage of OTF-W TB incidents disclosed by SLH surveillance, increasing by 9.8% and 2.9% compared to 2022, respectively.

Aside from the West Midlands, which had just one TB incident in 2023 (disclosed by a routine herd test), the counties with the lowest percentage of OTF-W incidents disclosed by SLH surveillance in 2023 were: Dorset (11.8%) and Shropshire (14.0%). Dorset observed a considerable fall in percentage of OTF-W TB incidents disclosed by SLH surveillance, a 16.8% decline compared to 2022. There was also a smaller decrease in Shropshire, falling by 3.8% compared to 2022.

Figure 4.1.13 Percentage of TB incidents disclosed by SLH surveillance (routine post-mortem meat inspection) in the HRA in 2023, for all TB incidents and OTF-W incidents, by HRA county. Counties are ranked by percentage TB incidents disclosed by SLH surveillance (shown in parentheses).

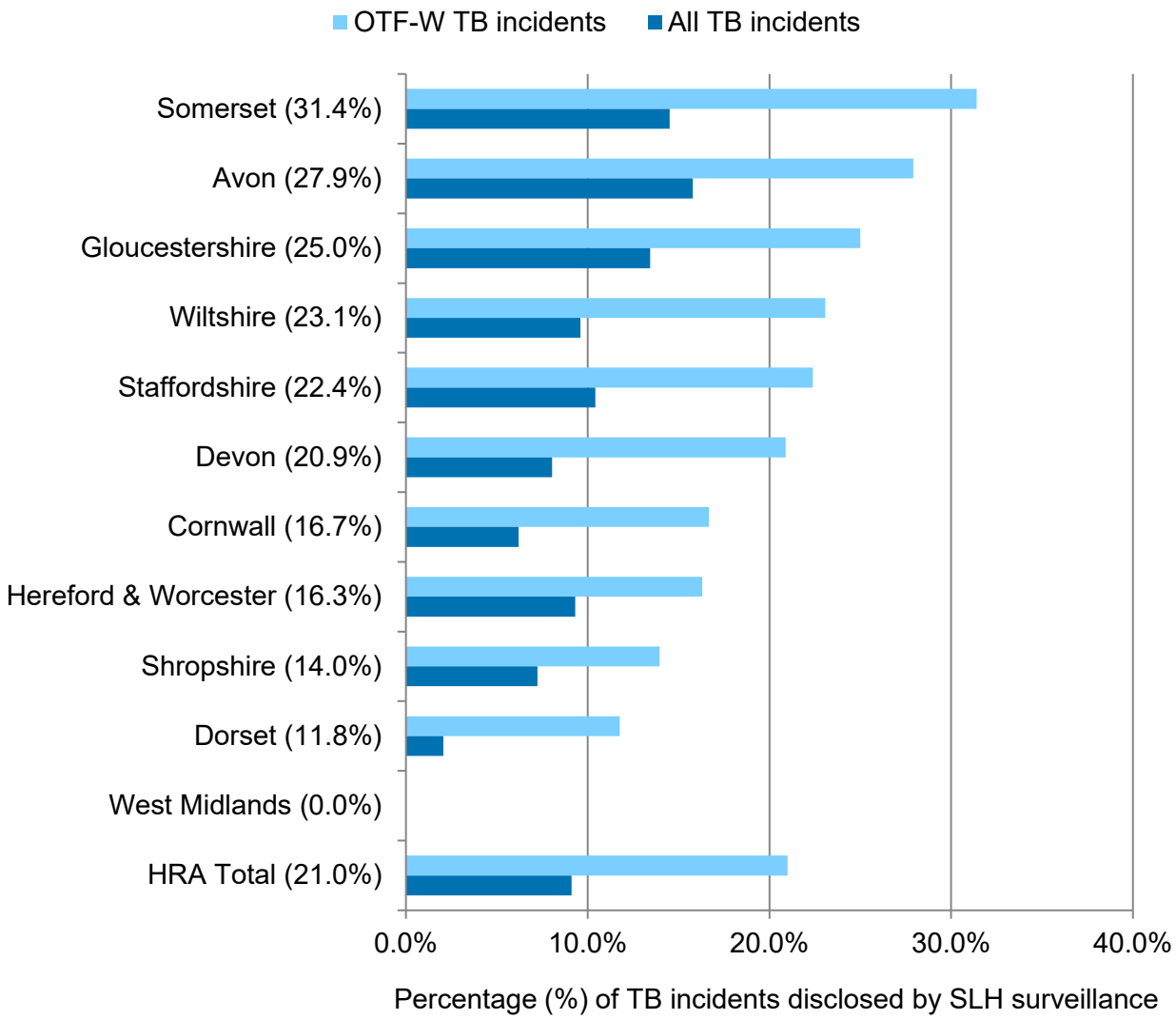


Figure 4.1.13 description: Bar chart showing the percentage of TB incidents disclosed by SLH surveillance (routine post-mortem meat inspection) in the HRA in 2023, for all TB incidents and OTF-W incidents, by HRA county. Somerset had the highest percentage of OTF-W incidents disclosed by slaughterhouse surveillance at 31.4% in 2023.

Number of reactors removed

Overall, 15,165 cattle were slaughtered for TB control purposes in the HRA in 2023, a 10% decrease compared to 2022 (n=16,879). These comprised 10,642 skin test (SICCT) test reactors (70.1% of all reactors removed), 4,437 IFN-γ blood test-positive animals (29.3%)

and 104 antibody test positives (0.7%). Compared to 2022, the number of SICCT test reactors declined by 14%, with the number of IFN-γ blood test-positive animals observing a smaller decrease of 3% (n=12,290 and n=4,589 respectively). Conversely, the number of antibody test positive animals increased compared to 2022 (n=0). The total number of animals removed, and the percentage detected by each test type, varied by county (Figure 4.1.14).

The county with the greatest number of cattle removed in 2023 for TB control reasons was Devon (1,321 animals), where 30% of the animals removed were detected by IFN-γ testing. Cornwall had the next highest number of cattle removed in total (843 animals), but the highest percentage of cattle removed as IFN-γ test positives (38%). Other counties with a high proportion of cattle removed as IFN-γ test positives were Hereford and Worcester (34%), and Somerset (33%) (Figure 4.1.14). No IFN-γ test positives were detected in the West Midlands in 2023, but this county only had a single TB incident. Compared to 2022, the percentage of cattle removed as IFN-γ test positives increased in Dorset and Cornwall by 12% and 10% respectively. Smaller increases were also seen in Devon, Hereford and Worcester, and Somerset, rising by 6%, 5%, and 2% respectively. Decreases in 2023 compared to 2022 were observed in Gloucestershire, Avon, and Shropshire, where the percentage fell by 14%, 11%, and 5% respectively. The fall seen in Avon was accompanied by the total number of reactors declining in 2023 (n=582) compared to 2022 (n=1275), as was the case for Shropshire (1337 in 2023, 1890 in 2022). . However, this was not the case for Gloucestershire which saw a small rise the total number of reactors compared to 2022 (n=875 in 2023, n=852 in 2022).

Figure 4.1.14 Number of cattle removed in the HRA in 2023 as SICCT test reactors, IFN-γ or antibody test positives, by HRA county. Counties are ranked by total number of animals removed for TB control reasons (percentage of animals removed per county due to IFN-γ testing shown in parentheses).

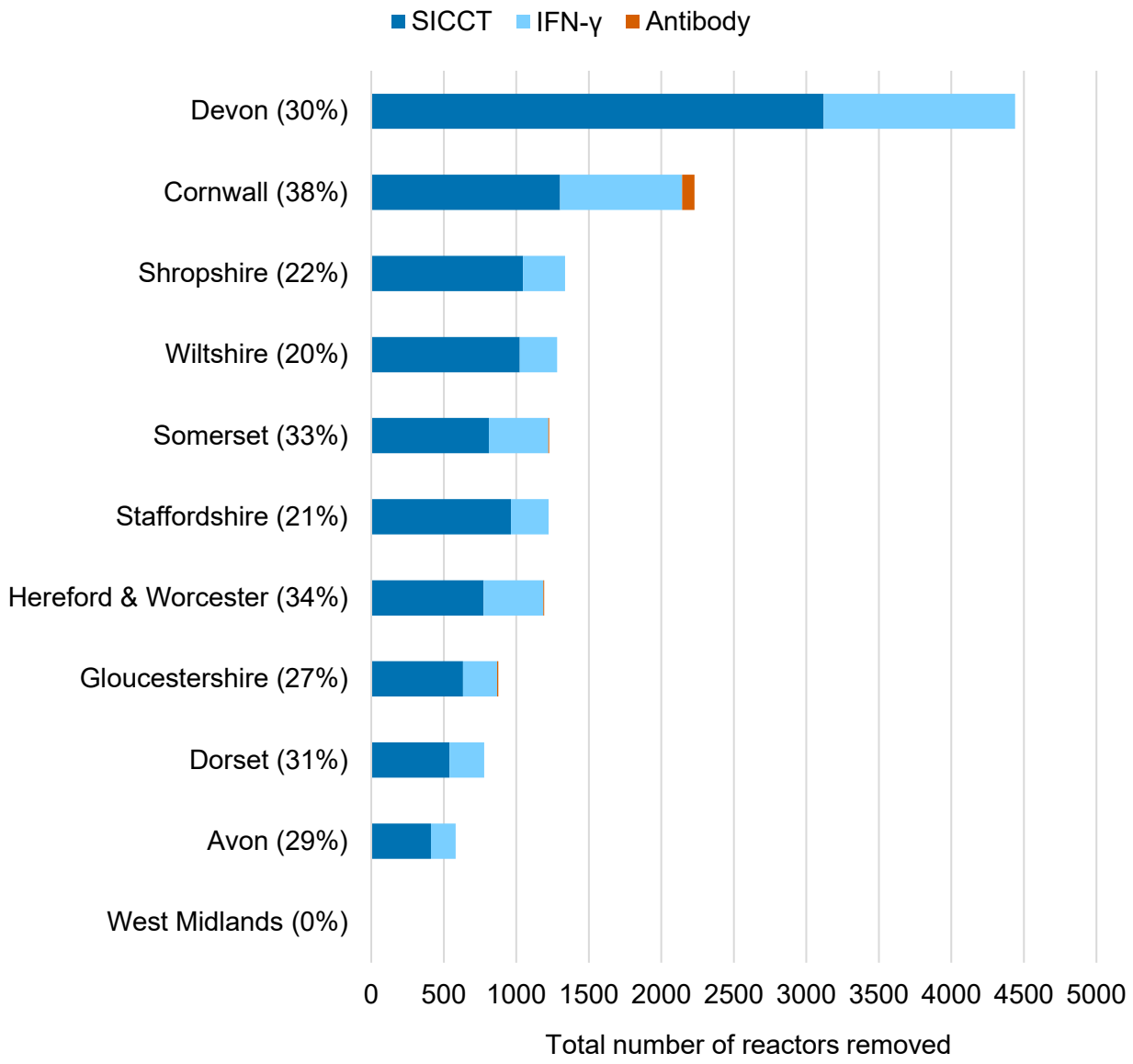


Figure 4.1.14 description: Number of cattle removed in the HRA in 2023 as SICCT test reactors, IFN-γ or antibody test positives, by HRA county. Devon had the highest number of total cattle removed in 2023.

Use of the supplementary IFN-γ blood test in the HRA

Throughout 2023 (as from July 2021), the policy for mandatory IFN-γ testing of TB incident herds in the HRA was as follows:

(1) *any new breakdowns (incidents) with lesion and/or culture positive animals (i.e. officially TB-free herd status withdrawn, OTF-W) that occurred within 18 months of the herd regaining OTF status following a previous OTF-W breakdown.*
(2) *chronic or persistent breakdowns with lesion and/or culture positive animals.*

As previously, additional deployment of the IFN-γ blood test took place at APHA's discretion in other situations. 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 fourfold to 80,000 in 2018, and peaking at just under 145,000 tests in 2021. Since then, the number of IFN-γ tests carried out in the HRA has been decreasing. In 2023, 94,216 animals received an IFN-γ test in the HRA, with 5.0% identified as positive. This is a 13% decrease on the number of HRA IFN-γ tests performed in 2022 (n=108,248) and a 35% decrease compared to the peak number of tests performed, in 2021 (n=144,621). There may be several reasons for this decrease, including but not limited to, the change in IFN-γ testing policy which took place in 2021, the diversion of APHA resources to control outbreaks of highly pathogenic avian influenza and Bluetongue disease, alongside the decrease in the number of new OTF-W incidents in all HRA counties in 2023.

The counties with the highest number of IFN-γ tests carried out in 2023 were Devon (24,762 tests), Cornwall (16,137 tests) and Staffordshire (10,851 tests). Over a quarter of all IFN-γ tests in the HRA in 2023 were conducted in Devon (26%). Counties with the fewest IFN-γ tests in 2023 were West Midlands (no tests, but just a single TB incident in this county), Dorset (2,915 tests), Avon (3,660 tests) and Gloucestershire (4,644 tests). Compared to 2022, there was a 64% increase in the number of tests in Wiltshire. The number of tests conducted also increased in Devon and Cornwall, by 32%, and 7% respectively. A decrease in the number of tests performed in 2023 compared to 2022 was seen in seven of the HRA counties (Figure 4.1.15), the greatest being in Shropshire (-61%), Avon (-52%) and Somerset (-35%).

As in previous years, the percentage of animals testing positive to the IFN-γ test varied by HRA county: from 2% in Somerset and Staffordshire, to 8% in Dorset. The total number of positive IFN-γ tests also varied by HRA county: from 1,445 in Devon, to 148 in Avon.

Figure 4.1.15a Number of IFN-γ animal tests performed in HRA counties, 2019 to 2023. Percentages of tests with a positive result are labelled on the chart. West Midlands did not have any gamma tests between 2019 and 2023 and is thus excluded from the chart.

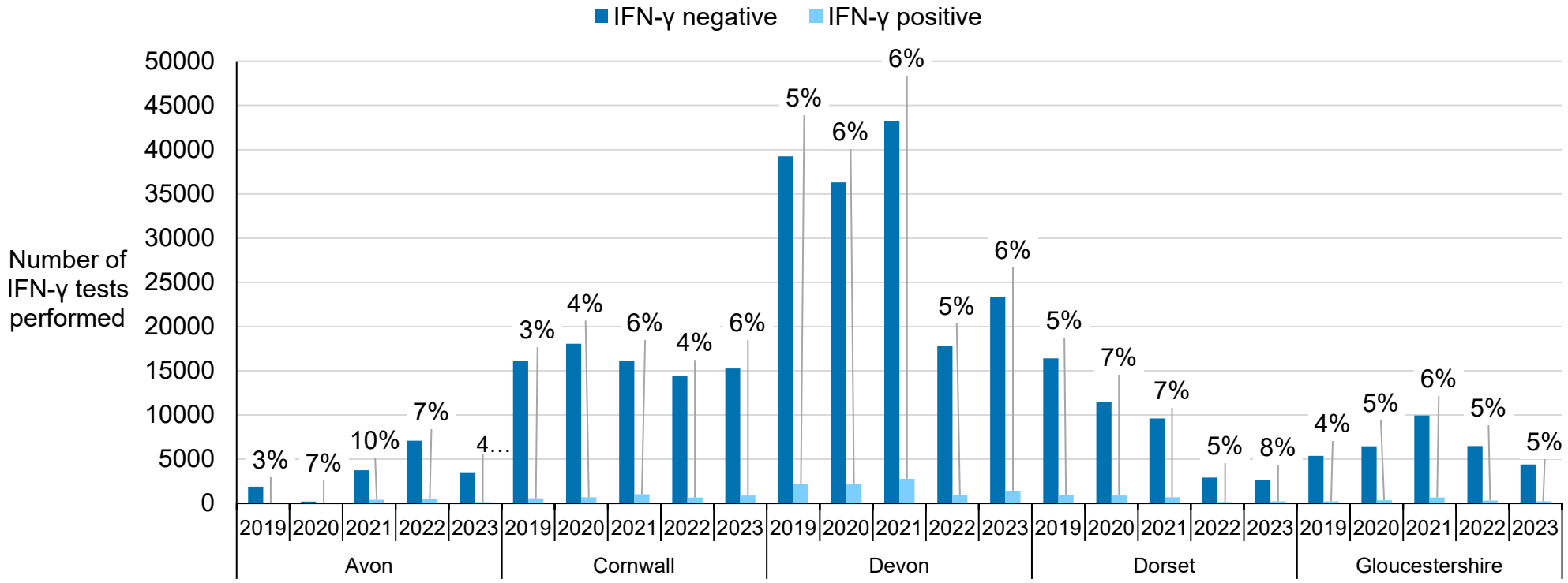


Figure 4.1.15a description: Bar chart showing the number of IFN-γ animal tests performed in HRA counties (Avon, Cornwall, Devon, Dorset and Gloucestershire), 2019 to 2023. Trends described in the text.

Figure 4.1.15b: Number of IFN-γ animal tests performed in HRA counties, 2019-2023. Percentages of tests with a positive result are labelled on the chart. Counties ranked by total number of IFN-γ tests performed in 2023. West Midlands did not have any gamma tests between 2019 and 2023 and is thus excluded from the chart.

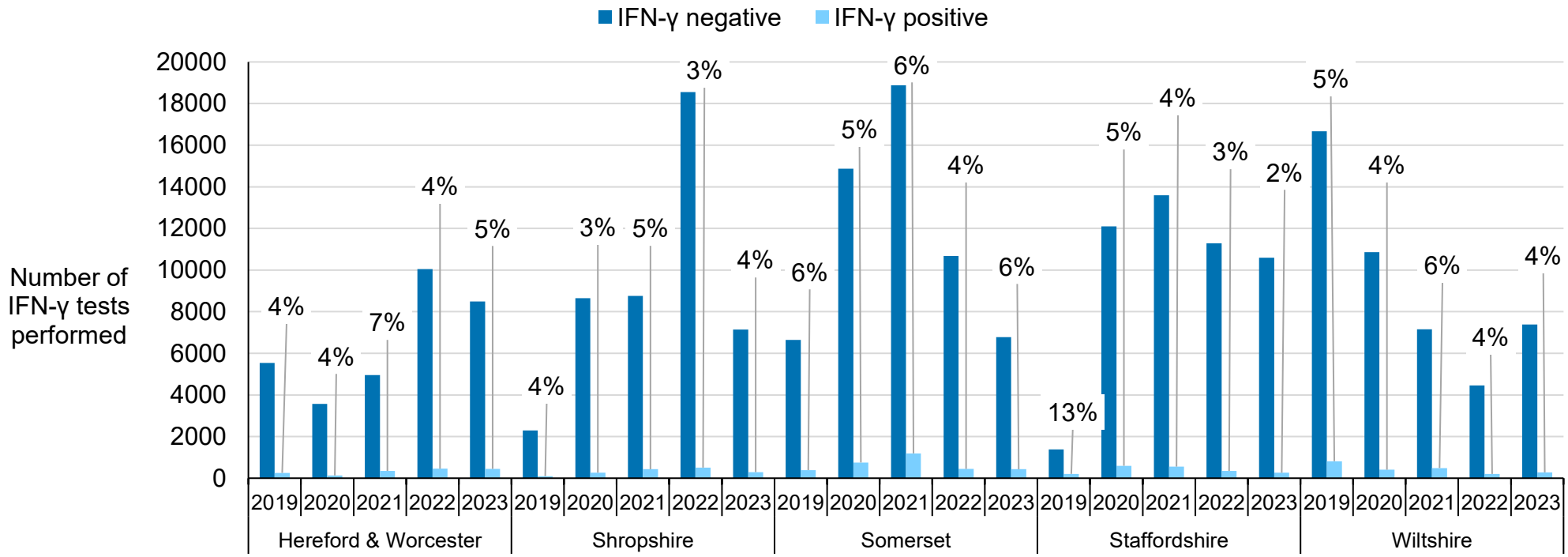


Figure 4.1.15b description: Bar chart showing the number of IFN-γ animal tests performed in HRA counties (Hereford & Worcester, Shropshire, Somerset, Staffordshire and Wiltshire), 2019 to 2023. Trends described in the text.

Sources of infection

The capacity to carry out veterinary investigations into the source of infection for new TB incidents has been impacted by the avian influenza outbreaks in 2021, 2022 and 2023 and the Bluetongue disease outbreak in the summer of 2023. A novel data-driven method to quantify the likelihood of risk pathways for TB infection was therefore developed by APHA. This method uses an algorithm to assess cattle movement data and WGS data for any *M. bovis* isolates from cattle to provide insights into possible risk pathways for new incidents. Details of how these risk pathways for sources of infection were determined can be found in Chapter 3.2 (Characteristics of herds found infected with TB) and in the Explanatory Supplement.

All new incidents (OTF-W and OTF-S) in the HRA in 2023 (n=1,855) were assessed using this data-driven algorithm. All incidents were assessed for the likelihood of being associated to infected cattle movements. However, only 512 incidents (28%) had WGS data available to look for evidence of local transmission of infection alongside the likelihood of being associated with infected cattle movements, all of which were OTF-W by virtue of having a positive culture result. It should be noted however that not all OTF-W incidents with a positive culture had WGS data at the time of data extraction.

Of the 512 incidents with WGS data available, most (n=288, 56.3%) had a local transmission event detected from the WGS data and no evidence of cattle movements associated with a high likelihood of infection. This was also true for incidents with WGS data in Hereford and Worcester (37 out of 55, 67%) and Cornwall (38 out of 57, 67%), and for the single incident in the West Midlands in 2023.

Another 129 incidents in the HRA with WGS data available (25%) did not have any evidence of local transmission of infection or cattle movements associated with a high likelihood of infection. This was true for most incidents in Dorset where WGS data were available (5 out of 8, 62.5%), and just over half of incidents with WGS data in Wiltshire (15 out of 29, 52%). For these 129 incidents, the source of TB infection in the cattle remains unclear.

For 38 incidents in the HRA with WGS data available (7.4%) no local transmission event was detected from WGS but there was evidence of cattle movements associated with a high likelihood of infection. This suggests these incidents most likely arose from the introduction of TB through cattle movements.

A total of 57 incidents in the HRA with WGS data available (11%) had evidence of local transmission of infection and local cattle movements with a high likelihood of infection. This was true for a relatively higher proportion of incidents with WGS in Gloucestershire (9 out of 31, 29%). For these 57 incidents, the source of infection in the cattle remains unclear, as both cattle movements and local transmission events may have introduced infection in the herd. No incidents in the HRA had a local transmission event identified

through WGS and evidence of non-local (more than 25km away from the infected herd) cattle movements associated with a high likelihood of infection.

For 1,341 incidents in the HRA (72%), WGS data were not available and therefore evidence of local transmission of infection could not be assessed. Of these, most (n=1,200, 89%) did not have any cattle movements associated with a high likelihood of infection either, and therefore the source of infection remains unclear. This pathway was assigned to most incidents in a county overall (between 58% and 86% of all incidents in a county), except for the West Midlands where it was not attributed to any incidents in the county.

A further 141 of incidents in England (11%) did have evidence of cattle movements with a high likelihood of infection, despite not having any WGS data available to analyse evidence of local transmission of infection. In these cases, there is a strong indication that cattle movements may have played a part in introducing infection to these herds (including OTF-S incidents), but in the absence of WGS data it is not possible to rule out local transmission events. Further detail on the source of infection pathways attributed to incidents without WGS are shown in the Supplementary Figures to the England Bovine TB Report 2023 (Appendix 1).

4.2 Epidemiology of TB in the Edge Area

This chapter summarises key findings from the Edge Area Year End Descriptive Epidemiology Reports.

- The number of new TB incidents disclosed in the Edge Area in 2023 (n=447) was 8.8% lower than in 2022 (n=490), although this decrease was not statistically significant.
- Despite the overall reduction in new incidents, marginal increases were observed in three of the 11 Edge Area counties: East Sussex and Oxfordshire (both up by 23%) and Hampshire (up by 14%). In 2023, the greatest number of TB incidents were detected in Cheshire (n=100), and the least in Nottinghamshire (n=12).
- The TB incidence rate per 100 herd years at risk (HYR) declined non-significantly in the Edge Area in 2023 compared to 2022 (7.2 vs 7.7). The same decreasing trend was observed with incidents per 100 unrestricted herds tested.
- End-of-year herd prevalence in the Edge Area rose marginally in 2023 (4.2%) compared to 2022 (4.0%), this increase was not significant. A decrease was seen in 6 of the 11 counties, but not in Berkshire, Cheshire, East Sussex, Hampshire or Oxfordshire.
- The median duration of TB incidents (time a herd is under movement restrictions) in the Edge Area was 196.5 days (6.5 months).
- The median period of TB herd restrictions in Buckinghamshire (249 days), Nottinghamshire (217 days), and Northamptonshire (208 days) being longer than the overall median for the Edge Area.
- Fifty-two percent of new TB incidents in the Edge Area in 2023 occurred in herds that had experienced at least one TB incident in the previous three years (recurrent breakdowns).
- The percentage of recurrent incidents was highest in Cheshire (69%), Berkshire (67%) and Nottinghamshire (58%).
- 89 incidents of the 149 incidents with WGS available had only evidence of local transmission of infection and no cattle movements associated with a high likelihood of infection

Geographical coverage of the Edge Area

The Edge Area was established in 2013 to form a buffer zone separating the HRA to the south and west of England from the LRA to the north and east of England (Figure 4.2.1). East Sussex is the only county of the Edge Area that is surrounded by the LRA. In January

2018, five counties that were originally split between the HRA and Edge Area (Cheshire, Derbyshire, East Sussex, Oxfordshire and Warwickshire) were fully incorporated into the Edge Area. Data reported in this chapter are for the 11 full counties that make up the Edge Area from 2018 onwards, including comparisons of TB trends over time.

Figure 4.2.1 illustrates the different routine testing intervals (six-monthly and annual) in the Edge Area, following reclassification of the HRA and Edge Area boundaries in 2018. From May 2019, cattle herds within the six-monthly surveillance testing portion of the Edge Area that meet specific criteria to be considered at a lower risk of contracting bTB have been eligible for annual testing under the Earned Recognition Scheme (see explanatory supplement for details). Those herds were eligible for contiguous TB testing if located near a farm sustaining a new OTF-W TB incident. Contiguous check testing was not usually required for herds on six-monthly surveillance testing but may have been applied in exceptional circumstances. An emergency measure came into force in December 2022 following the H5N1 HPAI outbreak in 2022 to 2023, which replaced all radial testing in the annual surveillance section of the Edge Area with check testing of herds immediately contiguous to a holding affected by an OTF-W incident. This emergency measure was still in place throughout 2023. Additionally, post movement testing of herds in the annual testing area of the Edge coming from areas of higher incidence in England (HRA, the six-monthly testing area of the Edge, and Wales) was introduced in August 2023.

Figures within this chapter show the data for the Edge Area overall, although specific details on trends within the 6-monthly and annual surveillance testing parts of the Edge Area are described and compared within the text.

Figure 4.2.1 Edge Area county map, showing the areas under six-monthly and annual routine herd testing, along with the location of holdings experiencing a new TB incident in 2023.

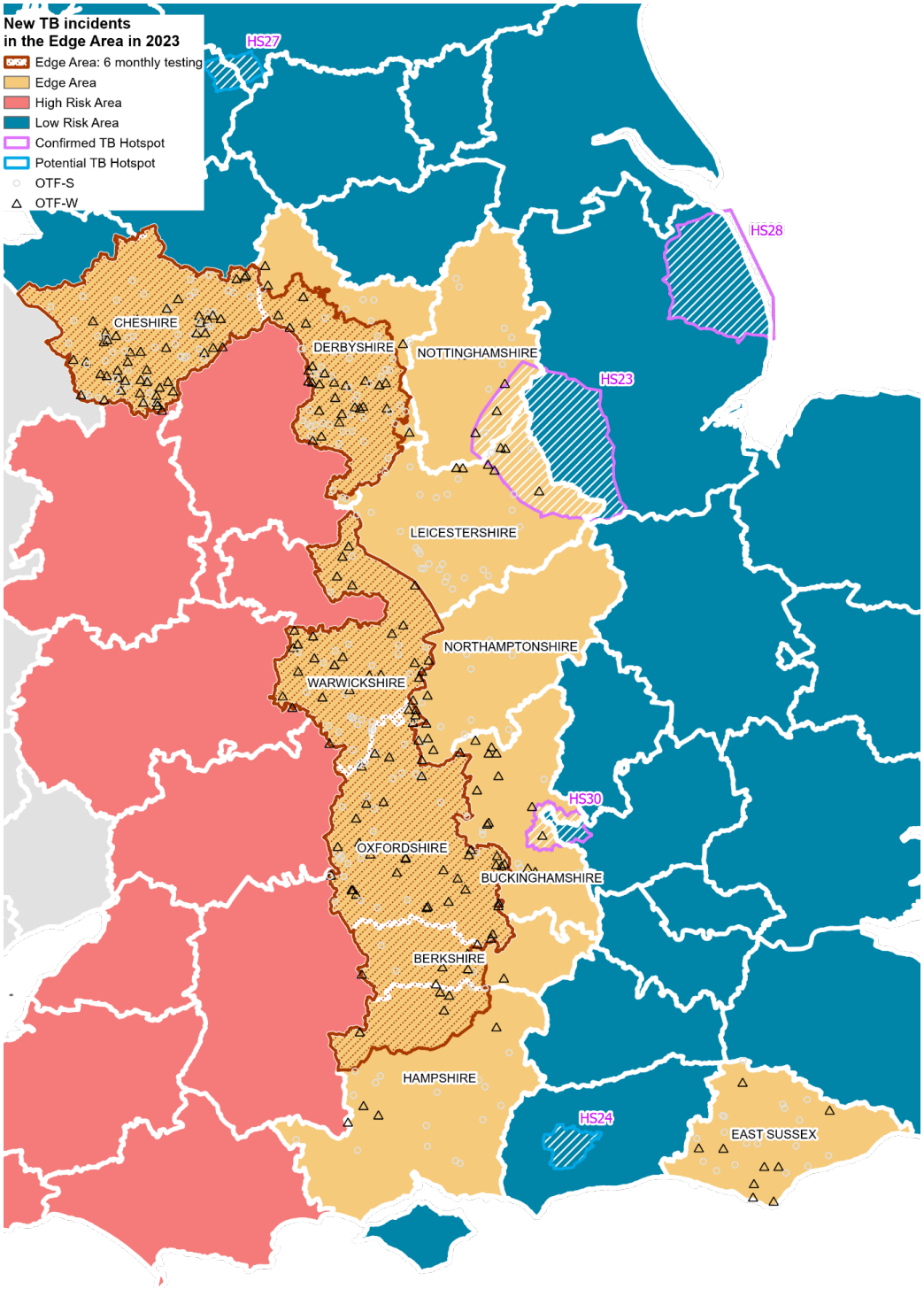


Figure 4.2.1 description: Decorative map of Edge Area counties in 2023, showing the six monthly testing area within the Edge Area counties, and locations of new TB incidents detected in Edge Area in 2023. The incidents are spread mostly on the western border of the Edge Area with the HRA, and throughout the East Sussex county.

Number of new TB incidents detected by county

The number of new TB incidents was highly variable across counties of the Edge Area. The highest numbers were disclosed in Cheshire, Derbyshire, Oxfordshire and Warwickshire (Figure 4.2.2). These counties, which are adjacent to the HRA and have large cattle populations, have historically disclosed the highest number of new TB incidents in the Edge Area, and continue to do so.

The number of new TB incidents in the Edge Area fell in 2023 (n=447) compared to 2022 (n=490), although this decrease was not statistically significant. Year-on-year reductions have been seen since 2020. The total number of new TB incidents increased in just three of the 11 counties in 2023: East Sussex (22 to 27), Oxfordshire (56 to 69) and Hampshire (22 to 25) (Figure 4.2.2). In Cheshire, Northamptonshire, and Warwickshire, the number of OTF-W incidents decreased in 2023 compared to 2022, however the number of OTF-S incidents in these counties increased.

The percentage of new TB incidents that were OTF-W in each county between 2019 and 2023 is shown in Figure 4.2.3. In 2023, the percentage of OTF-W incidents in the whole Edge Area had been decreasing over time, however some variation was seen at the county level. The percentage of OTF-W incidents was highest in Buckinghamshire (68%) and Oxfordshire (59%) and lowest in Leicestershire (20%). The increase observed in Oxfordshire and Hampshire in 2023 followed a five-year decline between 2017 and 2022 (Figure 4.2.3).

Figure 4.2.2 Annual total number of new TB incidents (OTF-W and OTF-S) from 2019-2023, by Edge Area county. 2023 incidents labelled on chart.

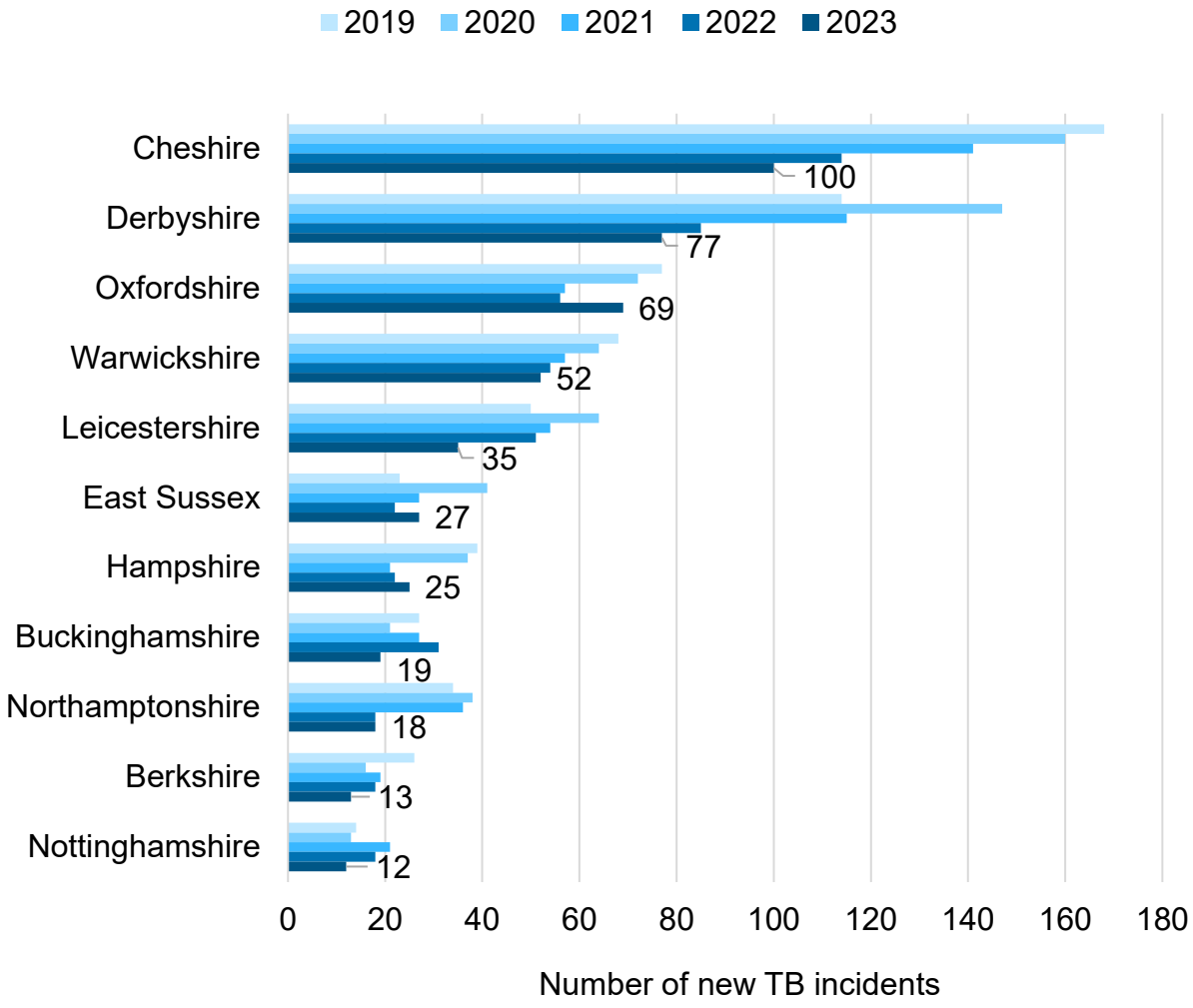


Figure 4.2.2 description: Bar chart showing the annual total number of new TB incidents (OTF-W and OTF-S) from 2019-2023, by Edge Area county. In 2023, Cheshire had the most new TB incidents (100).

Figure 4.2.3 The percentage of new TB incidents with OTF-W status from 2019 to 2023, by Edge Area county. Counties ranked by total new TB incidents in 2023. Percentage of OTF-W incidents in 2023 labelled on chart.

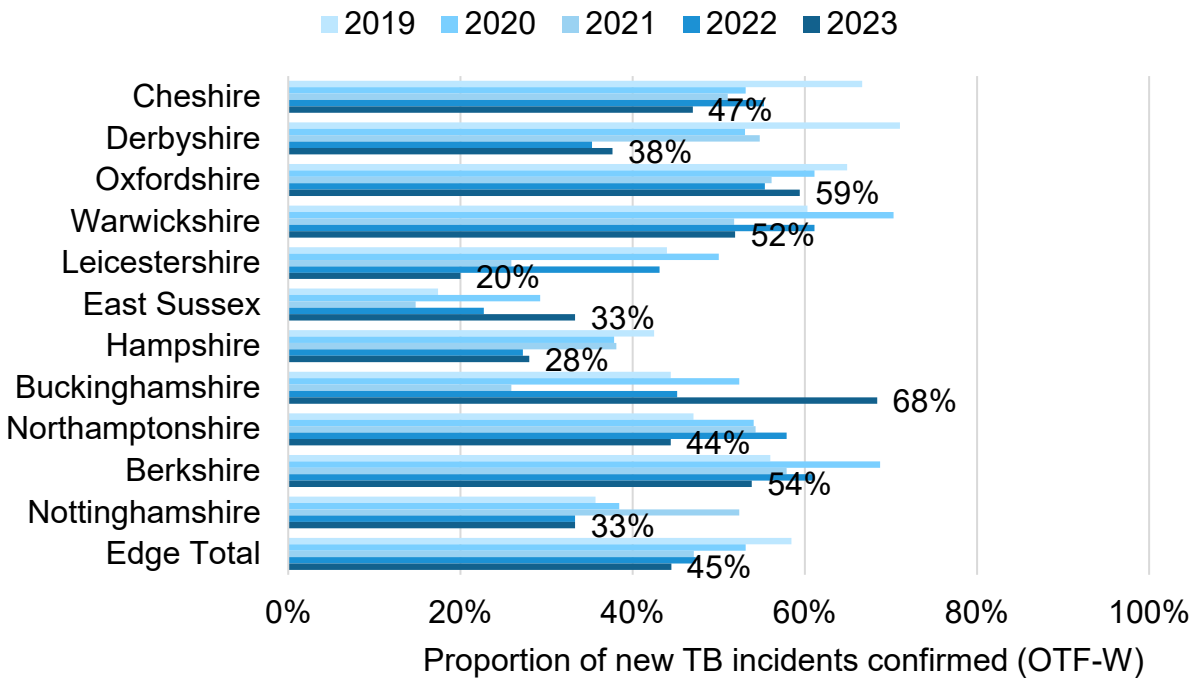


Figure 4.2.3 description: The percentage of new TB incidents with OTF-W status from 2019 to 2023, by Edge Area county. In 2023, Buckinghamshire had the highest percentage of OTF-W incidents at 68%.

TB herd incidence rate by county

Most new TB incidents in the Edge Area in 2023 occurred in herds located in the six-monthly surveillance testing region. Incidence rates presented here include all incidents (OTF-W and OTF-S). They may differ from those published in the Year End Descriptive Epidemiology reports for the Edge Area, which exclude TB incidents in non-grazing Approved Finishing Units. There was a non-statistically significant decrease in the TB herd incidence rate in the Edge Area in 2023 compared to 2022 (7.2 TB incidents per 100 HYR in 2023, down from 7.7 in 2022, p=0.326). This continued a general decline in the overall incidence rate for the Edge Area since 2020 (Figure 4.2.4).

As in previous years, there was variation in the burden of TB across the Edge Area in 2023. Incidence ranged from 18.4 incidents per 100 HYR in Oxfordshire down to 3.5 in Nottinghamshire (Figure 4.2.4). Of note, the incidence rate reported in Oxfordshire was the highest in England in 2023, including the 11 counties of the HRA (Figure 4.1.4, Chapter 4.1 Epidemiology of TB in the High Risk Area). Incidence per 100 HYR increased in Oxfordshire in 2023 following a three-year decrease, but this increase was not statistically significant. For Warwickshire, the incidence rate in 2023 was the second highest of all the

Edge Area counties however the incidence rate has been decreasing since 2019 (17 incidents per 100 HYR) .

At the county level, TB incidence per 100 HYR increased in three counties (Oxfordshire, East Sussex and Hampshire) and decreased in eight (Figure 4.2.4). Changes in incidence per 100 HYR in 2023 compared to 2022 were not statistically significant for any of the Edge Area counties except in Leicestershire, where there was a significant decrease (5.0 in 2023 compared to 6.8 in 2022, p=0.04).

Figure 4.2.4 Incidence rate per 100 herd-years at risk from 2019-2023, by Edge Area county. Counties ranked by incidence rate in 2023.

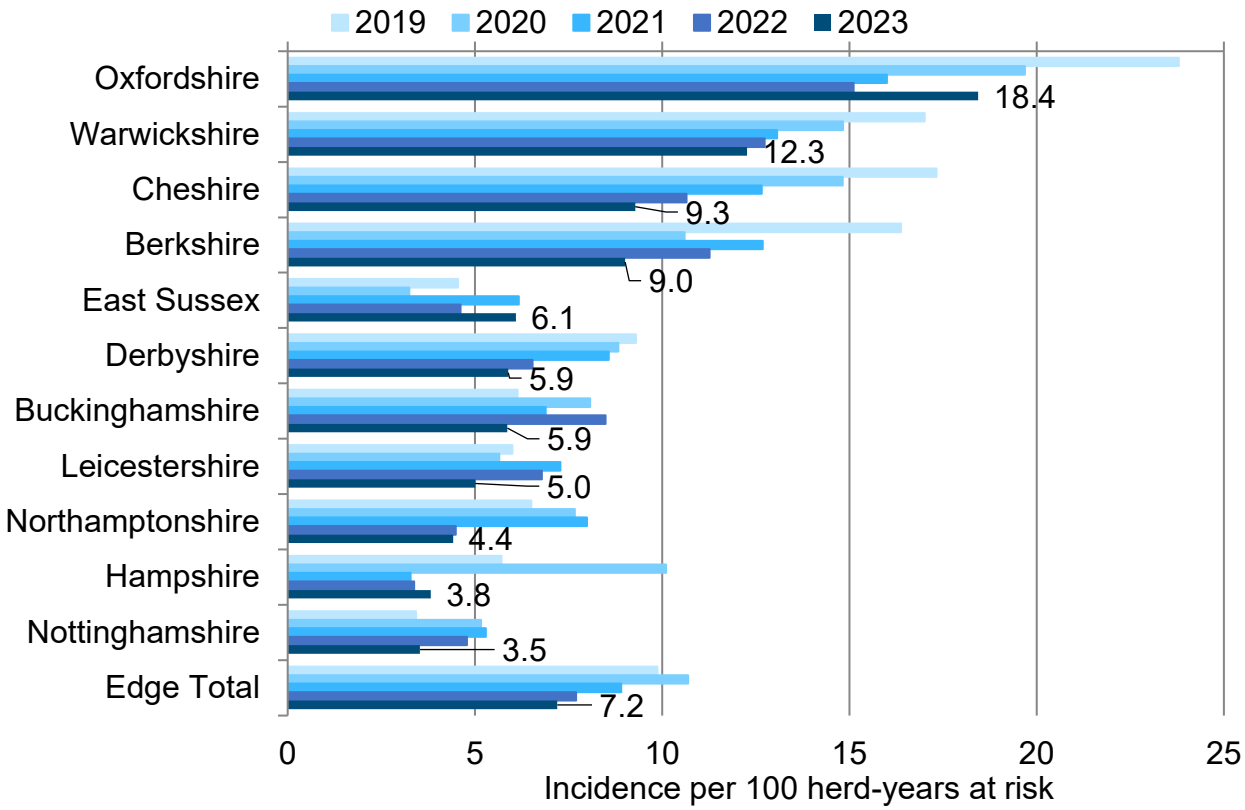


Figure 4.2.4 description: Incidence rate per 100 herd-years at risk from 2019-2023, by Edge Area county. Oxfordshire had the highest incidence rate at 18.4 new incidents per 100HYR. The Edge average was 7.2.

Some of the temporal variation in incidence rates may be due to changes in testing frequency over time. Since 2018, most herds in Oxfordshire, Cheshire, Warwickshire, West Berkshire, much of Derbyshire, and north-west Hampshire were subject to six-monthly routine testing, and this continued in 2023. When the routine testing frequency of

herds changes, the sensitivity of the TB surveillance system changes and the number of herd-years at risk (denominator) can be artificially inflated or deflated. In 2018, when six-monthly testing was introduced within the reclassified Edge Area boundaries, incidence per 100 HYR initially declined. In 2019, when the earned recognition scheme allowed eligible herds to revert to annual testing, incidence per 100 HYR increased again. The frequency of routine TB surveillance testing in the Edge Area has not changed since 2019. Even so, the number of herds eligible for earned recognition may vary annually. Therefore, the overall frequency of surveillance will still change slightly each year even when the area testing frequencies nominally remain the same.

An alternative measure of herd incidence rate, new TB incidents per 100 unrestricted (OTF) herds tested, is provided in Figure 4.2.5. This measure is less susceptible to changes in surveillance testing frequency than incidence rate per 100 HYR. It is not intended to replace incidence rate per 100 HYR, but is particularly useful to provide clarity when surveillance intervals change, as was the case in the Edge Area in 2018 and 2019 (see explanatory supplement for more details).

In the Edge Area overall, incidence rate per 100 unrestricted herds tested has fluctuated over the past five years, but showed an overall declining trend, from 8.7 in 2019 to 6.5 in 2023 (Figure 4.2.5). Incidence rate per 100 unrestricted herds tested decreased or remained the same in most Edge Area counties in 2023 compared to 2022, which was also the case for incidence rate per 100 HYR. Exceptions were, again, Oxfordshire, East Sussex, and Hampshire, where there was an increase. In Hampshire, the incidence rate per 100 unrestricted herds has been rising since 2021, consistent with the trend in number of new TB incidents and incidence rate per 100 HYR (Figures 4.2.2 and 4.2.4). In Cheshire and Warwickshire, incidence per 100 unrestricted herds has fallen year on year since 2018 and 2017, respectively.

Figure 4.2.5 TB incidence rate per 100 unrestricted herds tested from 2019-2023, by Edge Area county. Counties ranked by incidence rate in 2023.

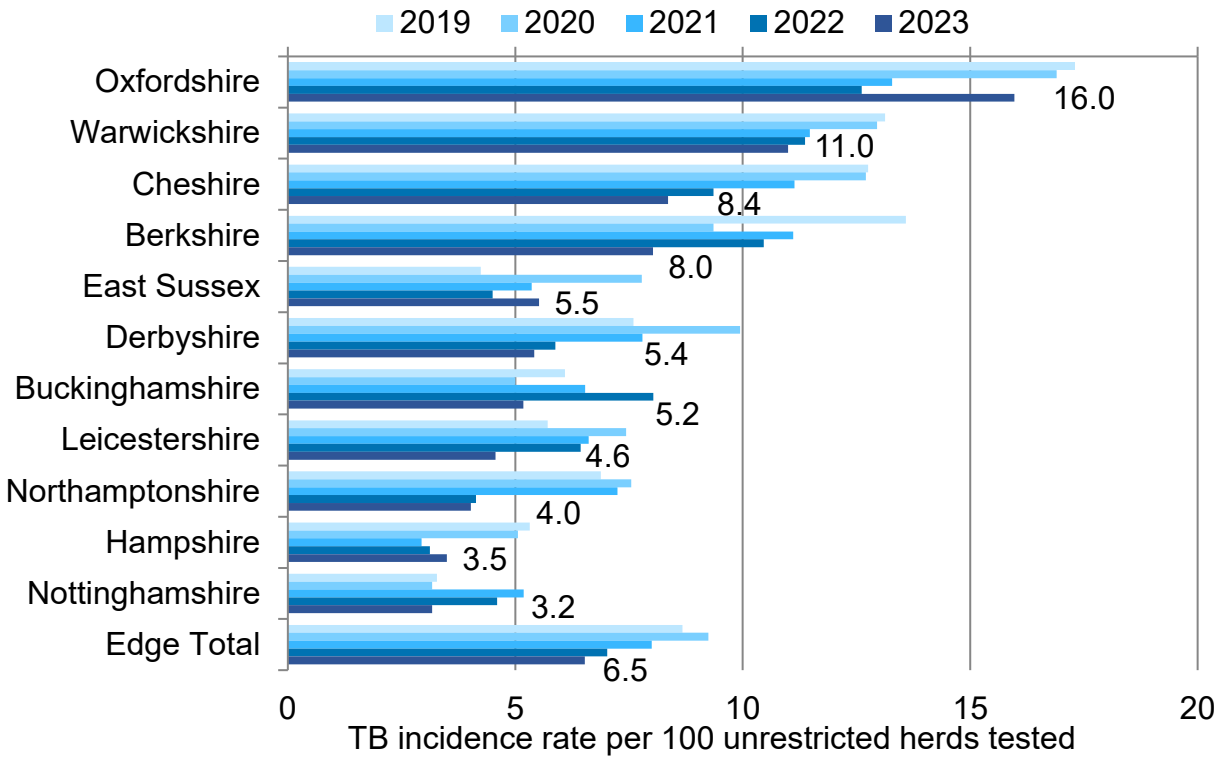


Figure 4.2.5 description: Bar chart showing the TB incidence rate per 100 unrestricted herds tested from 2019-2023, by Edge Area county. In 2023, as in previous years, Oxfordshire had the highest incidence per 100 unrestricted herds tested (16.0 new incidents per 100 unrestricted herds tested).

End-of-year herd prevalence by county

End-of-year herd prevalence is the proportion of herds under movement restrictions on 31st December due to an ongoing TB incident. Prevalence figures 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.

Prevalence at the end of 2023 in the Edge Area was 4.2%. This was a slight, non-significant increase compared to 2022 (4.0%, z-test p=0.88, Figure 4.2.6). This slight increase in the overall herd prevalence was underpinned by increases in Berkshire, Cheshire, East Sussex, Hampshire, and Oxfordshire. All other Edge Area counties showed a decline in prevalence in 2023 compared to 2022 (Figure 4.2.6).

At a county-level, herd prevalence in 2023 was lowest in Hampshire (1.8%). By contrast, Oxfordshire had the highest prevalence (11.5%) in the Edge Area and in the whole of England, including all the HRA counties. (Figure 4.1.5, Chapter 4.1 Epidemiology of TB in the High Risk Area).

Figure 4.2.6 End of year herd prevalence from 2019 to 2023, by Edge Area county. Counties ranked by prevalence in 2023.

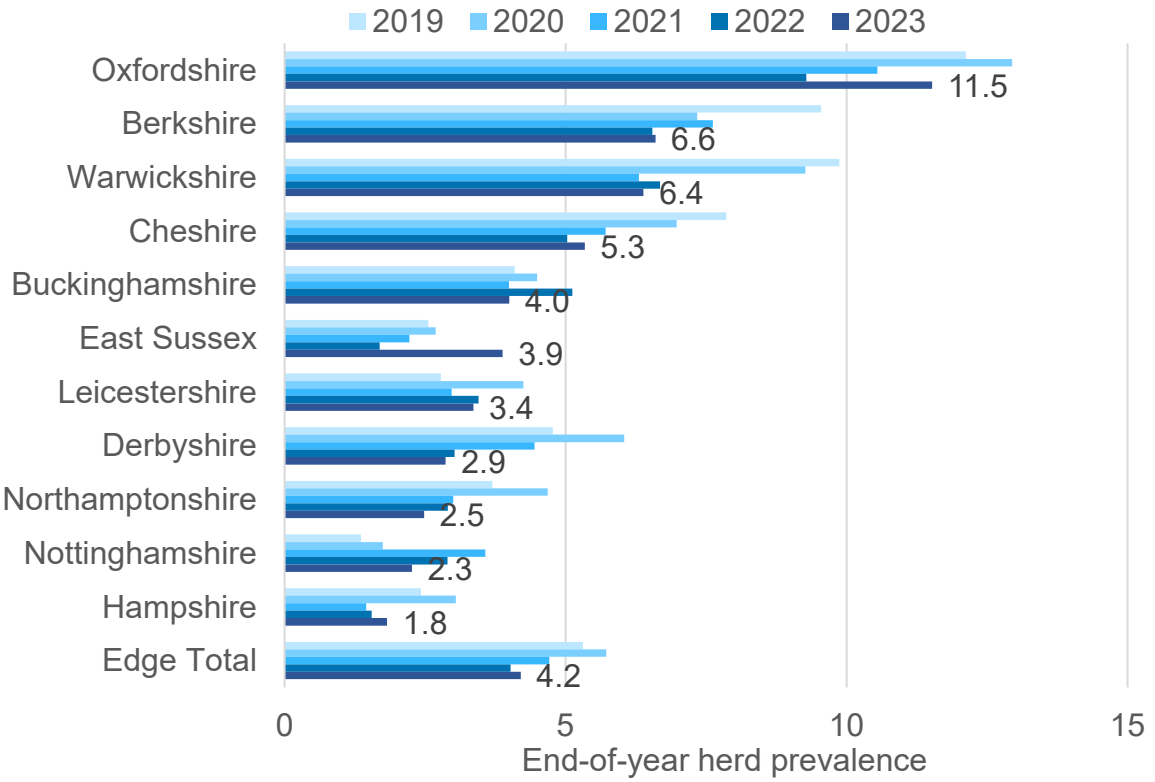


Figure 4.2.6 description: Bar chart showing the end of year herd prevalence from 2019 to 2023, by Edge Area county. As in previous years, Oxfordshire had the highest prevalence (11.5% of herds under TB restrictions at the end of 2023).

TB incident duration

A total of 205 TB incidents (including OTF-W and OTF-S) ended in the Edge Area during 2023 (56 incidents in the 12 monthly testing area and 149 in the 6 monthly testing area). Figure 4.2.7 shows the median duration of these incidents by Edge Area county.

Overall, for all TB incidents ending in the Edge Area in 2023, the median duration was 188 days, which was longer than in 2022 (183 days), this increase was statistically significant ($p<0.001$). The counties with the longest median duration for all TB incidents were Buckinghamshire (249 days) and Nottinghamshire (217 days), and the shortest median duration was recorded in Cheshire (158 days). For all counties except Berkshire and Oxfordshire, median duration of OTF-W incidents was longer than for all incidents together. The greatest differences were observed in Leicestershire (312 days vs 192.5 days), Northamptonshire (306 vs 208 days), and Hampshire (294 days vs 203 days), which were also the counties with longest median OTF-W incident durations. Cheshire had

the shortest median duration of OTF-W incidents in 2023 (177 days) (Figure 4.2.7). In 2022 and 2023, the median duration for all TB incidents in Nottinghamshire was the second longest of all the Edge Area counties in contrast to 2021 where median duration in that county was the shortest. The median duration of OTF-W incidents in Oxfordshire was third longest in 2021 and second longest in 2022 of all the Edge Area counties compared to 2023 where the duration was third shortest.

In the six-monthly surveillance testing part of the Edge Area, median duration across all TB incidents in 2023 was 186 days, a non-significant increase from 182 days in 2022. At a county-level median duration ranged from 158 days (Cheshire) to 256 days (Hampshire).

Median TB incident duration in the annual surveillance testing part of the Edge Area in 2023 was 196.5 days, and therefore slightly higher than in the six-monthly testing region. Median duration in this part of the Edge Area has increased non- significantly since 2022 (188 days). At a county level, median duration ranged from 162 days (Berkshire) to 249 days (Buckinghamshire). The range for the median duration was slightly higher in the six-monthly testing part of the Edge Area (98 days) compared to the annual testing part (87 days).

Figure 4.2.7 Median duration (days) of TB herd incidents that ended in 2023, by Edge Area county ranked by total number of incidents (in parentheses).

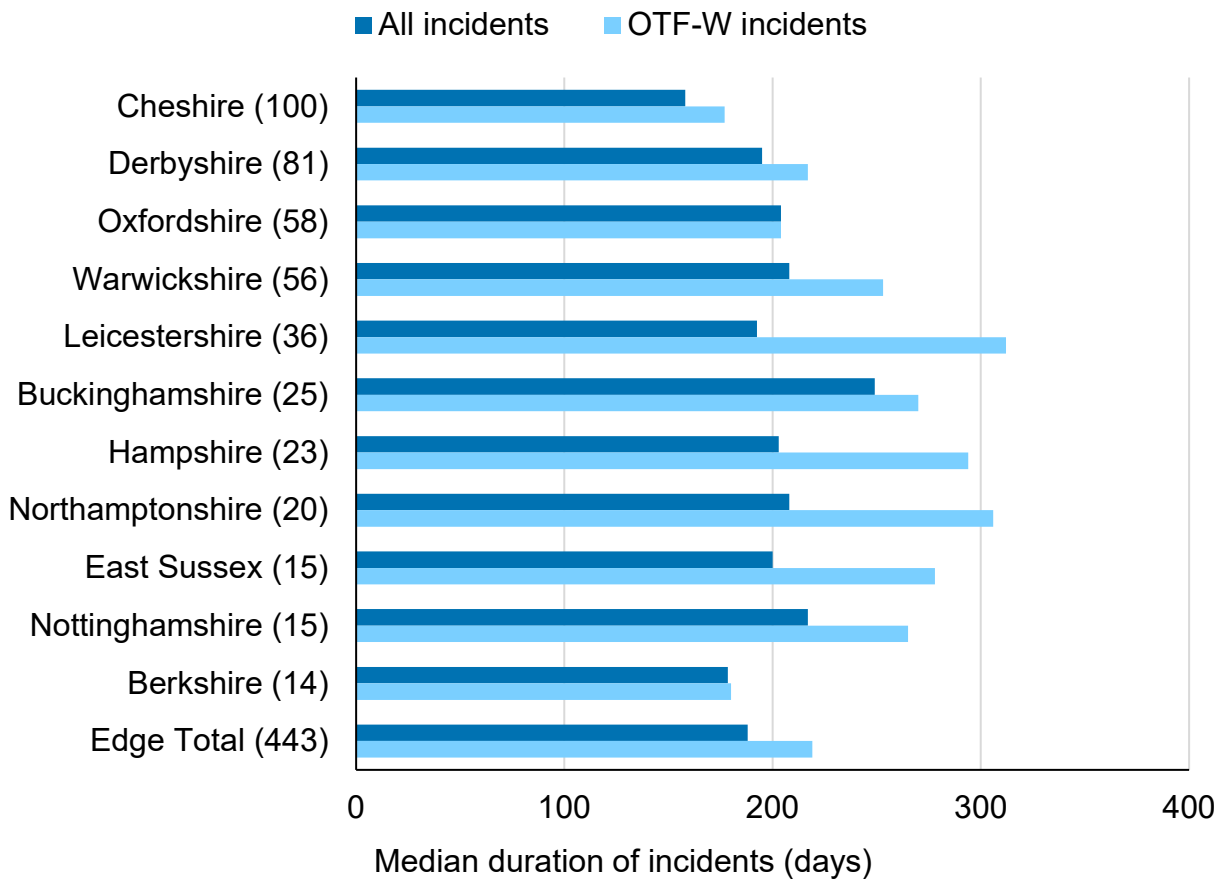


Figure 4.2.7 description: Bar chart showing the median duration (days) of TB herd incidents that ended in 2023, by Edge Area county. The highest median duration was in Buckinghamshire at 249 days, but Leicestershire had the highest median duration for OTF-W incidents (312 days).

Recurrence of TB incidents

Across the entire Edge Area in 2023, 52% of new TB incidents occurred in herds that had experienced at least one TB incident in the previous three years compared to 48% in 2022 (Figure 4.2.8). The percentage of incidents that were recurrent was higher in the six-monthly testing portion at 57% (56% in 2022) than in the annual testing section of the Edge Area at 42% (34% in 2022). This was the same as in 2022, however the difference in the percentage of incidents that were recurrent between the testing areas decreased in 2023 (22% in 2022 and 15% in 2023). Recurrence was highest in the counties of Cheshire (69%), Berkshire (67%) and Nottinghamshire (58%) (Figure 4.2.8). Although Nottinghamshire had the third highest percentage of herds with recurring TB incidents

seen in 2023, 2022 it was the lowest (6%) of all the Edge Area counties. In contrast, East Sussex had the lowest recurrence in 2023 (35%) compared to 2022 where recurrence was joint highest with Berkshire at 67%.

The percentage of recurrent incidents in Cheshire in 2023 (69%) was higher than in any of the HRA counties, and Berkshire had the same percentage as Staffordshire, which had the highest recurrence in the HRA (67%; Figure 4.1.10, Chapter 4.1 Epidemiology of TB in the High Risk Area). Recurrence in Warwickshire and Nottinghamshire was also the same or higher than the average recurrence reported across the whole of the HRA (57%).

Cheshire, Nottinghamshire, Leicestershire, Buckinghamshire, and Hampshire saw an increase in the proportion of recurrent TB incidents in 2023 relative to 2022. Whereas Warwickshire, Oxfordshire, Northamptonshire, Derbyshire and East Sussex experienced decreases and Berkshire remained the same (Fig 4.2.8).

Figure 4.2.8 Percentage of TB incidents in 2023 in herds that had experienced any TB incident in the previous three years, by Edge Area county.

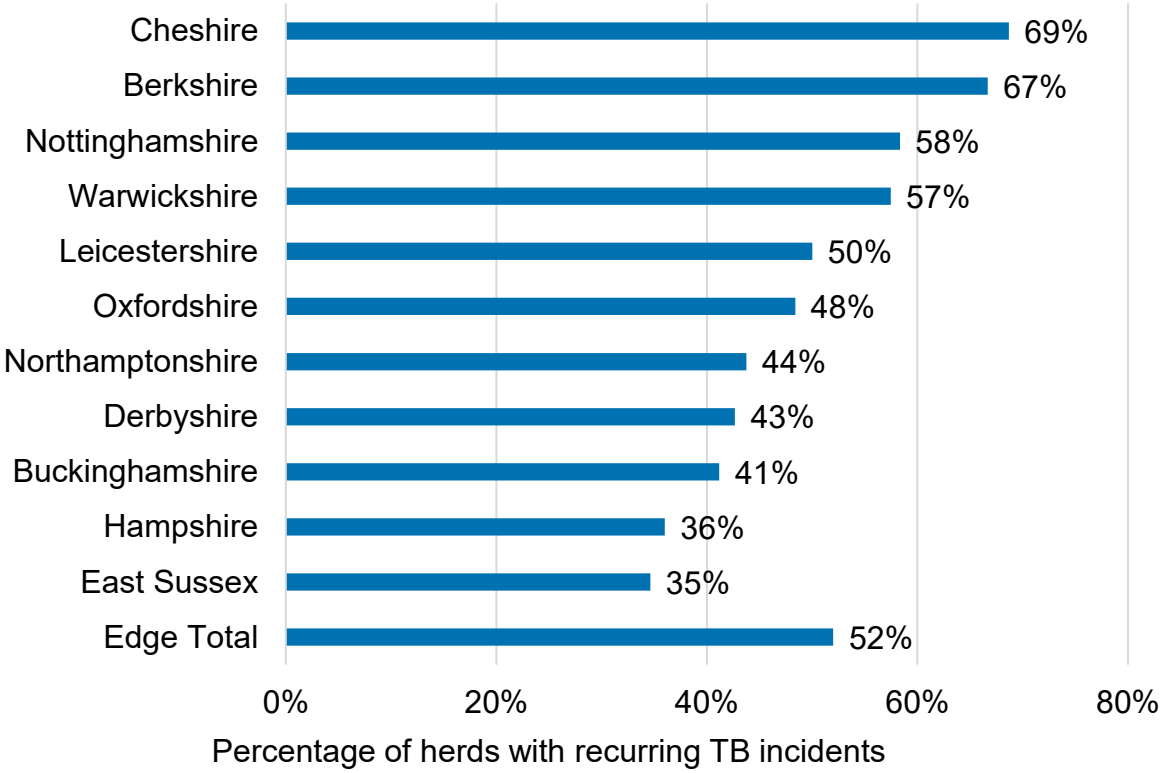


Figure 4.2.8 description: Percentage of TB incidents in 2023 in herds that had experienced any TB incident in the previous three years, by Edge Area county. Cheshire had the highest proportion (69%) of incidents that had experienced any TB incidents in the past three years in 2023.

Sources of infection

All new incidents in the Edge in 2023 (n=446) were assessed using the data-driven algorithms previously described. Of these, 149 (33%) had WGS data available and therefore assessed for the presence of local transmission of infection. The remaining TB incidents (OTF-W and OTF-S, n= 297, 67%) did not have any WGS data available and therefore could not be assessed for evidence of local transmission of infection. The 297 incidents were still assessed for the likelihood that the source of infection was associated with infected cattle movements.

Most of the 149 incidents (105 incidents, 70%) with WGS available had a local transmission event detected from the WGS data, with or without cattle movements identified as well. Cheshire and Oxfordshire had the highest number of incidents (30 incidents and 25 incidents, respectively), whilst Nottinghamshire has no incidents.

A total of 89 (60%) of the 149 incidents with WGS available had evidence of local transmission of infection, with no cattle movements associated with a high likelihood of infection. This pathway was attributed to most incidents across all counties in the Edge with WGS data available, except for Nottinghamshire (where no incidents were assigned this pathway). Cheshire had the highest number of incidents associated with the pathway (25, 61%), and Berkshire had the highest proportion of incidents associated with the pathway (4, 80%).

Fifteen incidents (10%) with WGS had evidence of a local transmission of infection as well as evidence of cattle movements involved with a high likelihood of infection. Of these, one incident in Oxfordshire had evidence of non-local movements (more than 25km), and the remaining 14 incidents had evidence of local (within 25km) movements. Warwickshire had the highest number of incidents with this pathway (4, 22%), followed by Buckinghamshire (3, 33%). East Sussex, Leicestershire, Northamptonshire, Nottinghamshire had no incidents associated with these risk pathways.

Of the 149 incidents with WGS available, another 15 incidents, (10%) had no local transmission event detected from the WGS data and cattle movements associated with a high likelihood of infection. Cheshire had the most incidents with this pathway (5, 12%), followed by Oxfordshire (4, 13%). Derbyshire, East Sussex, Hampshire, and Nottinghamshire had no incidents with this pathway.

For 30 incidents in the Edge (20% of those with WGS data available), there was no local transmission event identified despite WGS data being available, and no evidence of cattle movements with a high likelihood of infection. The source of infection for these incidents therefore remains unclear. Counties with the most incidents with WGS available that were attributed to this pathway were Nottinghamshire (4, 100%), Derbyshire (7 incidents, 33%), Oxfordshire (5, 16%) and East Sussex (2, 40%).

More details on the methodology for determining the risk pathways for the sources of infection can be found in Chapter 3.2 Characteristics of herds found infected with TB, Appendix 1 in the Supplementary Figures to the England Bovine TB Report and the Explanatory Supplement.

New areas of endemic infection and new clusters emerging

The Edge Area is strategically located along the front of endemic TB infection in England and as such, areas of spread and retraction often occur within Edge Area counties. Figure 3.1.6 (spread and retraction of endemic TB areas in 2023, Chapter 3.1) provides a visual depiction of changes to the endemic area in 2023. 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: clusters of TB incidents were evident in several locations in Cheshire, mostly in locations similar to 2022. There were four predominant clades of M. bovis: B1-11, B3-11, B6-11, and B6-22. Exposure to infected wildlife continued to be the main risk pathway, but there was a high degree of uncertainty around the source for many incidents.
- Hampshire: clusters of incidents have occurred in the central-western area of the county over the past few years. In recent years, M. bovis clade B6-62 has been isolated from both cattle and infected wildlife, suggesting there is evidence of a local transmission event.
- Oxfordshire: there were several persistent clusters of incidents in Oxfordshire in 2023, where more than one source of TB is likely to be occurring at the same time.

Areas of observed improvement in epidemiological indicators

- Incidence rate per 100 HYR, and the number of new TB incidents decreased in the Edge Area in 2023 compared to 2022.
- Cheshire: the number of new TB incidents continued to decline in 2023. This likely indicates a lower burden of infection.
- Derbyshire: the lowest annual number of new TB incidents was reported in 2023 since before 2013. After a peak of incidents in 2020, the number of incidents in 2023 more than halved. This reduction is likely due to enhanced TB control measures.
- Leicestershire: the total number of new TB incidents in 2023 continued to decrease since 2020.
- Northamptonshire: the total number of incidents in 2023 fell compared to previous years and was the lowest reported since 2016.

- Warwickshire: the number of new TB incidents dropped for the sixth consecutive year.
- Nottinghamshire: the number of new TB incidents decreased from 2022 to 2023 and was lower than the incidents reported between 2014 and 2021.
- Buckinghamshire: the incidence rate per 100 HYR and end-of-year herd prevalence fell in 2023, following the highest seen in the past decade in 2022.

4.3 Epidemiology of TB in the Low Risk Area

This chapter summarises key findings from the LRA TB Epidemiology reports for 2023.

Geographical coverage of the LRA

The Low Risk Area (LRA) was established in 2013. It extends to the north and east of the Edge Area, excluding East Sussex, but including the Isles of Scilly (Figure 4.3.1). Data reported in this chapter are for the 25 counties that make up the LRA. Most cattle herds in the LRA are routinely tested for TB every four years. The remaining herds are tested annually or every six months, such as those herds located within a 3km radius of another herd with an OTF-W incident (known as ‘radial’ testing), including those triggering a TB hotspot area. This TB surveillance regime for cattle herds is supplemented by post-movement TB testing of cattle brought into the LRA from herds in higher risk areas of England and Wales, and by post-mortem meat inspection of all cattle commercially slaughtered for human consumption (slaughterhouse TB surveillance).

Figure 4.3.1 LRA county map, showing the location of incidents in 2023 (OTF-W and OTF-S), as well as the five confirmed (HS21, HS23, HS28, HS29, and HS30) and three potential (HS24, HS26, and HS27) hotspots that were active in 2023. NB Isles of Scilly not shown due to scale.

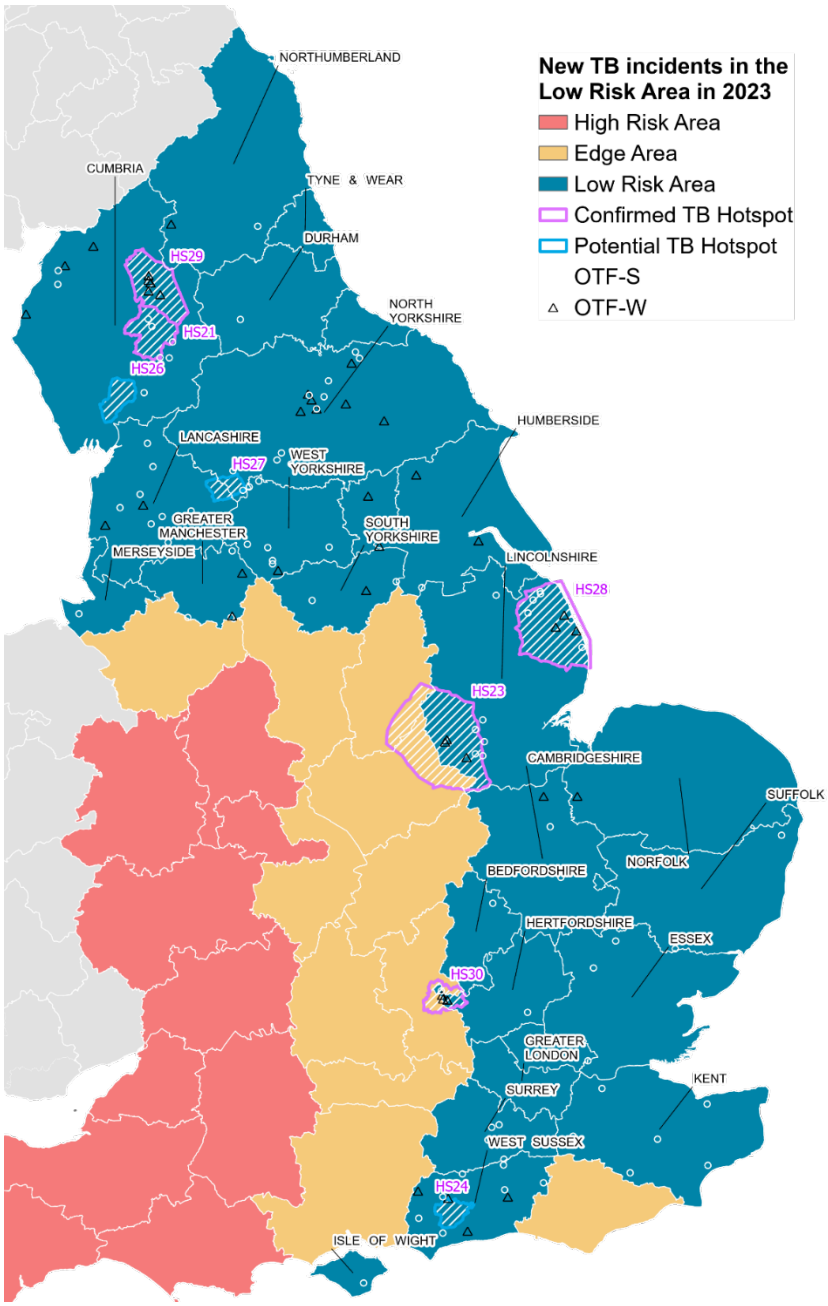


Figure 4.2.1 description: Decorative map of LRA counties in 2023, showing the locations of the confirmed and potential TB hotspots in England. The incidents are spread throughout the county.

Number of new TB infected herds

The number of new TB incidents in the LRA decreased in 2023 compared to 2022 (133 incidents and 145, respectively). Of those 133 new herd incidents in 2023, 42 (32%) were OTF-W (Figure 4.3.2), compared to 40 (28%) in 2022.

Increases in the total number of new TB incidents were seen in Hertfordshire (2 in 2022 to 5 in 2023), Humberside (2 in 2022 to 5 in 2023), North Yorkshire and Lincolnshire (in both counties up from 17 incidents in 2023 to 19 in 2023). New TB incidents were also observed in Bedfordshire (3), Northumberland (2), and Merseyside (1) in 2023 where none had been disclosed in 2022.

Notable decreases in the number of new TB incidents detected were seen in Essex (9 in 2022 to 3 in 2023), Kent (8 in 2022 to 6 in 2023), and Cambridgeshire (6 in 2022 to 4 in 2023). There was a large fall in the North West (from 26 in 2022 to 17 in 2023). This decrease in the North West was due to reduced numbers of cases in Lancashire (17 in 2022 to 11 in 2023) and Greater Manchester (9 in 2022 to 5 in 2023) (Figure 4.3.3).

Overall, the herd incidence rate in the LRA remained very low and stable (1.0 incidents per 100 herd-years at risk and 0.3 OTFW incidents per 100 herd-years at risk).

Figure 4.3.2 Total number of new TB incidents (OTF-W and OTF-S) by LRA county in 2023. Total incidents labelled on chart. NB: The figures does not show the three LRA counties that did not report any new TB incidents in 2023 (Cleveland, Isles of Scilly, and Greater London). Tyne and Wear has not had any incidents since the 1990s.

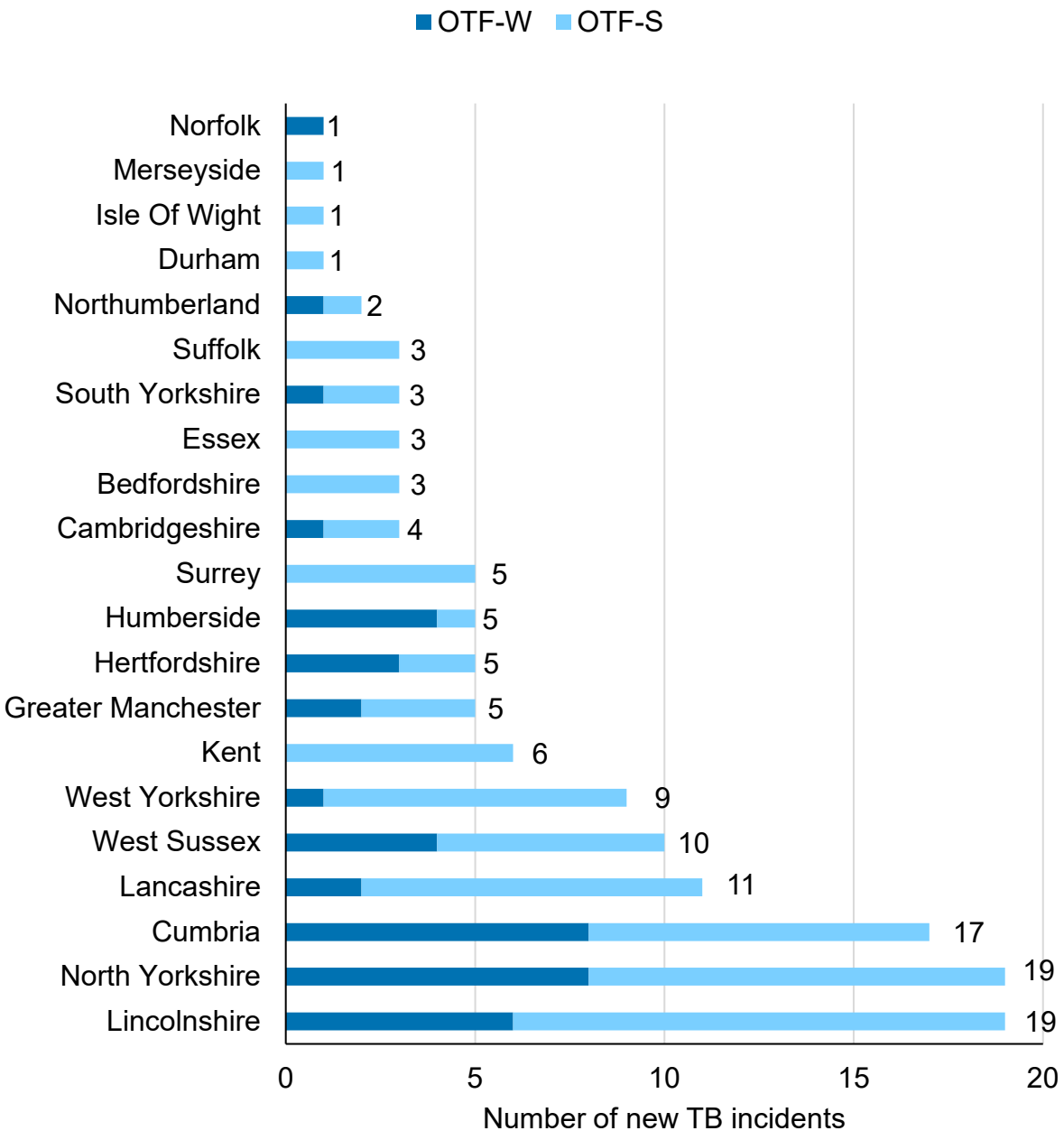


Figure 4.3.2 description: Bar chart showing the total number of new TB incidents (OTF-W and OTF-S) by LRA county in 2023. In 2023, Lincolnshire and North Yorkshire both had the highest number of new TB incidents at 19 new incidents each. North Yorkshire and Cumbria both had the most OTF-W incidents with 8 new OTF-W incidents each.

Figure 4.3.3 Annual total number of new TB incidents (OTF-W and OTF-S) by LRA county (2019 to 2023). Number of 2023 incidents labelled on chart. Not shown: two LRA counties did not report any new TB incidents between 2019 and 2023; Isles of Scilly and Tyne & Wear.

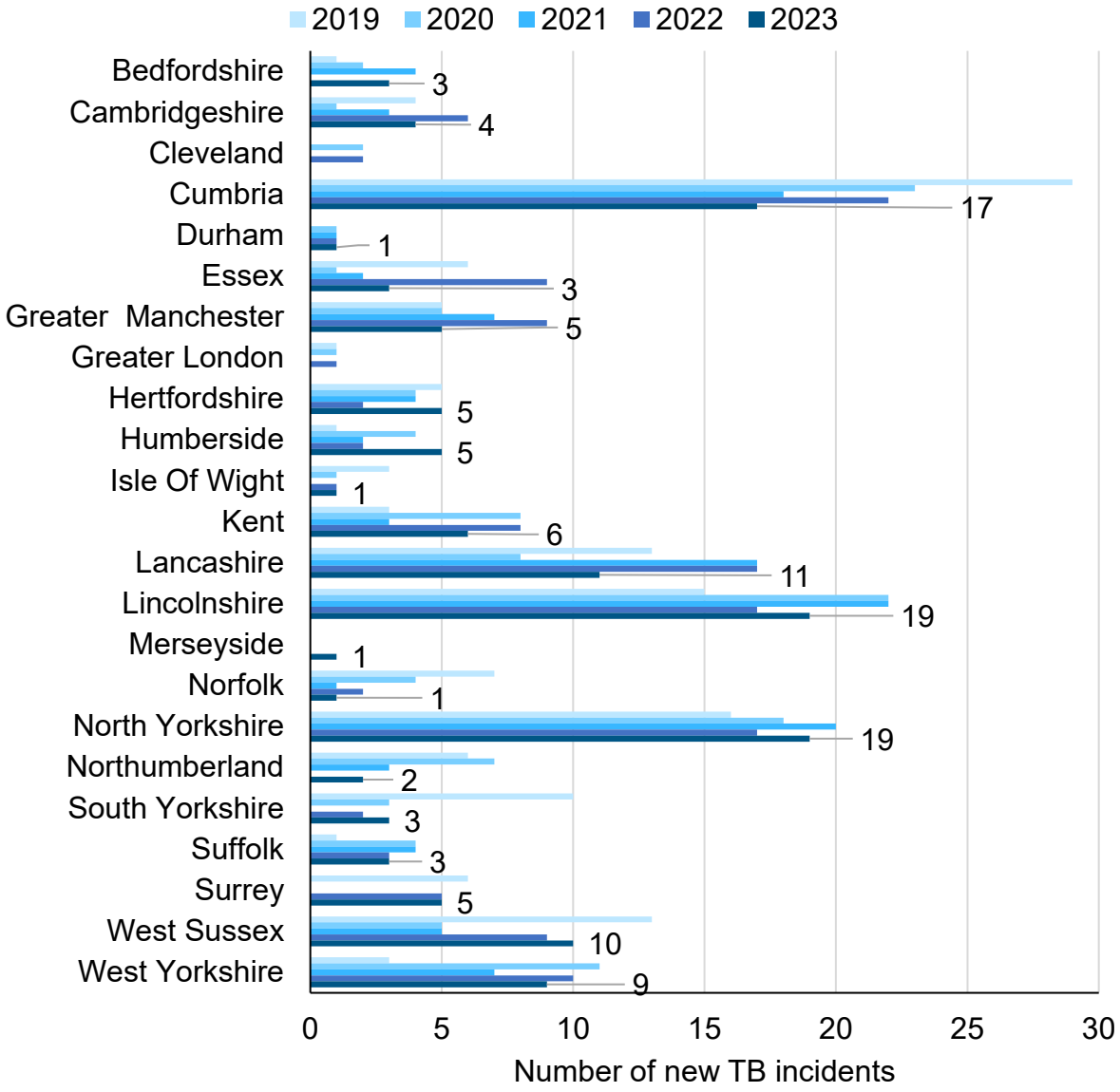


Figure 4.3.3 description: Annual total number of new TB incidents (OTF-W and OTF-S) by LRA county (2019 to 2023). Counties whose number of new TB incidents increased in 2023 compared to 2022 were West Sussex, South Yorkshire, North Yorkshire, Humberside, Hertfordshire, Merseyside, Lincolnshire, and Bedfordshire.

Sources of infection

The current methodology for determining the likely risk pathways and source of infection in new TB incidents in the LRA combines information on cattle movements into the herd with WGS data from any *M. bovis* isolates cultured from OTF-W incidents. The low number of OTF-W incidents in the LRA is reflected in the risk pathways assigned in new incidents in the LRA.

All new incidents in the LRA in 2023 (n=134) were assessed using this data-driven algorithm. Of these, 33 (25%) had WGS data available to look for evidence of local transmission of infection alongside the likelihood of being associated to infected cattle movements.
However, most (n=101, 75%) TB incidents (OTF-W and OTF-S) did not have any WGS data available and therefore could not be assessed for evidence of local transmission of infection. The 101 incidents were still assessed for the likelihood of being associated to infected cattle movements.

Of 33 incidents with WGS available, 16 (49%) had a local transmission event detected from the WGS data, as well as evidence of cattle movements associated with a high likelihood of infection. This was further split into 1 incident with evidence of non-local (more than 25km) cattle movements with a high likelihood of infection (North Yorkshire, representing 14% of incidents in the county with WGS), and 15 incidents with evidence of local (within 25km) cattle movements with a high likelihood of infection. Of these 15 incidents with WGS data available, most were from North Yorkshire (5, 71%), followed by Humberside (2, 50%). The source of infection for these incidents was unclear, as both cattle movements and local transmission events may have introduced infection in the herd.

Another 10 incidents (30%) had a local transmission event detected from the WGS data, with no evidence of cattle movements associated with a high likelihood of infection. This pathway was identified in 4 (40%) of incidents with WGS data in Cumbria and 3 (50%) incidents with WGS data in Lincolnshire. This was also the source of infection determined for the single incidents with WGS data in Greater Manchester and West Yorkshire in 2023. For these incidents, there is strong evidence of local transmission, and infection may have been introduced through residual infection in the herd, contiguous contact with infected cattle and direct/indirect contact with infected wildlife.

For 3 incidents in the LRA (9.1% of those with WGS data available), there was no local transmission event identified despite WGS data being available. These 3 incidents also had cattle movements associated with a high likelihood of infection, suggesting that these incidents were most likely due to the introduction of TB through cattle movements. Incidents with this pathway were observed in Cumbria, Lincolnshire, and North Yorkshire (1 incident each).

Another 4 incidents in the LRA with WGS data available (12%) did not have any evidence of local transmission of infection, nor any cattle movements with a high likelihood of infection identified with the TB incident. This source was attributed to most (50%, n=2) incidents in Humberside where WGS was available, the remaining two incidents occurred in West Sussex (1 incident) and Cumbria (1 incident). For these 4 incidents, the source of TB infection in the cattle remains unclear.

WGS data was not available for 101 incidents in the LRA (75% of all new TB incidents in 2023). Of these, most (n=85, 84.2%) also did not have any cattle movements associated with a high likelihood of infection. As WGS data was not available in these incidents, no further assessment on the presence of local transmission of infection could be investigated. This represented all incidents in Bedfordshire (n=3), Northumberland (n=2), Durham (n=1), Isle of White (n=1), and Merseyside (n=1).

A further 16 incidents in the LRA without WGS data had cattle movements with a high likelihood of infection, there is a strong indication that cattle movements may have played a part in introducing infection to these herds (including OTF-S incidents), but no WGS data was available to explore the possibility of local transmission of infection. These incidents were mostly in North Yorkshire (n=3); followed by Cambridgeshire, Essex, Surrey and West Sussex (n=2 each).

More details on the data and methodology for determining the risk pathways for the sources of infection can be found in Chapter 3.2 Characteristics of herds found infected with TB, Appendix 1 in the Supplementary Figures to the England Bovine TB Report and the Explanatory Supplement.

Confirmed and potential TB hotspot areas

In the LRA, hotspot procedures can be initiated by APHA around a cluster of OTF-W incidents of undetermined origin in cattle herds. Within a potential hotspot (HS), cattle herds located within at least 3km of the index herd undergo enhanced (more frequent) TB testing, and a concurrent survey of 'found dead' badgers and wild deer is implemented. If *M. bovis* infection is detected in the local wildlife that can be epidemiologically linked to the cattle TB incidents (i.e. a close genetic match between the local cattle and wildlife *M. bovis* isolates), then the potential hotspot becomes a confirmed hotspot.

In 2023, there were eight TB hotspots open in England: 5 confirmed (HS21 in Cumbria, HS23 in Lincolnshire, HS28 in Lincolnshire, HS29 in Cumbria, and HS30 in Hertfordshire) and 3 potential hotspot areas (HS24 in West Sussex, HS26 in Cumbria, and HS27 spanning Lancashire and North Yorkshire).

Hotspot 21

Confirmed Hotspot 21 (HS21) is located in East Cumbria and includes a homerange for clade B6-23 (genotype 17:z). Badger vaccination continued across a large part of the hotspot after beginning a phased move from industry-led culling operations in 2020.

There were no new OTF-W incidents and 4 new OTF-S incidents in HS21 in 2023. No WGS isolates of clade B6-23 of *M. bovis* were identified in the hotspot area for the fifth consecutive year. Similar to the previous three years, there were four new OTF-S incidents in HS21 during 2023.

In 2020, cattle herds in the outer section of HS21 became eligible to move to annual (instead of 6-monthly) TB surveillance testing, subject to certain eligibility criteria, and this area was extended in 2021 and again in 2022 to include more farms. Since October 2023, all farms in HS21 were eligible to move to annual testing, subject to certain eligibility criteria.

Hotspot 23

Confirmed Hotspot 23 (HS23) spans west Lincolnshire, north-east Leicestershire and south-east Nottinghamshire, and includes a homerange for clade B3-11. Licensed culling of badgers for TB control purposes started in parts of HS23 in September 2020 and continued for a fourth year into 2023.

In 2023 there were 14 new TB incidents in HS23 (9 OTF-W and 5 OTF-S) . This was a decrease of 6 compared to 2022 (20 incidents, 10 OTF-W and 10 OTF-S). In 2023, there were 3 OTF-W and 2 OTF-S incidents within the LRA portion of HS23 in Lincolnshire. Enhanced control measures were in place in HS23, with all cattle herds subject to annual surveillance testing and compulsory pre-movement testing.

Hotspot 24

This potential hotspot was launched in 2018 in the western half of West Sussex. Historical review of WGS phylogeny was carried out to ensure that the ongoing hotspot area in West Sussex was not closed prematurely, due to a lack of wildlife surveillance data. HS24 was formally closed in early 2024.

Hotspot 26

Since this potential hotspot was established in 2019 in South Cumbria, wildlife surveillance has not identified *M. bovis* in local badgers or wild deer. In 2023, for a third successive year there were no new incidents disclosed in HS26. This hotspot was formally closed in 2024.

Hotspot 27

Potential Hotspot 27 (HS27) was established in January 2020, straddling the south-west of North Yorkshire and the east of Lancashire.

In 2023 there were no new OTF-W incidents in the North Yorkshire part of HS27. There were three new OTF-S incidents on cattle farms around the perimeter of HS27, one of which overlapped the area. Since its implementation, only one wild deer carcase has been submitted for examination, which was *M. bovis* negative.

Hotspot 28

Potential Hotspot 28 was initially set up in late 2020 in East Lincolnshire, following the disclosure of five TB incidents with the same genotype in close proximity to each other over a short time period with no clear source of infection. HS28 became a confirmed TB hotspot following the detection of two positive badger carcases with clade B3-11 in early and late 2023 and its boundary was adjusted according to the location of cattle herds with recent TB breakdowns and associated badger carcases.

There was a total of 10 new incidents in HS28 in 2023 (3 OTF-W, 7 OTF-S). This compares to 8 incidents in 2022 (4 OTF-W and 4 OTF-S). All OTF-W incidents in 2023 were caused by WGS clade B3-11.
Enhanced control measures were in place in HS28, with all cattle herds subject to annual surveillance testing and compulsory pre-movement testing.

Hotspot 29

A new potential hotspot was established at the start of 2023 following a cluster of OTF-W incidents along the Eden Valley in East Cumbria. Clade B3-11 was detected from genetically linked incidents in 2021 and 2022, with strong supporting geographical and phylogenetic evidence of local spread of infection. A *M. bovis* clase B3-11 badger carcase was disclosed in the area as part of ‘found dead’ surveillance of wildlife in October 2023. The carcase was also related to cattle incidents locally by WGS analysis triggering the

move to a confirmed hotspot.

There were 6 new incidents in HS29 in 2023, 5 OTF-W (clade B3-11) and 1 OTF-S.

Enhanced control measures were in place in HS29 from early 2023, with all cattle herds subject to six-monthly surveillance testing and compulsory pre-movement testing. Whole herd movement restrictions are applied when only inconclusive reactors have been disclosed at a TB test.

Hotspot 30

A new confirmed TB hotspot was established in early 2023 around the town of Tring in west Hertfordshire, and spanning parts of the adjoining county of Buckinghamshire. This followed the detection of three OTF-W incidents (B6-62) in 2020 and 2021. Shortly afterwards, there was notification of a badger carcass infected with *M. bovis* clade B6-62 near Tring in February 2023, disclosed as part of the Southern Edge Area RTA Survey, meaning that the area instantly became a confirmed hotspot.

In 2023, there were two new OTF-W incidents disclosed with WGS clade B6-62 and one with WGS clade B3-11 in HS30.

Enhanced control measures were in place in HS30, with all cattle herds subject to annual surveillance testing and compulsory pre-movement testing.

Areas that require monitoring

As well as hotspot areas, APHA monitors any emerging clusters of cattle TB incidents in the LRA that may in the future require the initiation of hotspot procedures. Parts of the LRA that may be at risk of the spread of infection from adjoining areas of endemic TB in the Edge Area are also closely watched. Parts of the LRA identified as being at particular risk for this reason in 2023 included:

- Southeast Greater Manchester: one new OTF-W incident (clade B3-11) occurred in Stockport in 2023. Exposure to infected wildlife was considered the most likely risk pathway for that incident, due to:
    - historical OTF-W incidents in the same area with the same clade since 2020
    - its proximity to endemic TB areas in Cheshire and Derbyshire in the Edge
    - reports of badger activity, with TB infected badgers having been previously identified in the Stockport region (view the 2016 Edge Report and the study by Sandoval-Barron et al, 2018)
- Surrey: A cluster of OTF-S incidents occurred in central Surrey in the same location as an OTF-W incident in 2022 with an undetermined clade. The 2022 OTF-W incident was attributed to purchased infection.

- West Sussex: North of HS24, another OTF-W incident with an undetermined clade occurred in 2023 in the same location as a 2022 OTF-W incident which was also undetermined. The most likely source of infection for that incident in 2023 was determined to be contact with infected wildlife.

There are other areas within the LRA, not adjacent to the Edge Area, that also require close monitoring due to the detection of OTF-W incidents with no obvious source of infection from incoming movements of cattle in 2023:

- West Cumbria: An OTF-W incident with a novel clade in GB, B6-51, occurred near Wigton in 2023. Exposure to infected wildlife was considered the most likely risk pathway for the incident and the area is being kept under review.
- Central Lancashire: there was one OTF-W incident with WGS clade B6-84 where the source of infection was undetermined. A previous incident in 2021 occurred in another farm 8 miles away with the same clade.
- West Lancashire: there was one OTF-W incident with clade B6-86 which is uncommon in Great Britain and is thought to have a homerange in Scotland. The source of this incident was unknown and exposure to wildlife is possible. The isolate was 5 SNPs away from an isolate detected in a cattle incident in 2020 in Scotland and 4 SNPs away from a 2022 sheep isolate in Wales.
- West Sussex: there was one OTF-W incident with clade B6-11 in 2023. The source of this incident was undetermined.
- North Yorkshire: in 2023, there was one incident with WGS clade B3-11 that occurred to the east of an area where this clade has been detected every year since 2019. Contact with wildlife was the most likely source of infection for this incident.
- Northumberland: the source of one OTF-W incident in a beef-suckler herd with clade B6-84 was unknown, and supplementary gamma testing revealed one additional positive reactor with no visible lesions at slaughter. The herd had not had any cattle movements onto the farm in the previous 5 years nor any evidence of wildlife activity in the area.
- Humberside: the source of one OTF-W incident in the north of Humberside caused by infection with clade B6-11 of *M. bovis* was undetermined, but contacts with infected cattle and deer were possible.
- West Yorkshire: one OTF-W incident caused by the WGS clade B3-11 of *M. bovis* was disclosed in the south of the county in 2023. Since 2020, there have been 6 OTF-W incidents detected in West Yorkshire. All except one were caused by infection with clade B3-11. The source of this infection was undetermined. APHA is carrying out a review of TB incidents in West Yorkshire.