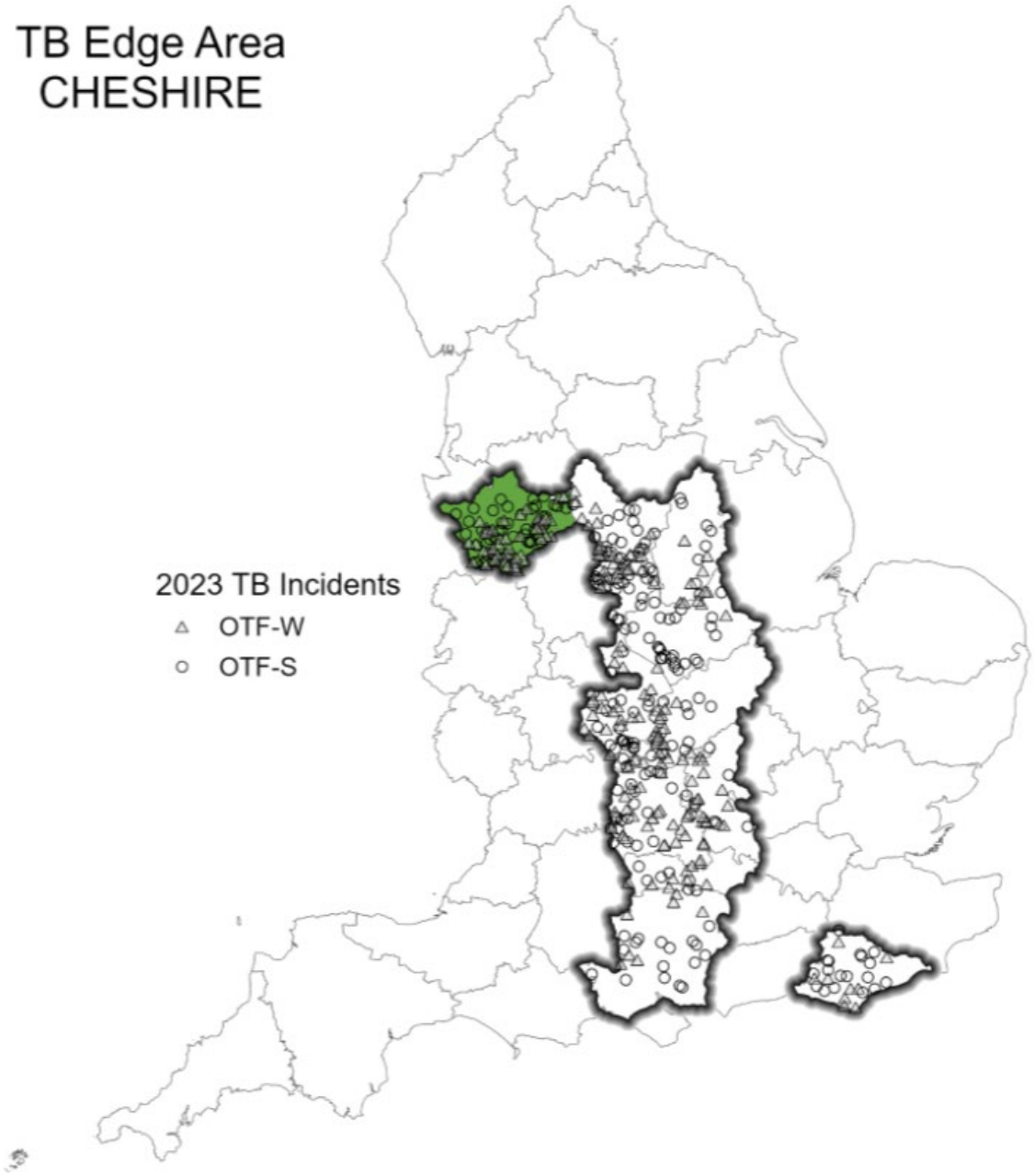
Animal &
Plant Health
Agency

Year End Descriptive Epidemiology Report: Bovine TB in the Edge Area of England 2023

County: Cheshire



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Introduction

The Edge Area was originally established in 2013, along with the Low Risk Area (LRA) and High Risk Area of England. In 2014, the 3 bovine tuberculosis (TB) risk areas were incorporated into the UK government's strategy to achieve Officially TB-Free (OTF) status for England by 2038. A key action was to recognise the different levels of TB in different parts of the country and to adjust the approaches to TB surveillance and control in each risk area accordingly. The current aim is to obtain OTF status for the Edge Area as soon as possible.

This report describes the frequency and geographical distribution of TB in cattle herds in Cheshire, an Edge Area county, in 2023. It examines what factors are likely to be driving TB in this area, and the risks the disease in this county may pose to neighbouring areas.

TB in cattle and other mammals is primarily caused by the bacterium *Mycobacterium bovis* (*M. bovis*), and the disease is subsequently referred to in this report as TB. Although other sources may refer to TB 'breakdowns', this report will use the term 'incidents' throughout.

This report is intended for those involved in the control of TB, both locally and nationally. This includes, but it is not limited to, cattle farmers, government and private veterinarians, policy makers and the scientific community.

Details of the data handling methodology used in this report, a glossary of terms, and the TB control measures adopted in the Edge Area, can be found in the explanatory supplement for the annual reports 2023.

Types of TB incidents

Unless otherwise specified, this report includes all new TB incidents detected during the reporting period (1 January to 31 December 2023). This includes both 'Officially Tuberculosis-Free Status Withdrawn' (OTF-W) and 'Officially Tuberculosis-Free Status Suspended' (OTF-S) incidents.

OTF-W incidents are those involving at least one skin test reactor, an animal positive to the Single Intradermal Comparative Cervical Tuberculin (SICCT) test, with either:

- typical lesions of TB identified at post-mortem (PM) meat inspection
- at least one animal with *M. bovis*-positive polymerase chain reaction (PCR) test, or bacteriological culture results in tissue samples collected from carcasses during the PM inspection

OTF-S incidents are triggered by reactors to the skin test, but without subsequent detection of TB lesions or positive PCR test, or culture, results in any of those animals.

TB incidents in Approved Finishing Units (AFUs) without grazing are not included in the prevalence and incidence calculations in this report, due to the limited epidemiological impact of these incidents.

Furthermore, the number of TB incidents and designation of those incidents as OTF-W or OTF-S may differ in this report compared to other official TB statistics, due to differences in the information available at the time datasets are accessed.

Cattle industry

Cheshire is predominantly a dairy county (68% of cattle) with some beef fattener and suckler herds of varying sizes, calf rearers, smallholders and pet cattle (see Appendix 1). Of all the cattle herds in the county, 53% contained up to 100 animals and 10% had over 500 animals, as shown in Appendix 1. The total number of cattle herds in Cheshire has reduced by 6% since 2022, as indicated in Appendix 2.

In Cheshire, there are no livestock markets. The closest markets are in Shropshire and Staffordshire, both in the HRA, and one in North Wales, all of which are frequently used by Cheshire cattle farmers. There were 4 abattoirs operating in Cheshire in 2023 and several larger throughput abattoirs within 30 miles of Cheshire. There were 36 AFUs without grazing in 2023, compared to 35 in 2022. There was also one exempt finishing unit (EFU).

Cheshire was originally divided between 2 TB risk areas: HRA in the southern quarter of the county along the border with Shropshire, and the Edge Area, in the rest of the county. The whole of Cheshire was fully incorporated into the Edge Area in January 2018 and cattle herds in Cheshire have been under a routine 6-monthly TB surveillance testing regime since January 2015 (in the original Edge Area portion) and January 2018 (rest of the county).

Herds that meet certain criteria and thus are identified as having a lower risk of TB, can benefit from “earned recognition” whereby they are tested annually. In Cheshire, 39% of cattle herds were regarded as having a lower risk of contracting TB, and thus eligible for annual testing under the earned recognition scheme in 2023.

The number of cattle markets in operation in 2023 is captured and maintained centrally by the Animal and Plant Health Agency (APHA) TB Customer Service Centre. Where possible, this data is then subject to further validation by APHA veterinarians subject to their best knowledge of the local area. Some small discrepancies may therefore exist where changes to markets were not captured in time for this report.

New TB incidents

The number of new TB incidents decreased by 12% in 2023, from 114 in 2022 to 100 in 2023, as shown in Figure 1. This was due to a 27% drop in new OTF-W incidents (down from 64 in 2022, to 47 in 2023). OTF-S incidents increased by 6% (up from 50 in 2022 to 53 in 2023).

Since 2017, there has been a steady decline in the total number of incidents from 181 to 100 in 2023 (45%) and the 2023 total was the lowest figure recorded in the county for the past 10 years.

The majority of this decrease was seen in the original Edge Area portion (the northern three quarters) of the county. Here there was a 35% decrease in the number of OTF-W incidents, with a 5% decrease in OTF-S incidents. This is likely to be a result of the control measures aimed at the early detection and removal of infected cattle, alongside badger TB control measures, leading to reduced environmental contamination with *M. bovis*.

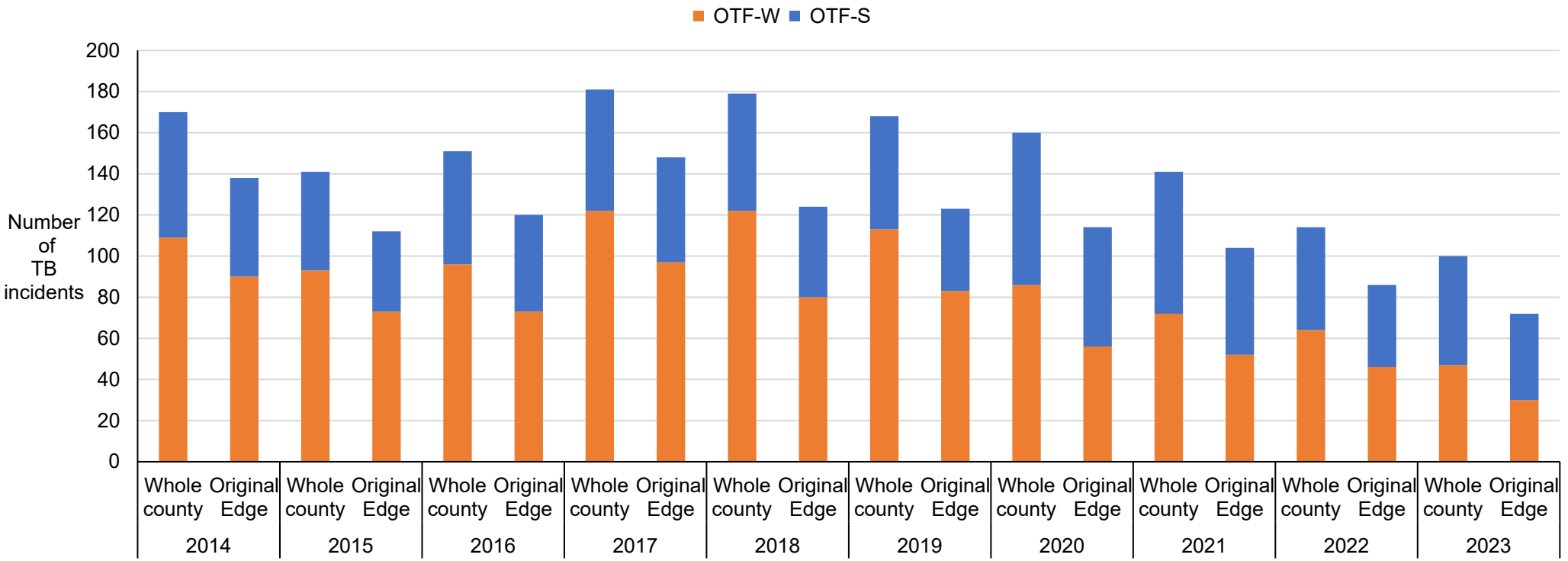

Figure 1: Annual number of new TB incidents in Cheshire, from 2014 to 2023.

Figure 1 description: Bar chart showing the number of confirmed TB incidents (OTF-W, in orange) and suspected (OTF-S, in blue) in the whole of Cheshire and the original Edge part of Cheshire (prior to the incorporation of the HRA part in 2018) between 2014 and 2023. In 2023, there were 100 TB incidents in the whole county, 47 OTF-W and 53 OTF-S. Out of those 100, 30 OTF-W and 42 OTF-S were in the original Edge Area of Cheshire.

In 2023, 81% of the total number of new TB incidents occurred in dairy herds (75% OTF-W incidents and 87% OTF-S incidents). Beef fattener herds (excluding AFUs) accounted for 9% of all new TB incidents and beef suckler herds also accounted for 9%.

Herds with 201 or more cattle were responsible for 73% of all new incidents compared to herds of 200 or fewer cattle (27%).

This is similar to the findings in 2021 and 2022 and reflects the fact that there are more large dairy herds than large beef herds (as shown in Appendix 1) and TB incidents are more likely to occur in large herds. Additionally, dairy cattle will remain on farm longer than beef fattening cattle. As a result, they may be more likely to be exposed to repeated environmental contamination in pasture or at housing during their lifetime. This is compared to intensive beef fattening herds which tend to stay indoors and consume preserved forage and concentrates.

These findings are consistent with herd size and cattle production type being risk factors for TB in Cheshire.

Disclosing test types

As in previous years, whole herd testing continued to detect the most incidents of TB in Cheshire in 2023. This was followed by 6-month post-incident check testing, and slaughterhouse surveillance, as shown in Figure 2. In 2023, as also seen in 2022, there were no incidents disclosed by tracing tests. This may be indicative of a change in risk awareness.

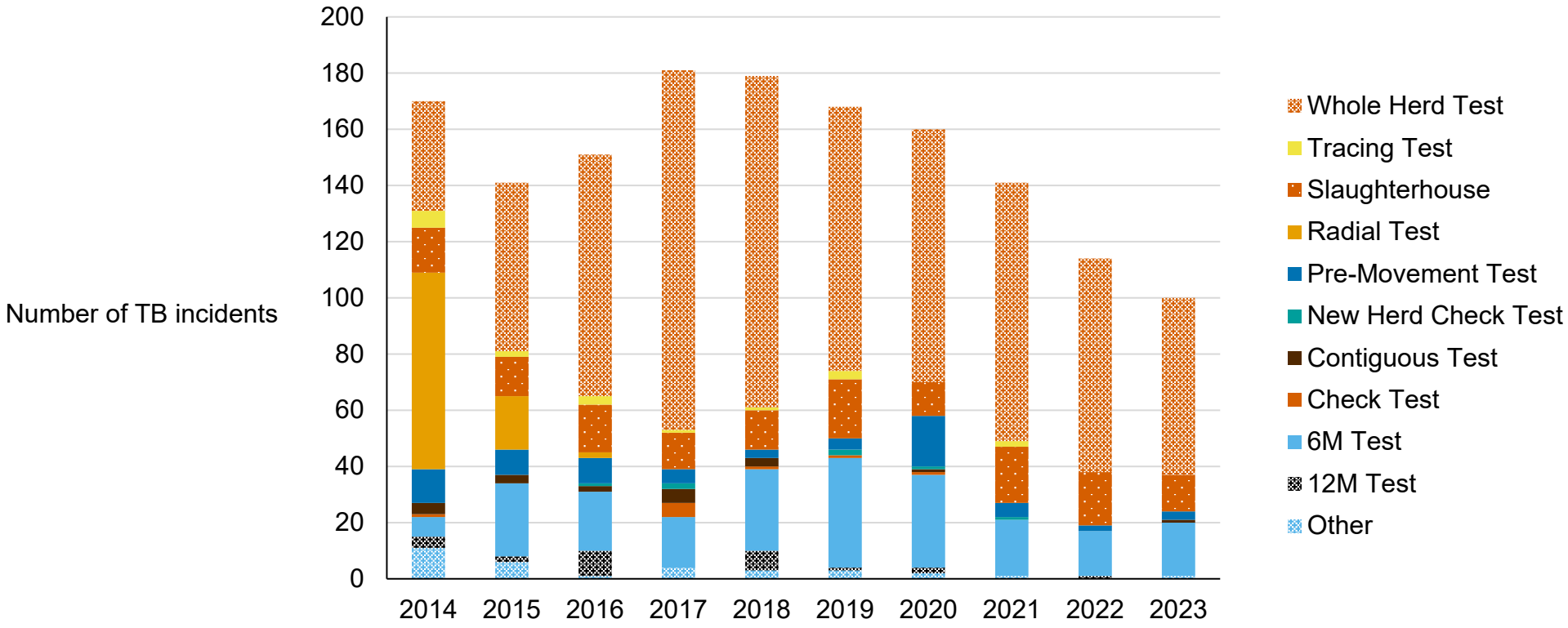

Figure 2: Number of new TB incidents (OTF-W and OTF-S) in Cheshire in 2023, according to the surveillance methods that detected them.

Figure 2 description: A bar chart showing the number of new TB incidents disclosed by test type in Cheshire between 2014 and 2023. In 2023, most incidents were disclosed by whole herd tests (63), followed by a 6-month post-incident test (6M test, 19), slaughterhouse cases (13), pre-movement tests (3), contiguous testing (1) and “Other” test type (1).

There were fewer incidents as a result of slaughterhouse surveillance than in previous years (32% decrease), but more incidents disclosed at the 6-month test carried out 6 months after the conclusion of a TB herd incident (19% increase) compared to 2022. The reason for this is unclear, though several factors may be involved. This includes the:

- reducing overall herd incidence and prevalence of TB in Cheshire
- several years of six-monthly whole-herd testing regime in the county
- mandatory interferon gamma (IFN-γ) testing of recurrent OTF-W incident herds

In Cheshire and other parts of the Edge Area under 6-monthly TB surveillance testing not all herds experiencing OTF-W incidents are automatically eligible for mandatory IFN-γ testing in parallel with the skin test. This may also reduce the overall sensitivity of the short-interval testing regimen in such herds, thereby increasing the risk of further infected cattle being identified at the 6-month test.

Duration of TB incidents

A total of 100 TB incidents were resolved in Cheshire during 2023. Of these, 44 were new TB incidents that started in 2023, 54 started in 2022, one started in 2021 and one started in 2020.

The median duration of OTF-W incidents that ended in 2023 was 177 days, interquartile range (IQR) 151.5 to 226.5, which is 7% lower than 2022. Two OTF-W incidents took over 550 days to resolve, but the majority (34 out of 44) were resolved within 240 days. Most OTF-S incidents that ended in 2023 (51 out of 56) were resolved within 240 days, however 5 took between 241 and 550 days to resolve, and the median was 151.5 days (IQR 142 to 166), 9% lower than 2022.

There were 3 TB incidents still open in Cheshire at the end of 2023 that had lasted for more than 550 days, compared to one in 2022 and 5 in 2021.

The median duration for all incidents that ended in 2023 in Cheshire was 158 days (IQR 146 to 207.5). This is shorter than the duration of incidents that closed in 2022, with a median of 173 days (IQR 152.5 to 235). For the whole Edge Area, the median duration of TB incidents that closed in 2023 was 188 days (IQR 159 to 265).

There were 58 TB incidents still open at the end of the reporting year on 31 December 2023. This included 14 OTF-W and one OTF-S incidents which were considered persistent (more than 550 days under restrictions).

Unusual TB incidents

In the last quarter of 2023, a new cluster of several TB incidents with large numbers of skin test reactors developed south of Nantwich, in the original HRA section of Cheshire. Whole

Genome Sequencing (WGS) and phylogenetic analysis showed that the *M. bovis* isolates obtained from those incidents were identical or very closely related to each other genetically, and all within the homerange for their WGS clade B3-11. There were other very closely related isolates in the locality and from incidents detected just over the border in Shropshire. On investigation, there were no known cattle, personnel or equipment links between the affected farms, and indirect transmission potentially from infected badgers was suspected to be the most likely source. The high numbers of reactors disclosed was concerning and unexpected within a 6-monthly herd testing regime, so is likely to be the result of generalised cattle exposure to infection within a short time window as there were very few visible lesions of TB at slaughter, but multiple farms affected.

During 2023, a total of 6 incidents across the county were classed as chronic (this means lasting longer than 12 months). Four of those incidents became persistent (this means lasting more than 550 days), triggering enhanced management procedures. All those incidents involved dairy farms, where infection had likely become persistent for various reasons including co-infection with Johne's Disease (*Mycobacterium avium* subspecies *paratuberculosis*) or continued indirect transmission from infected wildlife.

In another explosive incident disclosed in a 'flying' dairy herd near Nantwich in the last quarter of 2023, clade B1-11 of *M. bovis* was isolated. The location of the affected farm was just within the homerange of this clade, which is more commonly found in the southern half of Shropshire. There were also cattle movements from that area into the affected herd. The gross pathology of TB associated with the animals removed during this incident was quite severe, with many pulmonary lesions found and some evidence of reduced host responsiveness to tests measuring immunity to *M. bovis* infection.

In 2023, the south Duddon cluster (which lies 8km east of Chester along the A51 within West Cheshire) continued to expand eastwards towards Utkinton, with some evidence of recurrence of infection in some herds indicating ongoing exposure to infection. The *M. bovis* isolates associated with those incidents were shown to be genetically identical or very closely related on WGS. Likely risk pathways included exposure to infected badgers and residual cattle infection, but there was no evidence of cattle movement involvement. Two of the affected farms were previously on annual TB surveillance testing.

In the previous annual report, there were two explosive TB incidents involving neighbouring herds in north-east Cheshire, which were ongoing at the end of 2022 and identified as chronic infections. Between them, 124 skin test reactors and interferon gamma test positive animals were removed out of a total of 280 cattle tested on both affected farms. Both incidents were resolved at the end of 2023. The two affected farms had large numbers of wild red deer co-grazing with the cattle, and badger activity at pasture was detected. The two farms were within the homerange of the *M. bovis* clade B3-11, associated with these incidents, which were genetically very closely related to other local isolates of the bacterium.

Unusually, there were two incidents on separate farm premises involving cows with suspected tuberculous mastitis and mesenteric, retropharyngeal, bronchial, and mediastinal lesions. This led to likely milk-borne spread via pooled milk fed to calves. These calves were sold under 42 days of age and moved onto other farm premises. This resulted in multiple secondary incidents due to likely infected cattle being moved out of the primary incident herds. Some of the secondary incidents pre-dated the primary herd incidents and others were detected via forward (spread) tracings from the primary herd. Both cows were identified and slaughtered and there were no further traced incidents. This scenario tends to be sporadic, so it was unusual to encounter two incidents in 2023 associated with milk-borne spread of infection from milking cows to calves.

There was another TB incident on a dairy farm retailing raw milk for human consumption, but there was no evidence of udder infection and there were no reports of zoonotic infection associated with this farm. The reactors had broncho-mediastinal lesions, and all calves were fed milk replacer. Raw milk sales cease while TB restrictions are in place.

There was one incident, ongoing since 2022, with suspected Johne's Disease (*Mycobacterium avium paratuberculosis*) and *M. bovis* co-infection. The incident was still ongoing at the end of 2023.

TB in other species

There is no statutory routine TB surveillance of non-bovine species, apart from Post-Mortem Examination (PME) of animals slaughtered for human consumption, or carcasses submitted to veterinary laboratories for diagnostic investigations. Targeted TB testing takes place in non-bovine herds under TB movement restrictions due to laboratory-confirmed incidents of *M. bovis* infection, and in specific herds of camelids, goats and captive deer at an elevated risk of infection.

There were no new incidents of TB in other non-bovine farmed and captive species in Cheshire in 2023.

Anecdotally, there have been culled wild red deer with suspect lesions of TB in north-east Cheshire, which were not notified to APHA. Reporting of suspect tuberculous deer carcasses to APHA is a legal requirement. It is essential to help increase the understanding of TB infection in wildlife populations and the role they play in the transmission of TB.

Incidence of TB

Cheshire had a herd incidence rate of 9.0 new TB incidents per 100 herd-years at risk in 2023, a decrease of 14.7% on the rate recorded in 2022 (10.6). This was the third highest incidence out of the 11 Edge Area counties. The herd incidence in Cheshire was also higher than that for the whole of the Edge Area (7.2), but this has been the same since

2014 and may be a reflection of the high number of large dairy herds affected than elsewhere in the Edge Area. The incidence of TB per 100-herd years at risk has been declining in Cheshire since 2019. In 2023, it reached its lowest levels over the last 10 years, especially in the original Edge Area of the county, as shown in Figure 3.

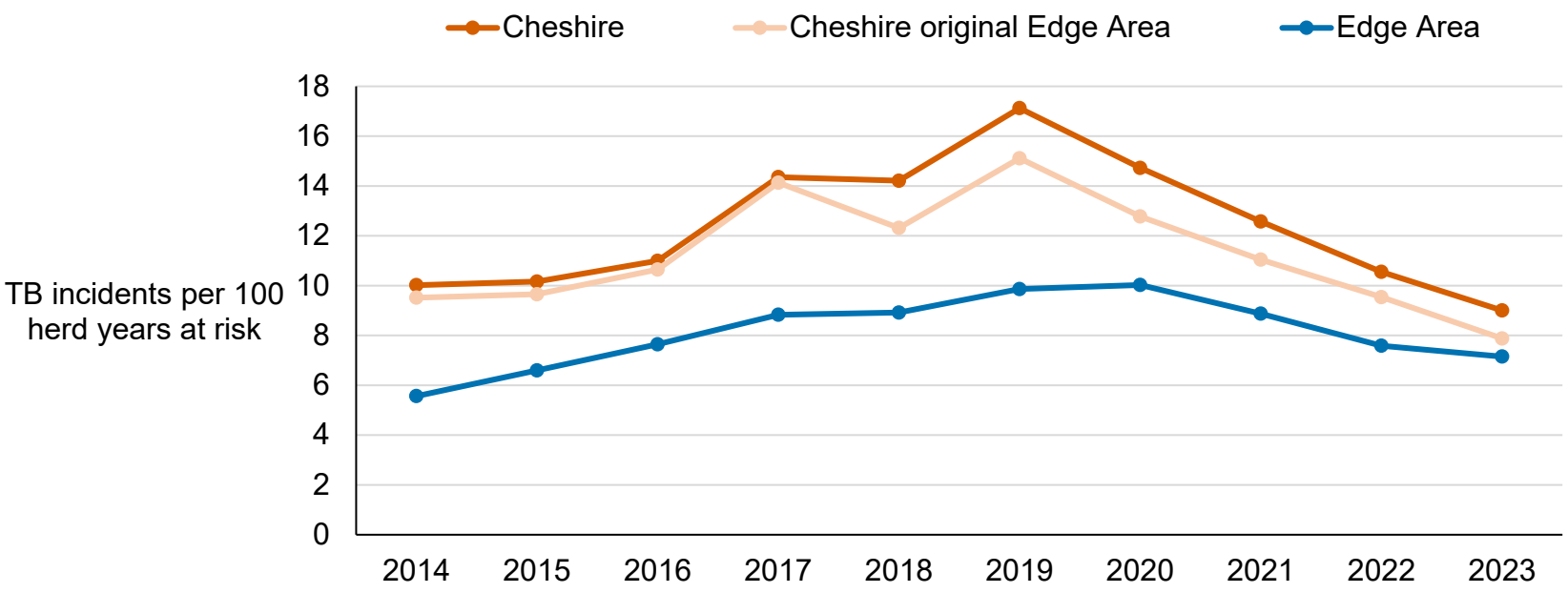

Figure 3: Annual incidence rate (per 100 herd-years at risk) for all new incidents (OTF-W and OTF-S) in Cheshire, from 2014 to 2023.

Figure 3 description: Line chart showing the incidence rate of new TB incidents per 100 herd years at risk (100 HYR) in Cheshire, the original Edge Area of Cheshire, and the overall Edge Area between 2014 and 2023. Incidence in Cheshire and in the original Edge part of Cheshire has been declining consistently since 2020, falling to the lowest level seen in the last 10 years. In 2023, the incidence rate in Cheshire overall was 9.0 new incidents per 100 HYR, and 7.9 new incidents per 100 HYR in the original Edge Area of Cheshire. In the Edge Area overall, incidence in 2023 was 7.2 new incidents per 100 HYR.

Prevalence of TB

For the first time since 2017 herd prevalence did not decrease in Cheshire, increasing slightly from 4.3% in 2022 to 4.4% in 2023, see Figure 4. However, this is significantly reduced from the peak herd prevalence reported in 2017 (8.5%) and was the second lowest herd prevalence reported in the county in the last 7 years. In the original Edge Area of the county, the herd prevalence decreased marginally from 3.7% in 2022 to 3.6% in 2023, continuing the downward trend seen in that area since 2019.

A number of factors may have contributed to decline in prevalence since 2017, such as:

- the badger TB control measures, including both culling and vaccination
- increased awareness of herd biosecurity
- increased knowledge of TB transmission routes (as a result of engagement with private vets, APHA advice, TB Hub, TB Advisory Service visits)
- more sensitive testing of herds affected by TB incidents including IFN-γ
- compliance with TB control measures with prompt removal of infected animals
- 6-monthly routine herd testing

Cheshire had the fourth highest end of year prevalence out of the 11 counties in the Edge Area. This was higher than the overall rate for the whole of the Edge Area in 2023 (3.7%).

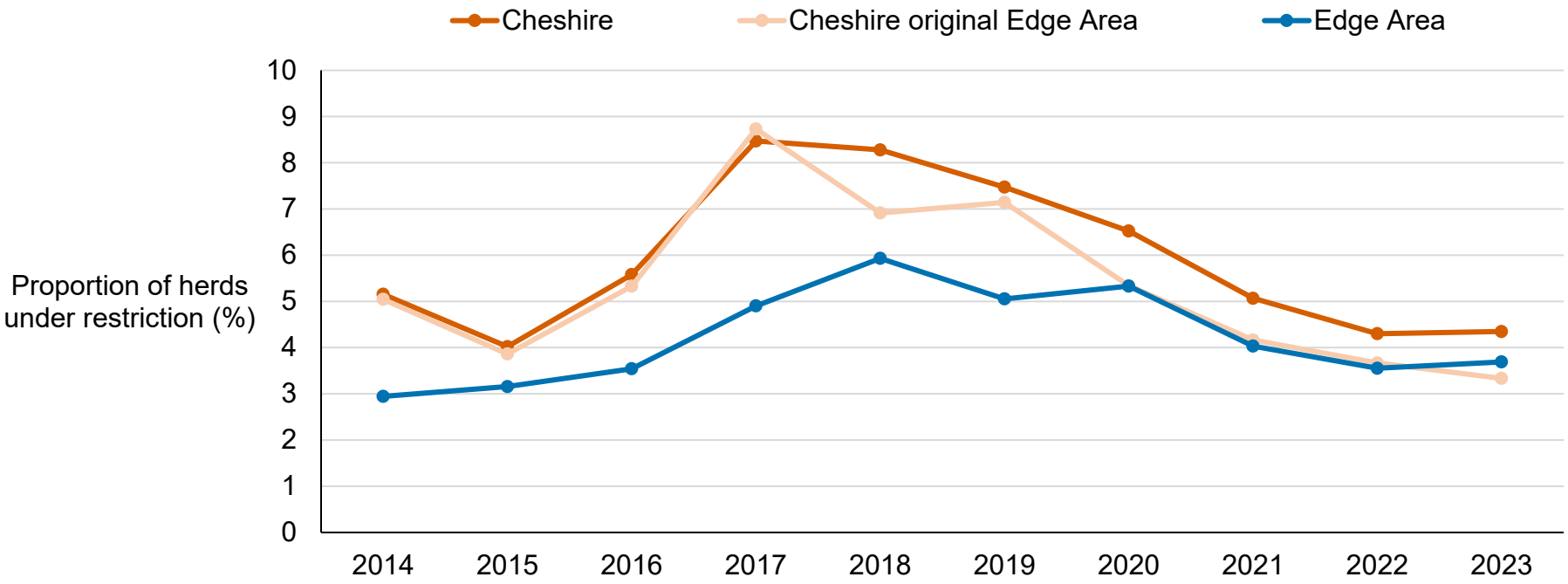

Figure 4: Annual end of year prevalence in Cheshire, from 2014 to 2023.

Figure 4 description: Line chart showing the annual end of year prevalence in Cheshire overall, in the original Edge Area of the Cheshire county, and within the overall Edge Area, between 2014 and 2023. Annual end of year prevalence has been decreasing consistently since 2018 in Cheshire overall. However, though there is a general decreasing trend, there was more variation between 2016 and 2019 in the Edge part of Cheshire, with a decrease in prevalence in the area in 2018 and a slight increase in 2019.
In 2023, the end of year prevalence for Cheshire was 4.4% of herds placed under TB restrictions in the county. This was the lowest level seen since 2016. In the original Edge part of Cheshire, prevalence was 3.3% of herds placed under TB restrictions, the lowest level since 2013 and lower than the prevalence for the Edge Area overall. Prevalence in the Edge Area overall in 2023 was 3.7% of herds.

Recurring TB incidents

Three-year recurrence

In Cheshire, 69 (69%) of new TB incidents in 2023 occurred in herds that had another TB incident in the past 3 years, as shown in Figure 5. There was a higher percentage of OTF-S herds with another TB incident in the previous 3 years compared to OTF-W herds (72% and 66% respectively).

The percentage of new incidents which recurred in herds with a history of TB in the previous 3 years was higher in Cheshire (69%) than the overall Edge Area (54%). The reasons for this are unclear and may be multi-factorial. They include the demographic population of cattle by stocking density and herd type. Cheshire has a relatively high density of dairy cattle with a large herd size. Dairy cattle have been identified as being at higher risk of contracting TB in Cheshire due to their longevity and herd size compared to beef cattle, which may be more commonly affected in other Edge Area counties. Other factors may include wildlife populations, farming practices or the changes to the IFN-γ testing policy introduced in Cheshire and other six-monthly surveillance parts of the Edge Area in July 2021, whereby only re-occurrent and persistent OTF-W incidents are automatically eligible for mandatory blood testing.

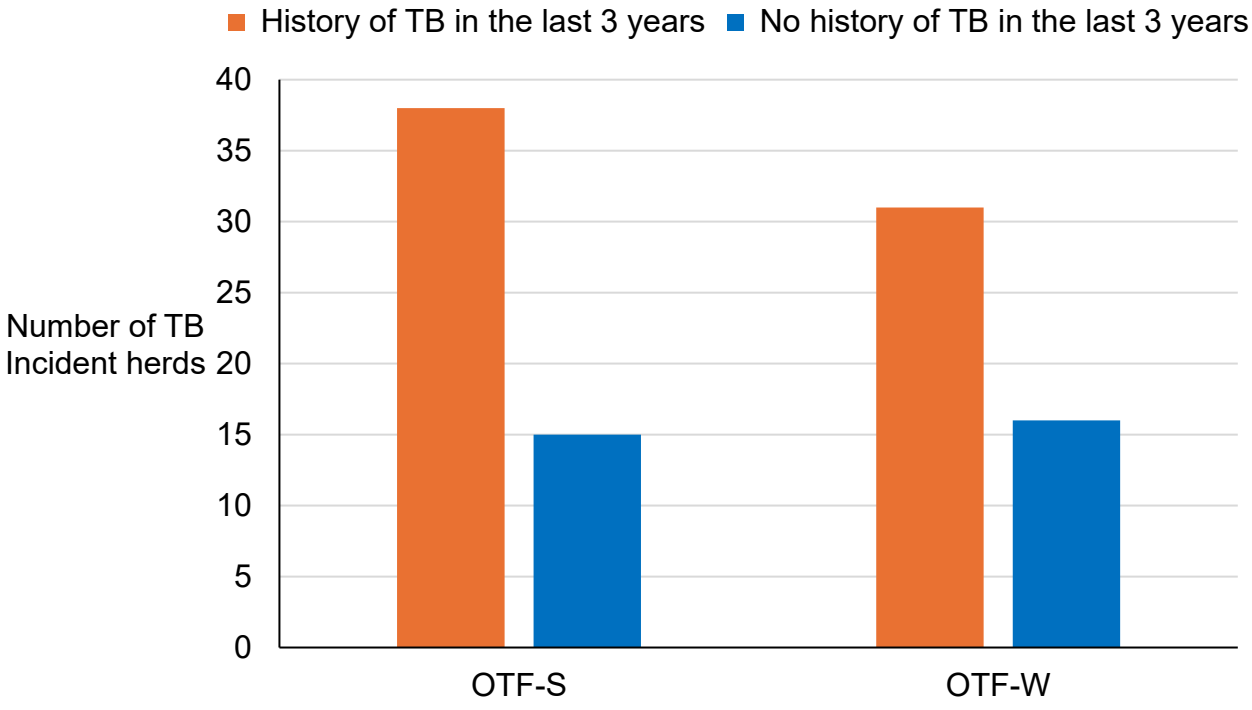

Figure 5: Number of herds with a TB incident (by OTF-W and OTF-S) in Cheshire in 2023, with and without a history of any TB incident in the previous 3 years.

Figure 5 description: Bar chart showing the number of herds with (in orange) and without (in blue) a history of a TB incident in the last 3 years in 2023, for OTF-S and OTF-W herds. A description of the data is provided in the text.

Overall recurrence

In 2023, 86% of incidents reported across the region were in herds with a history of TB in the herd's lifetime, including more than 3 years previously (47 out of 53 OTF-S and 39 out of 47 OTF-W), as shown in Figure 6.

Overall recurrence of TB decreased slightly compared to 2022 (87%, 44 out of 49 OTF-S and 54 out of 64 OTF-W).

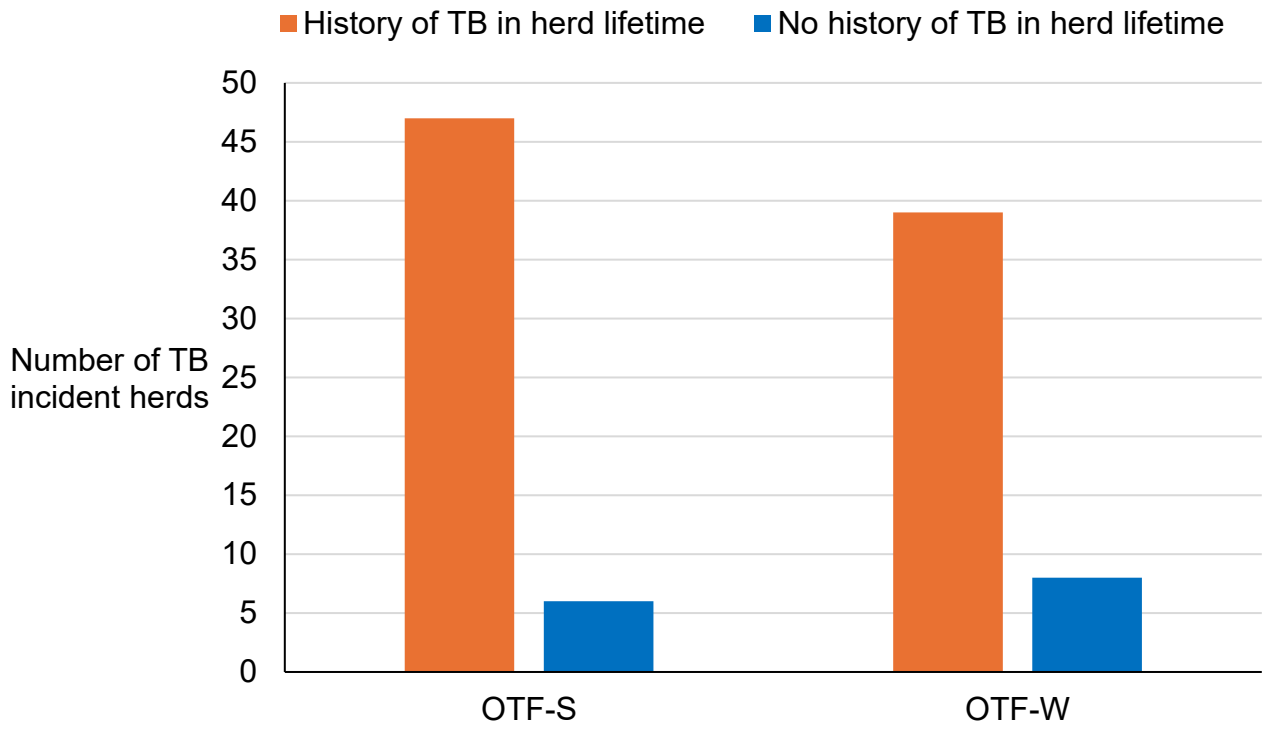

Figure 6: Number of herds with a TB incident (by OTF-W and OTF-S) in Cheshire in 2023, with and without a history of any TB incident during the herd's lifetime.

Figure 6 description**:** Bar chart showing the number of herds with (in orange) and without (in blue) a history of a TB incident in the herd's lifetime in 2023, for OTF-S and OTF-W herds. A description of the data is provided in the text.

Geographical distribution of TB incidents

As stated above, the incidence rate in Cheshire for 2023 was 9.0 incidents per 100 herd years at risk (third highest in the Edge Area), lower than the contiguous HRA counties of Shropshire (12.1) and Staffordshire (9.5), and higher than the contiguous Edge Area county of Derbyshire (5.9). Shropshire and Staffordshire remain a potential risk to Cheshire via cattle movements from those areas and potential movements of wildlife across the county borders.

There were clusters of incidents in several locations in Cheshire, mostly in similar locations compared to 2022. In 2022, a cluster developed along the A51 between Tarporley and Tarvin (South-Duddon) which extended eastwards in 2023. There was evidence of recurrence and WGS has shown close phylogenetic relationships between the isolates which belong to clade B3-11. The Nantwich cluster appeared in the last quarter of 2023 involving the parishes of Newhall, Buerton, Hankelow, Walgherton, Audlem, adjoining Wrenbury Cum Frith, Norbury, Austerson, Broomhall, Coole Pilate and Baddington. There were also small clusters of incidents centred on the parishes of Siddington, Clotton Hoofield, Winsford, Somerford, Swettenham, Lower Withington and Brereton. These are all areas of high cattle density.

North Cheshire remains clear of TB incidents in 2023, see Figure 7, but this is probably due to the lower cattle herd stocking density.

Parts of Cheshire are within the homerange for clades B1-11, B3-11, B6-11, B6-22 and B6-62.

The predominant clades of *M. bovis* isolated from cattle in Cheshire continued to be: B3-11 (66%, which includes isolates of spoligotype 25 such as genotype 25:a), and B6-11 (15%, which includes isolates of spoligotype 17 such as 17:a). Clade B6-22 was not detected in 2022 but was the third most common clade isolated in 2023 (7%, which includes isolates such as 9:d) (Figure 7). There were 2 incidents associated with clades B6-83 and B6-62 and one incident each caused by clades B4-11 and B1-11 respectively. There was one incident west of Nantwich in a ‘flying’ dairy herd caused by infection with clade B1-11 of *M. bovis* (which includes isolates such as genotype 35:a). This clade is commonly found in Shropshire and has been seen in recent years in small numbers in the same area. It is suspected that there are still infected badgers with this strain locally, although in much reduced numbers than previously.

Figure 7 shows the likelihood that cattle movements were associated with the source of the TB infection, according to the cattle movement algorithm. This algorithm is explained in more detail in the section ‘main risk pathways and key drivers for TB infection’ and in the explanatory supplement for the annual reports 2023. Similar to 2022, most incidents appear to be assessed as having a low to medium cattle movement likelihood.

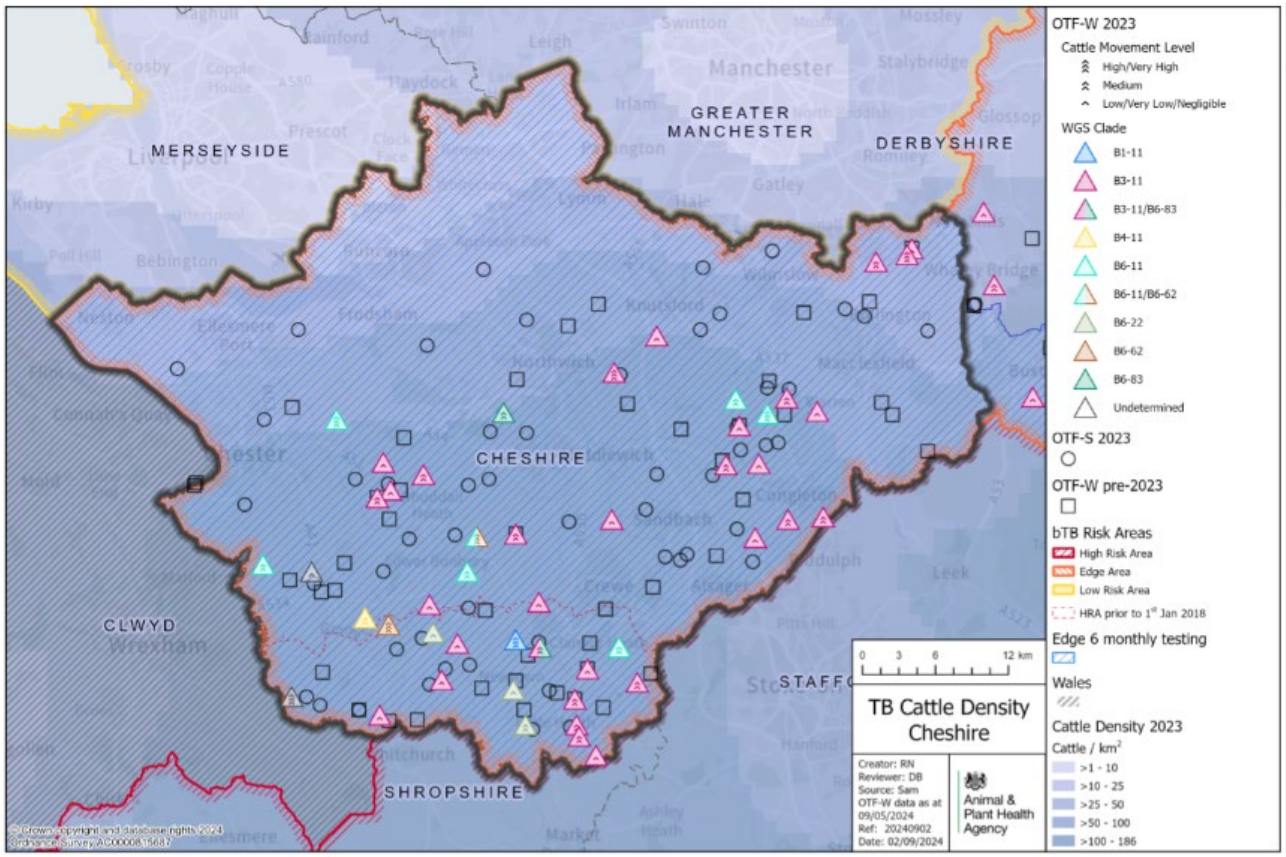

Figure 7: Location of cattle holdings in Cheshire with new TB incidents (OTF-W and OTF-S) in 2023 and cattle holdings with pre-2023 OTF-W incidents still ongoing at the beginning of 2023, overlaid on a cattle density map. The movement score for each farm is symbolised with 3 chevrons for cattle movements associated with a high likelihood of infection, 2 chevrons for a medium likelihood and one chevron for a low likelihood.

Figure 7 description: Map of the Cheshire showing the locations of cattle holdings in Cheshire with new TB incidents (OTF-S and OTF-W) in 2023 and pre-2023 OTF-W incidents on the map. The 2023 OTF-W incidents are shown as triangles, 2023 OTF-S as circles and pre-2023 OTF-W as squares. The 2023 OTF-W incidents are also coloured by WGS clade, and contain chevrons to show the cattle movement algorithm score allocated to the incident (low/medium/high risk of cattle movements). Most incidents occurred in the south and east of the county – further detail provided in the text.

Skin test reactors and interferon gamma test positive animals removed

In 2023, the downward trend in TB test positive animals removed from herds in Cheshire since 2018 continued, where a total of 812 test positive animals were recorded, as shown in Figure 7. This was the lowest total number of test positive animals removed from herds in Cheshire since 2014, when 1,526 positive animals were detected. Of the 812 test positive animals in 2023, 644 (79%) were skin test reactors, compared to 753 (76%) in

2022. Only 168 (21%) of animals removed for TB control reasons in 2023 were IFN-γ test positive, compared to 242 (24%) in 2022. This remains much lower than 2021 (499, 42%), and could be due to the change in the IFN-γ testing policy introduced in Cheshire and other 6-monthly surveillance parts of the Edge Area in July 2021, whereby only re-occurrent and persistent OTF-W incidents are automatically eligible for mandatory blood testing. This includes herds which have had a new incident within 18 months of a previous incident. Previously, all new OTF-W incidents in Cheshire were eligible for sampling. APHA can also undertake discretionary IFN-γ testing in TB incident herds where testing is likely to be beneficial, such as those with a large percentage of skin test reactors, or where there are particular groups of cattle affected.

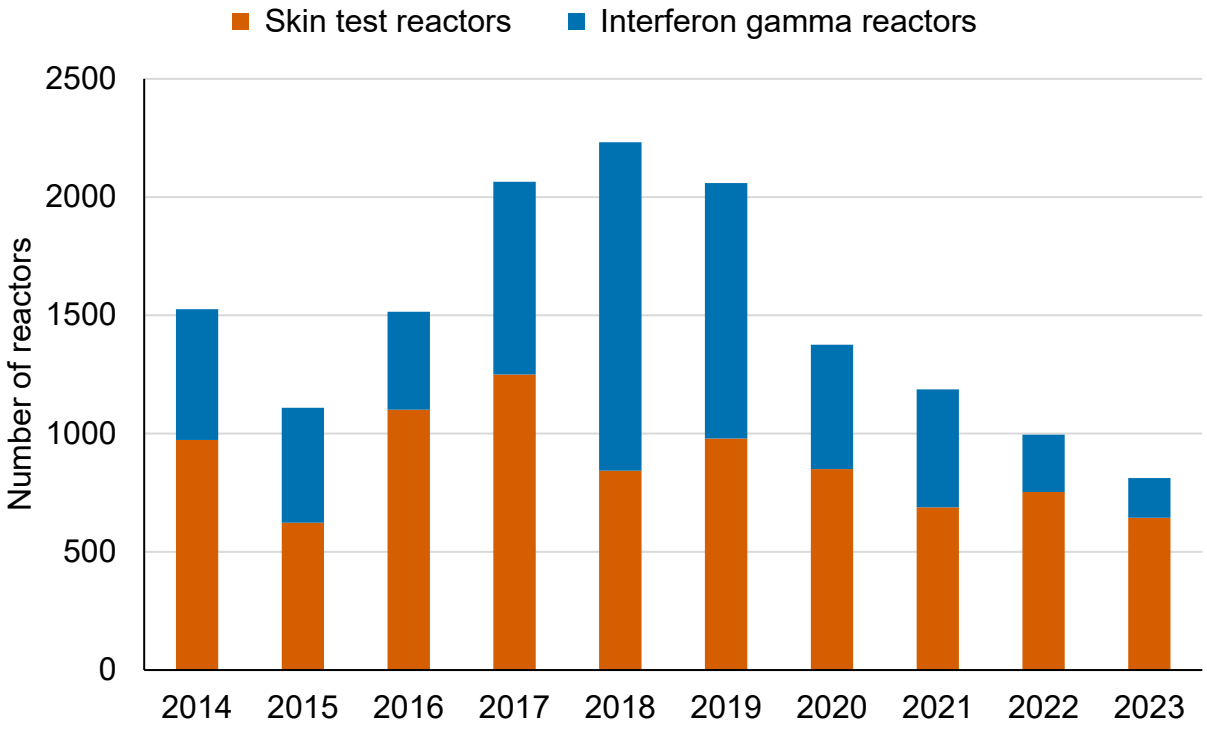

Figure 8: Number of skin test reactors (SICCT) and interferon gamma (IFN-γ) test positive cattle removed for TB control reasons in Cheshire, from 2014 to 2023.

Figure 8 description: Bar chart showing the number of skin test reactors and interferon gamma test reactors removed for TB control reasons in Cheshire between 2014 and 2023. In 2023, 644 skin test reactor cattle and 168 interferon gamma reactors were removed in Cheshire, the lowest number in the last 10 years.

Main risk pathways and key drivers for TB infection

It is important to try to understand the risk pathways and key drivers that are likely to have introduced TB infection into a herd. This information can help identify biosecurity measures that may reduce the TB risk for individual businesses.

Implementing practical measures can help to reduce the risk of TB incursion into a herd that is TB free (biosecurity), as well slowing disease spread within a herd where TB is present (biocontainment).

Furthermore, the ibTB online mapping tool can be used to inform purchasing choices, reducing the risk of introducing undetected infection when moving cattle into a herd.

In 2023, 85 out of 100 (85%) new TB incidents in Cheshire received a preliminary or final APHA veterinary investigation to identify the source of infection. The findings from this investigation are reported in Appendix 3. Only 11 were not selected for Disease Risk Form (DRF) visits as part of the triage system and in the other 4 incidents the herd keeper refused a DRF visit.

New data-driven methods to quantify the likelihood of risk pathways for TB infected herds have been developed by APHA. These 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. At the herd level, the cattle movement score is dictated by the animal with the highest ranked movement into that herd. 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 WGS local transmission of infection indicator uses WGS data from cattle *M. bovis* isolates to identify TB incidents that are linked by genetics, time and space. A TB incident where at least one other TB incident is identified that satisfies all the following 3 criteria is considered to have evidence of a local transmission event:

- it has a WGS with no more than 3 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 degree of uncertainty about the estimated true routes of TB infection into a herd. The absence of a local transmission event, or cattle movements associated with a high likelihood of infection does not completely negate these pathways. Nonetheless, the

evidence provided by the cattle movement and WGS data, when combined, can provide valuable insights into the possible risk pathways. Figure 9 provides the percentage of herds where each risk pathway combination was identified. The spatial distribution of these categories are presented in Figure 10. Each category is described in greater detail in the following text.

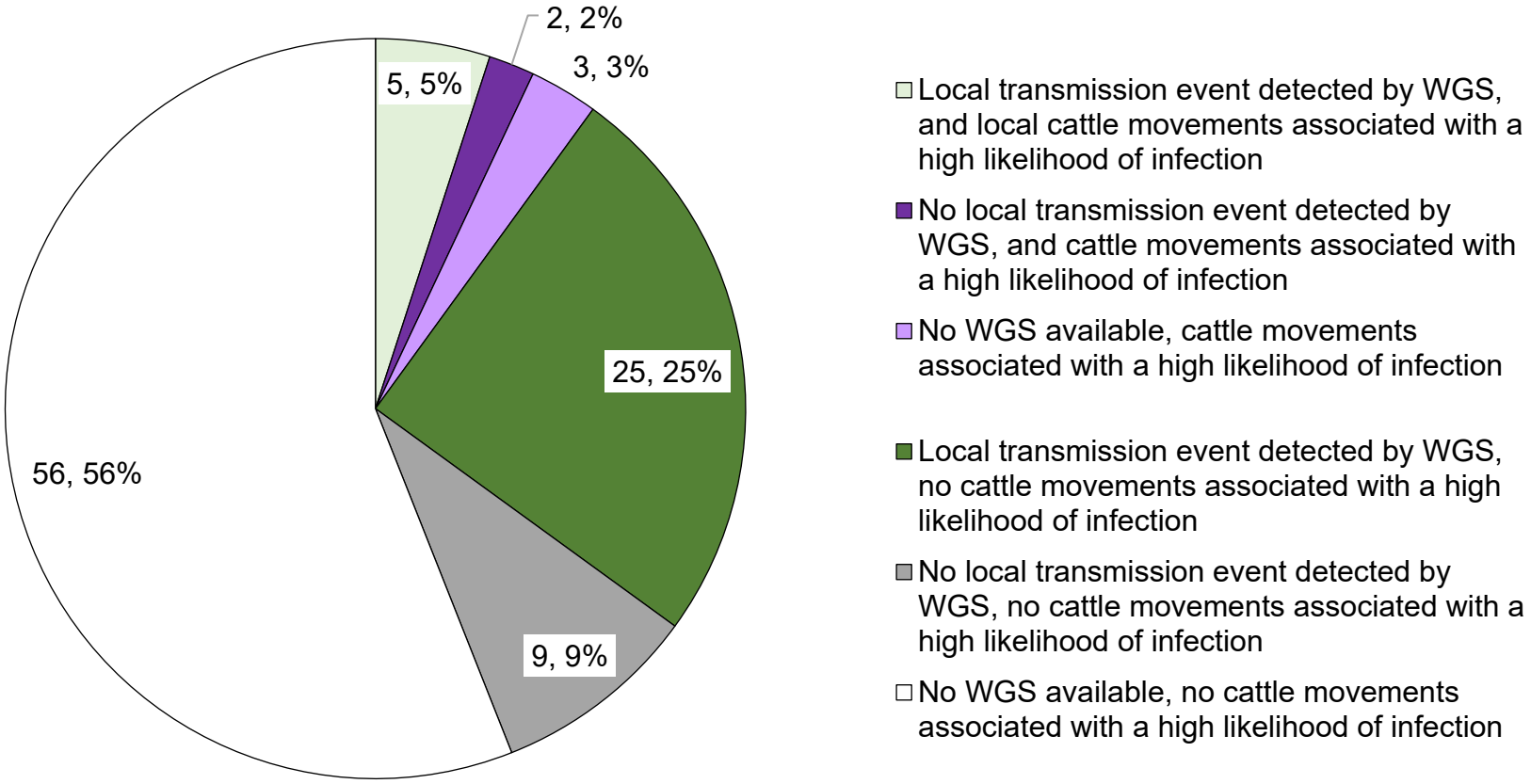

Figure 9: Risk pathway combinations identified by the WGS local transmission of infection indicator and cattle movement algorithm for all 100 new TB incidents starting in Cheshire in 2023.

Figure 9 description: Pie chart showing the risk pathway combinations identified by the WGS local reservoir indicator and cattle movement algorithm for all 100 new TB incidents in Cheshire in 2023. Most (56, 56%) did not have any WGS and no cattle movements were identified with a high likelihood of infection. Further description provided in the text.

WGS data was available for 41 (41%) of all new TB incidents in the county. The WGS local transmission of infection indicator identified a potential local transmission event for 30 (30%) new TB incidents in 2023.

Most of the TB incidents with WGS data available had a local transmission event identified without strong evidence of cattle movements (25, 25%). These are dark green symbols in Figure 10.

For these incidents, a broad spectrum of local pathways cannot be ruled out, including:

- residual infection in the herd
- contiguous contact with infected cattle
- direct or indirect contact with potentially infected wildlife

A further 5 new TB incidents (5%) had evidence of both a local transmission event and local cattle movements (within 25km) that were associated with a high likelihood of TB infection. For these TB incidents, local cattle movements may have played a part in the spread of this local infection, in addition to the previously listed local pathways. These incidents are symbolised in light green in Figure 10.

For 9 new TB incidents (9%), the WGS local transmission of infection indicator did not find evidence of a local transmission event, and there was also no evidence of cattle movements associated with a high likelihood of TB infection. The source of infection is unclear for these incidents (grey symbols).

For a further 56 new TB incidents in 2022 (56%), there was no evidence of cattle movements associated with a high likelihood of TB infection, and no WGS data available to explore the presence of a local infection indicator. These are shown as white dots in Figure 9, as there is insufficient evidence to determine a likely infection pathway.

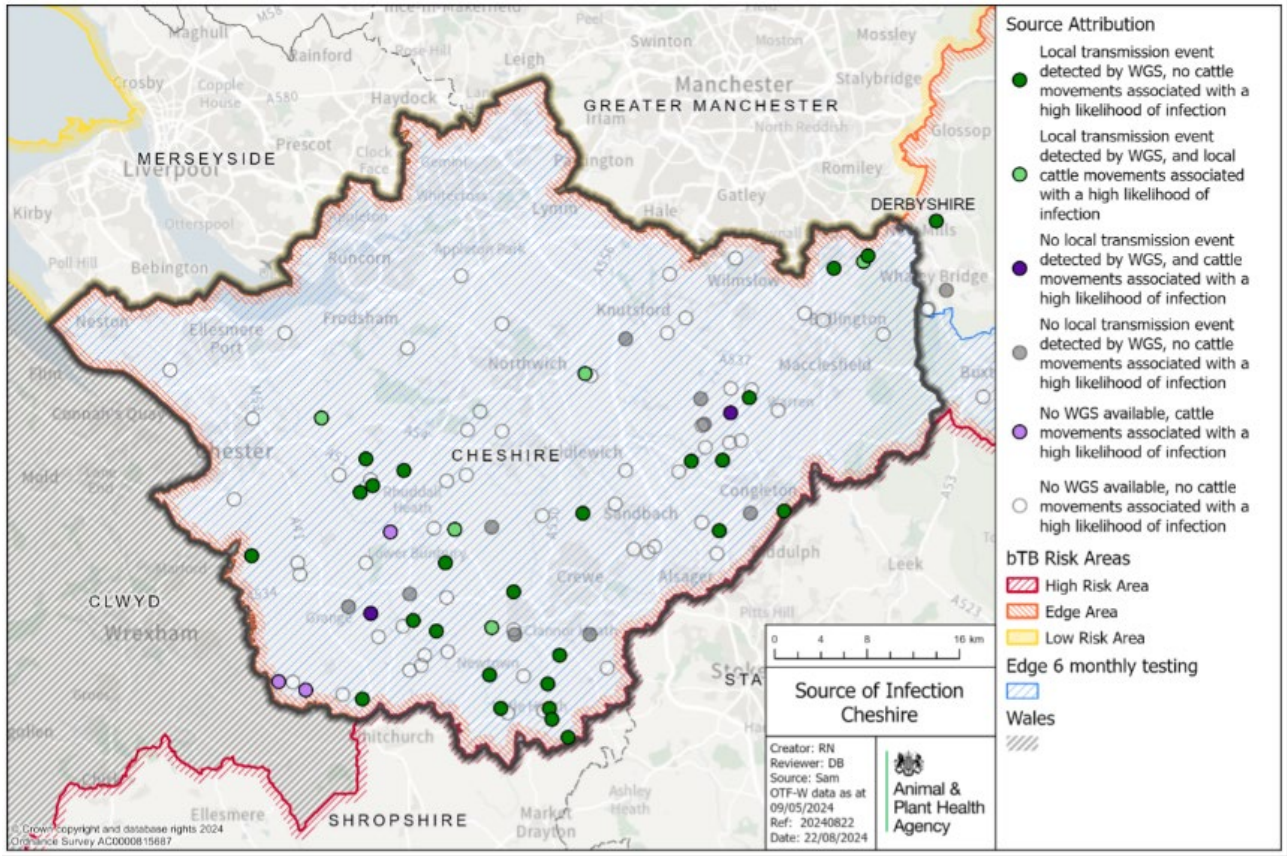

Figure 10: Map of the available evidence for risk pathways of TB infection into the herd, for all TB incidents (OTF-W and OTF-S) in Cheshire that started in 2023.

Figure 10 description: Map of the Cheshire county showing the locations of the 100 new TB incidents in Cheshire, coloured by the risk pathway identified for the incident. Dark green are herds with a local transmission event was identified from WGS and no cattle movements with a high likelihood of infection were identified in the herd. Light green represents incidents where local transmission event was identified from WGS and cattle movements with a high likelihood of infection were identified in the herd. Dark purple represents incidents where no local transmission event was identified from WGS and there were cattle movements identified with a high likelihood of infection in the herd. Light purple represents incidents with no WGS available and where there were cattle movements identified with a high likelihood of infection in the herd. Grey shows incidents where no local transmission event was identified from WGS and there were no cattle movements with a high likelihood of infection were identified in the herd either. White shows incidents with no WGS available and where there were no cattle movements with a high likelihood of infection were identified in the herd either. A breakdown of the incidents by group is provided in the text.

Genotyping was replaced with WGS of *M. bovis* isolates at APHA in 2021. TB incidents that were detected in Cheshire between 2020 and 2023, where the WGS local

transmission of infection indicator identified another infected herd within 3 SNPs, 9km and the past 4 years or within 6 months after are visualised in Figure 11. This shows the accumulation of local transmission events over time. The WGS clade is provided to identify clusters of related infection. In Cheshire, clade B3-11 has historically clustered, and continues to cluster along the border with the HRA counties of Shropshire and Staffordshire, alongside the Edge area county of Derbyshire. Clade B6-11 is more predominantly found towards the centre of Cheshire, but still localised to the southern half of the county.

There was one new incident with WGS clade B1-11 in the south of Cheshire. There were also 3 new incidents of B6-22 in the south of Cheshire, close to the border with Shropshire, similar to the locations of B6-22 isolations in 2021 and 2020.

Except for the ongoing cluster of B3-11 in the north-east of Cheshire, around the LRA border with the Stockport area of Greater Manchester, the northern border of Cheshire continued to be free of a local transmission of infection in 2023 (Figure 11).

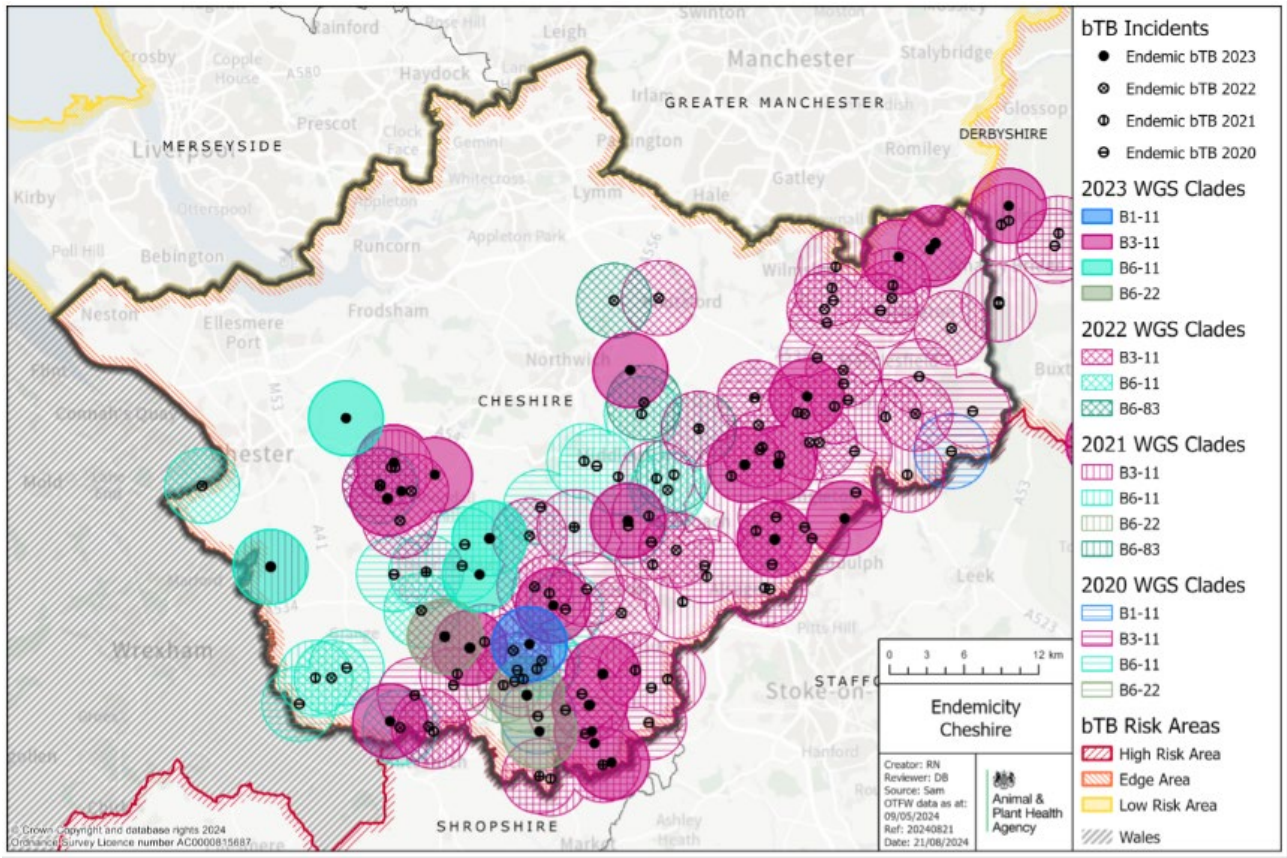

Figure 11: WGS clades of *M. bovis* detected in Cheshire between 2020 and 2023, where the WGS identified in the infected herd was within 3 SNPs of another TB incident in the past 4 years and 9km (OTF-W incidents only).

Figure 11 description: Map of Cheshire showing the WGS clades of *M. bovis* detected in Cheshire between 2020 and 2023, where the WGS identified in the infected herd was

within 3 SNPs of another OTF-W incidents in the past 4 years and within 9km of it. Clades are shown as circles on the map with each clade represented by a different colour. The year from which the clade was identified is shown by either having the colour be solid (2023) or different types of hash (2022 to 2020). All incidents show in the southern and eastern parts of Cheshire. Further detail is provided in the text.

Forward look

The percentage of OTF-W compared to OTF-S incidents went down in 2023 (47% of all incidents were OTF-W) compared to 2022 (55% of all incidents). This remained lower than in 2018 (68% of all incidents were OTF-W). Although the whole county incidence rate (9 incidents per 100 herd-years at risk) continued to decrease, the prevalence (4.4%) in 2023 increased marginally compared to 2022. OTF county status will not be achieved by 2025, but with the use of all available tools to identify and to reduce the burden of infection, it might be possible to achieve OTF status by 2038.

There was a 14.5% decrease in the number of skin test reactors and a 30.6% decrease in IFN-γ test positives compared to 2022. Since 2017, there has been a 48.5% reduction in the number of skin test reactors and 79.4% decrease in the number of IFN-γ test positives. Various factors are likely to have influenced this including an IFN-γ testing policy change in 2021 as already described.

Regular liaison meetings between local TB eradication stakeholders should be encouraged to engage with all interested parties to ultimately reduce the burden of disease in Cheshire.

In 2023, 128 badgers were vaccinated in Cheshire, a 10.3% increase compared to 2022 (116) and represented 4.2% of all badger vaccination in England in 2023. Further information on badger vaccination in Cheshire can be found in the summary of badger vaccination in 2023. Uptake of badger vaccination should be widely encouraged within the county upon the completion of culling operations if the overall incidence of bovine TB is to continue to decrease in Cheshire. In 2023, 1,055 badgers were culled under a supplementary licence in Cheshire.

The reporting of suspect TB carcasses in wildlife is essential to help increase the understanding of TB infection in wildlife populations and the role they play in the transmission of TB and is strongly encouraged by APHA. Stakeholder engagement with deer stalkers and other members of the public to help support this cause would help increase knowledge of TB in wildlife (and wild deer population).

Maintaining and improving upon the following measures will be vital to continue to address the most common risk pathways for TB infection in cattle in Cheshire. These include:

- badger TB control measures to reduce the risk of transmission to cattle, including the further expansion of badger vaccination
- 6-month herd testing in higher risk herds to enable earlier detection of disease within herds

- wider discretionary use of the IFN-γ blood testing in OTF-W incident herds and in unusual or problematic OTF-S incidents (in addition to its mandatory use in recurrent OTF-W incidents).
- encouragement to use the TB Advisory Service (visits, badger sett surveys and advice)
- increase awareness of biosecurity within and between farms through use of the TB Hub, APHA visits, TB Advisory Service, private vets, Farm Level Reports and WGS.
- increase awareness of the risk of unwittingly introducing TB into herds through incoming cattle movements, and use of the ibTB online mapping tool as a decision support tool.

Appendix 1: cattle industry demographics

Table 1: Number of cattle herds by size category in Cheshire as of 31 December 2023 (RADAR data on the number of holdings in 2023)

Size of herds	Number of herds in Cheshire
Undetermined	6
1 to 50	466
51 to 100	164
101 to 200	179
201 to 350	157
351 to 500	95
Greater than 500	121
Total number of herds	1,188
Mean herd size	196
Median herd size	83

Table 2: Number (and percentage of total) of animals by breed purpose in Cheshire as of 31 December 2023

Breed purpose	Number (and percentage of total) cattle in Cheshire
Beef	62,340 (26%)
Dairy	159,544 (68%)
Dual purpose	11,244 (4%)
Unknown	13 (0.006%)
Total	233,141

Appendix 2: summary of headline cattle TB statistics

Table 3: Herd-level summary statistics for TB in cattle in Cheshire between 2021 and 2023 (Sam data showing the number of herds flagged as active at the end of 2023)

Herd-level statistics	2021	2022	2023
(a) Total number of cattle herds live on Sam at the end of the reporting period	1,436	1,431	1,348
(b) Total number of whole herd skin tests carried out at any time in the period	2,176	2,025	1,989
(c) Total number of OTF cattle herds having TB whole herd tests during the period for any reason	1,204	1,172	1,154
(d) Total number of OTF cattle herds at the end of the report period (herds not under any type of TB movement restrictions)	1,285	1,292	1,238
(e) Total number of cattle herds that were not under restrictions due to an ongoing TB incident at the end of the report period	1,354	1,359	1,276
(f.1) Total number of new OTF-S TB incidents detected in cattle herds during the report period	69	50	53
(f.2) Total number of new OTF-W TB incidents detected in cattle herds during the report period	72	64	47
(g.1) Of the new OTF-W herd incidents, how many can be considered the result of movement, purchase or contact from or with an existing incident based on current evidence?	9	7	3
(g.2) Of the new OTF-W herd incidents, how many were triggered by skin test Reactors or twice-inconclusive reactors (2xIRs) at routine herd tests?	44	37	24

Herd-level statistics	2021	2022	2023
(g.3) Of the new OTF-W herd incidents, how many were triggered by skin test Reactors or 2xIRs at other TB test types (such as forward and back-tracings, contiguous or check tests)?	28	27	23
(g.4) Of the new OTF-W herd incidents, how many were first detected through routine slaughterhouse TB surveillance?	20	19	13
(h.1) Number of new OTF-W incidents revealed by enhanced TB surveillance (radial testing) conducted around those OTF-W herds	0	0	0
(h.2) Number of new OTF-S incidents revealed by enhanced TB surveillance (radial testing) conducted around those OTF-W herds	0	0	0
(i) Number of OTF-W herds still open at the end of the period (including any ongoing OTF-W incidents that began in a previous reporting period)	39	34	34
(j) New confirmed (positive *M. bovis* culture) incidents in non-bovine species detected during the report period (indicate host species involved)	0	0	0
(k.1) Number of grazing approved finishing units active at end of the period	0	0	0
(k.2) Number of non-grazing approved finishing units active at end of the period	34	35	36
(k.3) Number of grazing exempt finishing units active at end of the period	1	1	1
(k.4) Number of non-grazing exempt finishing units active at end of the period	0	0	0

Table 4: Animal-level summary statistics for TB in cattle in Cheshire between 2021 and 2023

Animal-level statistics (cattle)	**2021**	**2022**	**2023**
(a) Total number of cattle tested with tuberculin skin tests or additional IFN-γ blood tests in the period (animal tests)	499,941	496,115	490,395
(b.1) Reactors detected by tuberculin skin tests during the year	688	753	644
(b.2) Reactors detected by additional IFN-γ blood tests (skin-test negative or IR animals) during the year	499	242	168
(c) Reactors detected during year per incidents disclosed during year	8.4	8.7	8.1
(d) Reactors per 1,000 animal tests	2.4	2.0	1.7
(e.1) Additional animals slaughtered during the year for TB control reasons (dangerous contacts, including any first time IRs)	17	28	17
(e.2) Additional animals slaughtered during the year for TB control reasons (private slaughters)	4	5	6
(f) Slaughterhouse (SLH) cases (suspect tuberculous carcasses) reported by Food Standards Agency (FSA) during routine meat inspection	39	59	43
(g) SLH cases confirmed by *M. bovis* PCR testing or bacteriological culture	24	20	23

Note (c) Reactors detected during year per incidents disclosed during year, reactors may be from incidents disclosed in earlier years, as any found through testing during the report year count in the table above.

Note (g) SLH cases confirmed by culture of *M. bovis*, not all cases reported are submitted for culture analysis. All cases reported are from any period prior to or during restrictions.

Appendix 3: suspected sources of *M. bovis* infection for all the new OTF-W and OTF-S incidents identified in the report period

In 2023, 85 out of 100 (85%) new TB incidents in Cheshire received a preliminary or final APHA veterinary investigation to identify the source of infection. Not all DRF investigations were carried out in 2023. This was due to the continued impact and diversion of field resources as part of the 2022 to 2023 avian influenza outbreak which continued into spring 2023, in addition to the Bluetongue Virus outbreak from summer 2023 onwards.

Each TB incident could have up to 3 potential risk pathways identified. Each risk pathway is given a score that reflects the likelihood of that pathway bringing TB into the herd. The score is recorded as either:

- definite (score 8)
- most likely (score 6)
- likely (score 4)
- possible (score 1)

The sources for each incident are weighted by the certainty ascribed. Any combination of definite, most likely, likely, or possible can contribute towards the overall picture for possible routes of introduction into a herd. If the overall score for a herd is less than 6, then the score is made up to 6 using the 'Other or unknown source' option. Buffering up to 6 in this way helps to reflect the uncertainty in assessments where only 'likely' or 'possible' sources are identified.

Table 5 combines the data from multiple herds and provides the proportion of pathways in which each source was identified, weighted by the certainty that each source caused the introduction of TB. The output does not show the proportion of herds where each pathway was identified (this is skewed by the certainty calculation). WGS of *M. bovis* isolates can be a powerful tool in identifying a likely source of infection, however WGS clades are not determined for OTF-S herds. As a result of varying levels of uncertainty, only broad generalisations should be made from these data. A more detailed description of this methodology is provided in the explanatory supplement for the annual reports 2023.

Table 5: Suspected sources of *M. bovis* infection for the one incident with a preliminary or a final veterinary assessment in Cheshire, in 2023

Source of infection	Possible (1)	Likely (4)	Most likely (6)	Definite (8)	Weighted contribution
Badgers	33	44	43	1	69.0%
Cattle movements	22	5	3	2	11.8%

Source of infection	Possible (1)	Likely (4)	Most likely (6)	Definite (8)	Weighted contribution
Contiguous	3	1	0	0	0.9%
Residual cattle infection	18	7	1	0	8.4%
Domestic animals	0	0	0	0	0.0%
Non-specific reactor	0	0	0	0	0.0%
Fomites	3	0	0	0	0.6%
Other wildlife	1	1	0	0	0.7%
Other or unknown source	2	0	0	0	8.6%

Each TB incident could have up to 3 potential pathways so totals may not equate to the number of actual incidents that have occurred.

Data Protection:
For information on how we handle personal data visit www.gov.uk and search Animal and Plant Health Agency Personal Information Charter.

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Any enquiries regarding this publication should be sent to us at the National TB Epi Mailbox.

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