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Analysis of bovine tuberculosis surveillance in cattle at slaughter in Great Britain

2019 to 2022

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Abstract

This report evaluates the results of tuberculosis (TB) surveillance in cattle at routine (commercial) slaughter between 2019 and 2022. It is an update to a previous report conducted by the Animal and Plant Health Agency (APHA) in 2021 for the period 2016 to 2019. Post-mortem meat inspection (PMMI) of cattle at routine slaughter is an important component of the TB surveillance system: in 2022, 10% of all new TB incidents and 19% of TB incidents in cattle herds with Officially Tuberculosis Free status withdrawn (OTF-W) in Great Britain (England, Scotland and Wales) (GB) were initiated by slaughterhouse surveillance.

Between January 2019 and December 2022, 3,345 samples from commercially slaughtered non-TB reactor cattle with suspected tuberculous lesions were submitted to APHA for culture from 243 slaughterhouses. The bovine TB bacterium *Mycobacterium bovis* (*M. bovis*) was identified in 2,171 (65%) of those slaughterhouse case samples, which originated from officially tuberculosis free (OTF) and TB incident herds.

Cattle originating from the High Risk Area (HRA) of England accounted for the highest number of slaughterhouse submissions (73% of GB total submissions), even though they represented only 32% of all cattle slaughtered. The laboratory positive submission rate per 1,000 animals processed has decreased from 0.25 in 2019 to 0.21 in 2022.

The annual submission rate per 1,000 animals processed was higher in the HRA of England than in other regions, except for 2022, where the HRA rate was the third highest. In 2022, the highest rate was in the High TB Area West (HTBW) area of Wales, and this was the highest rate observed in the HTBW area since before 2012.

M. bovis was identified in 57% (1,567 out of 2,741) of the slaughterhouse case samples submitted from OTF herds and there was a decline in the samples tested for histology from 412 in 2019 to 128 in 2022. The decline in the number of samples undergoing histological examination at APHA is due to the introduction of polymerase chain reaction (PCR) testing from the end of March 2022 which provides a much faster result compared to histological examination. Only samples with a non-valid PCR test result were processed for histology. PCR-positive samples were still sent for culture to identify the Whole Genome Sequencing (WGS) clade of the *M. bovis* isolate responsible for the TB incident. Where PCR testing failed, samples were also sent for culture. Between April and December 2022, 642 slaughterhouse samples were subject to PCR testing, of which 392 were positive for *M. bovis*.

Of the 14,907 new TB incidents (breakdowns) declared in cattle herds between 2019 and 2022, 11% (1,673) were initiated by routine slaughterhouse surveillance, as opposed to tuberculin skin testing of live cattle on farms. This percentage was the same as for the

previous two reporting periods (2013 to 2016 and 2016 to 2019). Of these, 1,625 (97%) subsequently became OTF-W incidents once the presence of *M. bovis* was confirmed by culture. The remaining 48 (3%) slaughterhouse cases are awaiting confirmation and have not yet been given OTF-W status. The overall proportion of OTF-W TB incidents in GB initiated by slaughterhouse surveillance increased slightly from 18% in 2019 to 20% in 2022, an increase mainly observed in the HRA, Edge Area and HTBW.

Glossary

- AIC: Akaike Information Criterion
- BCMS: British Cattle Movement Service
- Check test: skin test performed on cattle as part of enhanced TB surveillance (such as after detection of a slaughterhouse case in a herd)
- Control test: refers to a skin test performed on cattle as part of TB control measures (such as check tests, short interval tests)
- CPHH: county parish holding herd number, which identifies an animal or group of animals kept in a holding as an epidemiological unit
- CTS: Cattle Tracing System
- Exempt herds: herds that had not had a tuberculin skin test in 51 months prior to the TB incident (allowing three months for a herd in a 4-yearly tested area to be tested) and those that had no recorded test on Sam
- HRA: High Risk Area, one of the three TB risk regions in England
- HTBE: High TB Area East, one of the five TB risk regions in Wales
- HTBW: High TB Area West, one of the five TB risk regions in Wales
- IDEXX test: diagnostic blood test used on cattle to detect antibodies produced in an animal against *M. bovis* infection
- Incident: case of TB in a herd. Used interchangeably with the term ‘breakdown’
- IQR: Interquartile range
- ITBM: Intermediate TB Area Mid, one of the five TB risk regions in Wales
- ITBN: Intermediate TB Area North, one of the five TB risk regions in Wales
- LIMS: Laboratory Information Management Systems
- LRA: Low Risk Area, one of the three TB risk regions in England
- LTB: Low TB Area, one of the five TB risk regions in Wales
- Non-exempt herds: herds which do not fall under the category of Exempt herds.
- Non-TB reactor cattle: cattle which have been subject to ante-mortem tuberculin skin testing and did not have a reaction to the tuberculin
- Non-visible lesions (NVL): no lesions typical of bovine TB detected in the carcass at post-mortem examination
- OTF: a bovine herd in which infection with *M. bovis* is not suspected and is able to trade animals freely (where the herd is not subject to any form of TB movement

restrictions). See World Organisation for Animal Health Terrestrial Code Article 8.12.6 for full definition of a herd free from infection with M. *tuberculosis complex*)

- OTF-S: officially bovine tuberculosis free status suspended
- OTF-W: officially bovine tuberculosis free status withdrawn
- PCR: polymerase chain reaction test
- PMMI: post-mortem meat inspection (of carcases in abattoirs)
- RADAR: an APHA database called Rapid Analysis and Detection of Animal-related Risks
- Region: refers to the herd origin unless stated otherwise
- Sam database: APHA's herd registration and notifiable animal disease control and surveillance system, which records, for example, details of herds, TB tests, TB incidents and the details of any slaughtered (reactors, slaughterhouse cases and direct contacts) and inconclusive reactor cattle
- Sensitivity (of a test): the proportion of truly infected individuals in the screened population that are correctly identified as infected (positive) by the test
- Slaughterhouse: (i) premises registered as official slaughterhouses identified internally by a 4-digit code, or (ii) CPHH that are slaughterhouse type premises where either keeping animals before sending them to slaughterhouse or killing them on site (these have very low submissions and are included in the report only for completeness, and the animals involved will all have died at this premises type)
- Slaughterhouse case: a privately slaughtered, non-TB reactor animal presenting with lesions consistent with TB during routine post-mortem meat inspection (PMMI) in an abattoir. A slaughterhouse case is considered 'confirmed' or 'positive' if the bacterium *M. bovis* has been detected by PCR testing or isolated from the suspect lesions in laboratory cultures at APHA. Carcasses with suspected lesions of TB that prove negative by PCR testing (or, if applicable, bacteriological culture) do not affect the original OTF status of the herd of origin (whether it was OTF or OTF-S/OTF-W)
- Specificity (of a test): the proportion of truly uninfected individuals in the screened population that are correctly identified as uninfected (negative) by the test
- Spoligotype: the result of one molecular technique used for genomic typing of organisms of the *Mycobacterium tuberculosis* complex, known as Spacer Oligonucleotide typing (this was replaced by WGS in April 2021)
- TB incident or TB breakdown: the identification in a herd of one or more animals with a positive reaction to the tuberculin skin test, positive blood test results, or one or more slaughterhouse cases with a positive culture result for *M. bovis* (the affected herd is placed under movement restrictions and loses its OTF status (OTF-S or OTF-W))
- Variable number tandem repeat (VNTR) typing: a molecular test used to help determine the spoligype of *M. bovis* (this was replaced with WGS in April 2021)

- Visible lesions (VL): lesions typical of bovine TB detected in the carcass of a skin test reactor, an interferon-gamma (IFN-γ) blood test positive animal or an IDEXX antibody positive animal at post-mortem examination
- WGS: Whole Genome Sequencing, the technique currently used in APHA to determine the genetic relatedness of strains of *M. bovis* isolated in bacteriological cultures from infected animals, replaces the previous DNA typing method referred to as ‘genotyping’ (a combination of spoligotyping and ‘VNTR’ typing)

Executive summary

Section 1: slaughterhouse case submission numbers and rates between 2019 and 2022

Over 9 million cattle were recorded processed in 243 slaughterhouses in GB across the period (about 2.3 million each year).

In the same period, samples were collected from 3,345 animals with suspected tuberculous lesions at routine slaughter, equivalent to an overall rate of 0.36 submissions per 1,000 animals slaughtered. This is a considerably lower number of samples and submission rate than the previous reporting period, 3,784 (linear test for trend, $p=0.0026$) and 0.41 respectively in 2016 to 2019 (incidence rate ratio, $p<0.0001$).

During 2019 to 2022, *M. bovis* was identified by laboratory culture or PCR in 2,171 of the 3,345 suspect cattle samples (65%).

Of the 243 slaughterhouses processing cattle in GB over the reporting period, 164 (89%) had an annual throughput exceeding 40 animals.

The majority (73%) of samples submitted in the study period were from TB slaughterhouse cases detected in High Risk Area (HRA) herds, while the number of submissions from beef cattle was higher than for dairy cattle. This may reflect the higher throughput of beef animals in British slaughterhouses (around 4 times that of dairy animals).

The number of submissions and those positive for *M. bovis* decreased between 2019 and 2022. The submission rate per 1,000 animals processed was stable over that time but varied by region.

The submission rate in the HRA was higher than other GB regions for most of the period except in 2022, where the rate was higher in the High TB West (HTBW) area (HTBW 0.80, HRA 0.66 per 1,000 animals slaughtered). The rate in the HRA in 2022 was also equal to that of the Intermediate TB North (ITBN) area (0.66) and only marginally greater than that for the High TB East (HTBE) area (0.63). Elsewhere in GB, the submission rates were comparatively stable over the reporting period.

Of the 243 slaughterhouses processing cattle in GB during the reporting period, only 45 (19%) had a submission rate greater than 0.5 per 1,000 animals slaughtered, slightly lower than the previous reporting period, 21%.

Section 2: proportion of laboratory positive slaughterhouse cases between 2019 and 2022

Looking at the 10-year trend between 2013 and 2022, 10,830 samples from cattle with lesions indicative of TB (slaughterhouse cases) were submitted to APHA laboratories for confirmation by bacteriological culture (or from 30 March 2022, PCR testing). Of these, 8,424 (78%) were submitted to APHA from OTF cattle herds that were not under movement restriction at the time of lesion detection.

Of the 3,345 samples with lesions submitted for laboratory confirmation during 2019 to 2022, 2,741 (82%) were from OTF herds. This is an overall decrease of 12% compared to number of samples with lesions submitted in the 2016 to2019 period (3,784 samples, of which 3,189 from OTF herds).

In the reporting period *M. bovis* was identified from 57% of the slaughterhouse case samples submitted from OTF herds. The equivalent percentage for samples submitted from TB incident herds was 47%.

Multivariable logistic regression identified herd region, herd type, time since the last TB test and TB incident, the number of cattle movements onto the farm, and the annual throughput of the slaughterhouse to be significant risk factors affecting the odds of a slaughterhouse case being confirmed in the laboratory and leading to a new OTF-W incident. The proportion of beef cattle handled by the slaughterhouse was not significantly associated with the odds of a slaughterhouse case proceeding to an OTF-W incident.

Section 3: proportion of new TB herd incidents initiated by slaughterhouse cases between 2019 and 2022

When looking at incidents of TB disclosed by any surveillance stream test, there were 14,907 new TB incidents in cattle herds during this period in GB with 8,361 if these classified as OTF-W. Of the 14,907 incidents, 1,673 (11%) were initiated by the slaughterhouse surveillance steam which involves post-mortem meat inspection in the slaughterhouse, and 1,625 (97%) of these slaughterhouse incidents were subsequently classed as OTF-W.

The overall proportion of OTF-W TB incidents in GB initiated by slaughterhouse surveillance have increased slightly from 18% in 2019 to 21% in 2022 (z-test, p=0.045). The proportion of OTF-W incidents that originated in the slaughterhouse increased in the Low Risk Area (LRA) and Edge Area regions in England, and marginally increased in the HRA. Proportions for all Welsh regions varied, with an increase observed in the HTBW area, and reductions in the Low TB Area (LTB) and ITBM.

In Scotland, the proportion of OTF-W incidents that originated in the slaughterhouse decreased overall, though there was an increase to a peak of around 70% in 2021 before decreasing to the lowest proportion since 2015.

Counties demonstrating unusually high proportions of OTF-W TB incidents disclosed in the slaughterhouse include Cleveland (0% in 2013, 0% in 2019 and 50% in 2022) and Surrey (0% in 2013, 17% in 2019, and 40% in 2022) in the LRA of England, and Ayrshire in Scotland (0% in 2013, 50% in 2019, and 25% in 2022) among others. However, these were counties with very low numbers of total incidents.

Multivariable logistic regression analysis determined that TB incidents in herds located in the Intermediate TB Area Mid region were two times more likely to be detected in the slaughterhouse compared with TB incidents in herds in the HRA; while herds located in the High TB Area East region and Intermediate TB North Area were less likely to be detected in the slaughterhouse. Other factors significantly affecting the odds of disclosure of a TB incident in the slaughterhouse include the time since the last test, larger herd sizes, the last test type, having more than one reactor, previous history of an OTF-W incident in the previous 4 years and the number of cattle movements on to the holding in the 12 months prior to the TB incident.

A total of 29 WGS clades of *M. bovis* were isolated in the reporting period, but due to the low frequency of clades detected, no further analysis could be conducted.

Section 4: identification of test reactors in the source herd following a laboratory-positive slaughterhouse case between 2019 and 2022

Between 2019 and 2022, 63% (1,023 out of 1,625) of new OTF-W TB incidents disclosed in the slaughterhouse had reactors at subsequent tuberculin skin herd tests, an increase compared to 61% in the last reporting period (1,182 out of 1,933). This increase was not statistically significant (z-test, p=0.221).

Reactors at follow-up skin testing appeared more likely when the slaughterhouse case originated from larger herds; from the ITBM in Wales, Scotland or the LRA in England; dairy herds; or ‘non-exempt’ herds (Table 4.1).

The proportion of new TB incidents (OTF-W and OTF-S) detected by PMMI with no reactors detected subsequently in the herd during control tests in GB was around 45% in 2022. As in previous reports, the proportion of OTF-W TB incidents disclosed in the slaughterhouse with no reactors at subsequent control tests in herds with 100 animals or less rises to 47% and is even higher (71%) when restricted to herds with 50 animals or less.

OTF-W incidents detected by skin testing had a median of 4 (IQR 2-7) reactors at the first whole herd test, compared to 0 (IQR 0-4) for OTF-W incidents detected at the slaughterhouse. The mean number of reactors was higher by skin testing than slaughterhouse surveillance for most TB herd regions, except for in the LRA and Scotland, where the mean was very similar for both skin and slaughterhouse testing, and the HTBE in Wales, the slaughterhouse detected on average two additional reactors at the next

whole herd test compared to skin testing. For the ITBN in Wales, both the median and mean number of reactors found after an OTF-W incident detected at the slaughterhouse was twice as high as the number disclosed after detecting the incident at skin testing. This may have been influenced by the introduction of a new policy which targeted blood testing in clear skin-tested herds in the ITBAN from June 2021.

Multivariable logistic regression analysis showed that TB incidents in larger herds, those detected in the Edge Area or LRA in England, and those detected in 2020 were more likely to have reactors at the check test triggered by a slaughterhouse case.

The number of movements onto the farm in the 12 months prior to the start of the incident, incidents detected in 2022, and incidents from the HTBE and ITBN in Wales were significantly associated with a lower probability of detecting reactors at the next check test.

Section 5: impact of PCR testing on slaughterhouse case confirmation between 2019 and 2022

As it provides a much quicker result, PCR testing was introduced as the main confirmatory diagnostic method for slaughterhouse case submissions from 30 March 2022. This resulted in histological examination of tissue samples no longer being routine, and instead preserved only for samples without a valid PCR result if there was sufficient tissue left for culture.

A total of 642 samples from slaughterhouse cases in cattle were subject to PCR testing between April and December 2022, of which 392 were positive by PCR.

Section 6: model to explore residual variation in detection rates of TB slaughterhouses cases across cattle abattoirs in GB

This section presents the output of the statistical model created at Cambridge University and subsequently adopted at APHA Weybridge under project SE3133.

This model explores patterns in residual variation in slaughterhouse case detection rates between British slaughterhouses after accounting for individual animal-level risk factors, such as:

- sex
- age
- breed
- days in high or low risk herds
- contact with high or low risk herds

- skin testing status
- year
- quarter
- risk area

These patterns can be summarised by the posterior mean odds ratio (OR) and credible intervals (Appendix 3). Slaughterhouses with positive posterior ORs reported more TB cases than the average expected by the model for the types of animals that they processed, and slaughterhouses with negative posterior ORs reported fewer cases than the average expected. The size of the interval is mainly down to the throughput of the slaughterhouse, the higher the throughput the smaller the interval and hence more precision around the estimated mean

Using data from 2019 to 2022, there were 12 slaughterhouses with an upper credible interval below zero, meaning that post-mortem surveillance for TB on these premises appeared to be less effective than expected by the model

Introduction

Bovine tuberculosis (TB) is a chronic, predominantly respiratory, and notifiable disease caused by the bacterium *Mycobacterium bovis*, (*M. bovis*); a member of the *M. tuberculosis* complex (MTBC). *Mycobacterium bovis* can infect and cause TB in most mammals, including humans. The disease is currently endemic in parts of GB, and cattle can become infected when they come into close contact with infectious animals, including some wildlife species (direct transmission) or are exposed to their excretions and secretions (indirect transmission via contaminated environment or feed). The movement of cattle with undetected infection can spread the disease between herds and into new areas. There are substantial differences in the incidence of bovine TB across GB.

Additionally, differences in overall surveillance and control policies make it unsuitable to directly compare TB in cattle between countries and therefore these are best considered separately. GB is therefore divided into nine different risk regions for TB. Within England, there are three risk regions: the High Risk Area (HRA), Edge Area and Low Risk Area (LRA). Wales has five risk regions: the High TB Area East (HTBE), High TB Area West (HTBW), Intermediate TB Area Mid (ITBM), Intermediate TB Area North (ITBN) and Low TB Area (LTB). Scotland remains Officially TB free (OTF) and is considered as a single risk region.

Surveillance for TB in cattle can be classified into four ‘streams’. ‘Routine’ testing and ‘slaughterhouse’ surveillance look for TB in herds (or animals) that are not expected to be at increased likelihood of infection. ‘Area and herd risk’ testing (such as short interval, check test, tracing, inconclusive reactor, radial and contiguous herd tests), together with ‘Trade and other’ testing (such as post-import, pre- and post-movement and private tests),target herds (or individual cattle) thought to be at an increased risk of infection,

and/or those where owners consider infection could have a greater health or economic impact on their herd. This report will concentrate on slaughterhouse surveillance of TB in cattle. More detailed analyses of other surveillance streams, including the epidemiology and incidence of TB over time, are available in the annual GB bovine TB reports (Animal Plant and Health Agency, 2023).

Slaughterhouse surveillance entails ante-mortem and post-mortem meat inspection (PMMI) of cattle routinely (commercially) slaughtered for human consumption, looking for the characteristic granulomatous lesions of TB in the carcasses and viscera of cattle on the slaughter line. A ‘slaughterhouse case’ refers to the detection of suspect lesions of TB in the carcass or viscera of a slaughtered animal. A slaughterhouse case is ‘confirmed’ if *M. bovis* can be identified in the suspect lesions by laboratory testing (bacteriological culture and, more recently PCR testing).

When the Official Veterinarian in the slaughterhouse reports a slaughterhouse case to APHA the OTF status of the herd of origin is suspended (OTF-S) and movement restrictions applied (if not already in force for other reasons), pending the submission of lesions to the laboratory and the final test results. If the suspicion of *M. bovis* infection is subsequently confirmed by positive laboratory test results (including a positive skin check test before the completion of PCR or culture), the OTF status of the affected herd is automatically ‘downgraded’ from OTF-S to OTF withdrawn (OTF-W) and a new TB incident is declared. By contrast, if the laboratory test results are negative, movement restrictions are lifted in England and Scotland, and following a further negative check test in Wales.

Slaughterhouse surveillance is particularly important in Scotland, following its attainment of OTF status in 2009, and in the LRA of England, where most cattle herds are routinely tested for TB every four years. In Scotland, slaughterhouse surveillance has replaced routine surveillance testing in cattle herds where a sufficient proportion of their animals are slaughtered each year and the risk of TB introduction through cattle movements is low.

There may be some instances where submission of samples from a slaughterhouse case is not required, such as when identified in a herd that is already restricted due to an ongoing OTF-W TB incident.

Slaughterhouse surveillance is an important element of the surveillance system for TB in cattle in GB, supplementing active TB testing of live cattle on farms. In GB in 2022, 10% of all new TB incidents (366/3,564) and 19% (363/1,931) of all OTF-W TB incidents were detected in the slaughterhouse (Animal Plant and Health Agency, 2023). More specifically, 18.2% of all incidents in Scotland, 10.1% in the HRA, 9.6% in the Edge Area, and 8.3% in the LRA of England; 19.5% in the HTBW, 12.5% in the LTB, 11.2% in the HTBE, 7.1% in the ITBM, and 3.0% in the ITBN of Wales were disclosed through slaughterhouse surveillance during 2022 (Animal Plant and Health Agency, 2023).

Confirmation of slaughterhouse cases in GB was based solely on the identification of the bacterium in laboratory cultures up until the end of March 2022, when APHA TB laboratories adopted PCR testing as the primary confirmatory technique. The proportion of suspected GB slaughterhouse samples where *M. bovis* was isolated was 65% in 2022 (Animal Plant and Health Agency, 2023).

Sensitivity of PMMI is generally regarded as low, particularly in the early stages of *M. bovis* infection where the proportion of small incipient lesions can be high (de Kantor and Ritacco, 2006).This report updates an earlier report published by APHA in 2021 which evaluated the results of TB surveillance in cattle at routine slaughter during 2016-2019 (Animal Plant and Health Agency, 2018). The 2019 data included in the previous report were not complete at the time of writing as it extracted from the APHA laboratory information system early in 2020. As such, some test results from samples collected in 2019 were still pending. We have included 2019 data to update the results presented in the previous report. Previous results published for 2019 may therefore differ slightly.

Methods

Data extraction and management

Data used in this report were extracted from three sources: the Cattle Tracing System (CTS, source British Cattle Movement System (BCMS)), the Animal and Plant Health Agency (APHA) TB management (Sam) and the APHA laboratory information and sample management system database (LIMS). The relevant data were downloaded from Sam on 27 October 2023.

1. Animal and herd level data

The ear tag numbers and laboratory information for bovine animals (cattle, farmed water buffalo and farmed bison) with suspect TB lesions identified at routine slaughter (slaughterhouse cases) submitted to APHA between 1 January 2019 and 31 December 2022 were extracted from LIMS. These data were appended to the database used for the previous report (1 January 2016 and 31 December 2019), updating the 2019 data.

Herd data, TB testing and TB incident history for the herd of origin of each slaughterhouse case were extracted from Sam database. Where a TB incident was not confirmed by laboratory testing, the current herd type used was the herd type recorded in Sam database or the herd type at time of sample archive. Where a TB incident was confirmed, the herd type is the type at the time of the TB incident.

Farm county parish holding number (CPH), birth date, death date, movements onto the county parish holding herd number (CPHH) in the 12 months prior to the death date, slaughterhouse identifier and location were all extracted from cattle tracing system (CTS) using animal ear tags as the identifier. Confirmed slaughterhouse cases were considered to trigger a new herd TB incident ('disclosing cases') if the TB lesions were identified in animals from OTF herds, or within 7 days of another disclosing slaughterhouse case from the same herd.

For the period of the current report, individual animal test data were used (rather than estimating numbers from test records conducted during the year), which is more accurate and has led to an apparent increase in the number of animals tested compared to the previous period. Note this revised approach is only possible since the advent of Sam database, which enables the recording of every animal test performed. It is thus likely that the rates shown prior to 2013 and in previous reports are slightly inflated compared to the new method due to this change in the denominator.

2. TB incident data

Data on all TB incidents that began between 1 January 2019 and 31 December 2022 were extracted from Sam database. As before, these data were appended to the dataset downloaded for the previous report, and the 2019 data was updated. All TB incidents with a confirmed slaughterhouse case at the very start of the TB incident were assumed to have been disclosed by the detection of lesions in the slaughterhouse. All other slaughterhouse cases were assumed to have been detected in animals slaughtered during TB incidents (herd already under movement restrictions) or as a result of on-going surveillance and control activities.

3. Slaughterhouse throughput data

Denominator data describing all individual animal movements to slaughterhouses between 1 January 2009 and 31 December 2019 had been extracted from CTS for the previous update. Similarly, the denominator data was updated with new data from the 1 January 2019 to 31 December 2022 for the current update. These movements to slaughter were aggregated by:

- year
- month
- slaughterhouse
- county
- region of source holding
- test interval of source holding
- type of source holding (based on the current type registered for herds active under the holding)

The slaughterhouse region was obtained using the map reference provided in Rapid Analysis and Detection of Animal-related Risks (RADAR) database for the slaughterhouse.

Data quality

Slaughterhouse case submission dates for this report come from the APHA TB management system (Sam database). Information describing suspect slaughterhouse cases were extracted from APHA's TB Culture System (TBCS)/Laboratory Information Management System (LIMS) database. Sam database was used to validate that negative slaughterhouse cases were indeed such; otherwise, only submissions that appeared in the APHA LIMS database contributed to the data and analysis presented in the report.

The CPHH associated with the animal immediately prior to slaughter was established using the animal's ear tag record on CTS (with rare exceptions). The previous CPHH was also recorded if the animal was resident within 30 days of slaughter unless the animal's slaughter data in Sam database referred to the more recent CPH (where it was slaughtered or died). Additionally, there is a 28-day period prior to slaughter used in the field for identifying the previous residence for slaughterhouse cases. Checks were made to ensure that the CTS information matched that on Sam/LIMS to ensure the animals were the same.

There may be some historical inaccuracies associated with herd type data recorded on Sam. The herd type recorded at the start of a TB incident is static and will not change, even if the production type of that herd subsequently changes. However, the number of herds per production type in existence for a particular time period is defined by either the current herd type or the herd type when archived, and so is subject to change as the population demographics of the national herd changes. This has implications for the calculation of incidence by herd type. The number of TB incidents per 100 live dairy herds in, for example 2016, may seem higher using data downloaded in 2019 than it did at the time, that is to say it is possible that the reduction in the number of current herds classed as dairy may artificially inflate past incidence in dairy herd type.

Although at least one cattle movement was recorded to 243 slaughterhouses between 2019 and 2022, 45 of these slaughterhouses were represented by a CPHH number and not a 4- digit slaughterhouse ID. These may be lairages associated with the slaughterhouses, but they are the final movement destination recorded for a number of animals. However, the number of animals passing through these apparent lairages was 936, which represents less than 0.01% of the whole throughput between 2019 and 2022. Obvious lairages were removed from the data by attempting to find the true slaughterhouse ID of the lairage by identifying the slaughterhouse from the movements on to that from the lairage; the movement thus counting for the true slaughterhouse (Note,

this was not done for reports before 2009). Those that remain have no onward movement onto a true slaughterhouse.

Consistency and sense checks were conducted using STATA 15.0®. Data were cleaned and checked for duplicate records from the same animal; new variables were created, and datasets were merged to prepare the necessary datasets for analysis.

Statistical analyses

All statistical analysis was conducted using STATA 15.0®. Relationships between outcome and predictor variables were first examined in univariable analyses using chi-squared tests or t-tests, as appropriate. Multivariable logistic regression analysis was then used to identify risk factors for binary outcome variables.

The following outcome and predictor variables were investigated:

Outcomes

- slaughterhouse cases that resulted in an OTF-W TB incident vs. those that did not (binary variable)
- OTF-W TB incidents detected by slaughterhouse surveillance vs. those detected during on-farm surveillance (binary variable)
- OTF-W TB incidents detected in the slaughterhouse that had reactors in subsequent testing vs. those that did not (binary variable)

Predictors

- characteristics of source herd (herd type, testing history, herd size)
- country risk region (for Wales and England) or country of source herd
- total number of movements into source herd/holding during the time period
- time since last skin test of source herd/holding in days
- last ante-mortem herd test type conducted in source herd/holding
- time since the last and time to the next TB incident in source herd/holding
- nature of the last TB incident in source herd/holding
- number of reactors in any last TB incident of source herd/holding
- exemption status of herds
- number of movements onto the holding in the previous 12 months
- slaughterhouse throughput
- slaughterhouse region
- date (month, year, season)
- WGS clade of *M. bovis* isolated and number of clades identified in an incident

Predictor variables that were statistically significant during univariable analysis and contributed to a good fit of the multivariable model were included in the final multivariate model published in this study.

Where appropriate, standard errors were adjusted for clustering at the herd or slaughterhouse level. Where the relationship between outcome and continuous predictor was not linear, fractional polynomial transformation of the predictor was investigated and implemented if it reduced the Akaike information criterion (AIC) or improved the model fit using the Hosmer-Lemeshow goodness of fit test (described in more detail below). Logarithmic transformations (ln(n+1)) were also used for continuous predictor variables with positively skewed distributions. If the transformations of the continuous predictor did not improve the model fit, then the predictor was used in its untransformed format. All plausible 2-way interaction terms were tested between predictors in the final models. Models were evaluated and compared using the AIC.

The fit of each multivariable logistic regression model was tested using the Hosmer-Lemeshow goodness of fit test, whereby a statistically significant p-value (p0.05) was considered strong evidence of an unsatisfactorily fitting model.

Herd size, slaughterhouse throughput, time since last test and number of reactors were converted to categorical variables. The categories were defined by the approximated rounded quintiles of the numerical data.

To account for TB incidents in which more than one WGS clade was detected, it was necessary to adjust the data where the WGS clade was included as a risk factor. Where multiple WGS clades were identified in the same herd, each TB incident was duplicated and the robust standard errors in the model were adjusted for clustering within the breakdown ID.

Results

Section 1: slaughterhouse case numbers and rates between 2019 and 2022

The aim of this section is to examine the number and rate of bovine carcasses with tuberculous lesions detected during routine post-mortem meat inspection of cattle in British slaughterhouses, stratified by slaughterhouse, slaughterhouse throughput, region, year and herd type.

Slaughterhouse case numbers in GB and by region

There were 9,268,032 cattle slaughtered in 243 slaughterhouses or premises acting as slaughterhouses in GB in the report period. This included 45 premises with a farm CPHH where animals were killed without a forwarding slaughterhouse. A total of 3,345 slaughterhouse cases were detected and submitted for culture at APHA, leading to an overall submission rate of 0.36 submissions per 1,000 animals slaughtered. *M. bovis* was identified in 2,171 of the 3,345 submitted samples (65%). The number of slaughterhouse cases detected were significantly lower in 2019/22 compared to the previous reports, 3,784 in 2016 to 19 and 5,639 in 2013 to 16 (linear test for trend, $p=0.026$ and $p=0.001$, respectively). The submission rate in the 2019-22 report was significantly lower compared to the 2016 to19 report (0.41, incidence rate ratio, $p<0.0001$) and the 2013 to16 report (0.63, incidence rate ratio, $p<0.0001$). The decreases in the proportion of samples where *M. bovis* was identified were significant between 2016 to2019 and 2019 to2022 (68%, in 2016-19, z-test, $p=0.0074$), and between 2013 to2016 and 2016 to2019 (73% in 2013to 16, z-test, $p<0.0001$) (Animal Plant and Health Agency, 2018).

It is important to note that not all suspected slaughterhouse cases of TB are automatically sampled for confirmatory testing in the laboratory.

The annual numbers of slaughterhouse cases from which samples were submitted to an APHA laboratory – by slaughterhouse region (where the slaughterhouse is located), herd of origin region, slaughterhouse throughput per year and herd type – are shown in Table 1.1a-d. The numbers reported also include slaughterhouse cases that were detected in herds already under movement restrictions due to a TB incident. By far most submissions came from herds (and slaughterhouses) located in the HRA (Table 1.1a and 1.1b). There was a steady decline in the annual submission numbers (and cattle slaughtered) between 2019 and 2021 from 922 to 755, followed by a slight increase in 2022. This increase was driven by a 45% rise in the number of slaughterhouse cases detected in Welsh herds. In England, the annual numbers of cases detected declined year on year, and in Scotland increased between 2019 and 2020, then declined over the subsequent years. In the

previous reporting period, 2016 to 2019, the annual submission numbers were relatively stable, following a considerable decrease between 2013 and 2016 (Figure 1.1a). This decrease was mainly driven by reductions in the HRA, while submission numbers have been comparatively stable in other regions (Figure 1.1b).

Unsurprisingly, number of submissions from all slaughterhouses with low throughput (≤40 a year) were low, with none of these submitting any samples (Table 1.1c). The number of submissions from beef herds was higher than for dairy herds (Table 1.1d). This reflects the higher throughput of beef animals, which is consistently around 3 times that of dairy animals. However, caution should be taken with interpreting trends associated with herd type, as current production type is used to define the herd's type for the entire reporting period. In particular, the loss of dairy herds and transfer to beef in recent years could result in higher numbers of beef herds than there actually were.

Table 1.1a: Annual total numbers of slaughterhouse cases submitted to the APHA (subs) and total number of animals slaughtered (N) in GB, between 2019 and 2022, by slaughterhouse region. Figures include slaughterhouse cases detected in herds under movement restrictions due to a TB incident.

Slaughterhouse region		2019	2020	2021	2022
England					
HRA	subs	652	640	562	590
	N	754,089	750,630	716,145	756,018
Edge	subs	43	32	27	42
	N	141,459	127,345	112,223	110,397
LRA	subs	132	97	91	67
	N	861,969	866,775	820,823	817,858
England Total	subs	827	769	680	699
	N	1,757,517	1,744,750	1,649,191	1,684,273
Scotland	subs	20	10	11	10
	N	451,821	454,565	451,086	449,885
Wales					
HTBE	subs	3	0	0	1
	N	7,519	243	250	232
HTBW	subs	2	9	17	34
	N	3,395	32,607	31,890	33,207
ITBM	subs	68	78	42	54
	N	136,488	129,285	111,541	116,552
ITBN	subs	2	2	5	1
	N	5,637	5,694	5,361	4,532
LTB	subs	0	0	0	1
	N	75	141	137	158
Wales Total	subs	75	89	64	91
	N	153,114	167,970	149,179	154,681
Total submissions	subs	922	868	755	800
Total throughput	N	2,362,452	2,367,285	2,249,456	2,288,839

Table 1.1b: Annual total numbers of slaughterhouse cases submitted to the APHA (subs) and total number of animals slaughtered (N) in GB, between 2019 and 2022, by herd region of origin. Figures include slaughterhouse cases detected in herds under movement restrictions due to a TB incident.

Herd region of origin		2019	2020	2021	2022
England					
HRA	subs	589	577	478	441
	N	701,732	714,066	665466	670,942
Edge	subs	144	110	103	132
	N	336,061	341,326	309944	302,630
LRA	subs	44	43	50	54
	N	608,662	603,869	579802	591,067
England Total	subs	777	730	631	627
	N	1,646,455	1,659,261	1,555,212	1,564,639
Scotland	subs	31	18	17	20
	N	463,858	456,645	456,134	472,123
Wales					
HTBE	subs	29	34	29	33
	N	54,109	53,446	49,538	52,456
HTBW	subs	52	48	44	77
	N	101,042	100,552	93,386	96,674
ITBM	subs	19	16	12	10
	N	26,205	26,517	25,940	27,403
ITBN	subs	7	14	13	23
	N	32,372	31,492	30,769	34,611
LTB	subs	7	8	9	10
	N	38,411	39,371	38,477	40,933
Wales Total	subs	114	120	107	153
	N	252,139	251,378	238,110	252,077
Total submissions	subs	922	868	755	800
Total throughput	N	2,362,452	2,367,285	2,249,456	2,288,839

Table 1.1c: Annual total numbers of slaughterhouse cases submitted to the APHA (subs) and total number of animals slaughtered (N) in GB, between 2019 and 2022, *by slaughterhouse throughput****. Figures include slaughterhouse cases detected in herds under movement restrictions due to a TB incident.***

Throughput level		2019	2020	2021	2022
Less than 1 animal/year	subs	0	0	0	0
	N	18	5	6	23
1 to 40 animals/year	subs	0	0	0	0
	N	1,176	457	319	402
41 to 250 animals/year	subs	3	3	2	3
	N	6,426	4,947	3,668	3,612
251 to1500 animals/year	subs	28	13	27	20
	N	33,603	27,815	28,474	24,294
1501 to7500 animals/year	subs	49	47	34	33
	N	136,285	121,934	112,650	119,937
Less than 7500 animals/year	subs	842	805	692	744
	N	2,184,944	2,212,127	2,104,339	2,140,571
Total submissions	subs	922	868	755	800
Total throughput	N	2,362,452	2,367,285	2,249,456	2,288,839

Table 1.1d: Annual total numbers of slaughterhouse cases submitted to the APHA (subs) and total number of animals slaughtered (N) in GB, between 2019 and 2022, **by herd type**. Herd type is defined by the current data which may introduce error in earlier years. Figures include slaughterhouse cases detected in herds under movement restrictions due to a TB incident.

Herd type		2019	2020	2021	2022
Beef	subs	577	510	458	458
	N	1,661,809	1,689,797	1,607,414	1,631,406
Dairy	subs	337	349	291	335
	N	554,282	532,945	495,829	501,107
Other	subs	6	6	6	7
	N	135,863	137,488	141,204	149,234
Total submissions	subs	922	868	755	800
Total throughput	N	2,362,452	2,367,285	2,249,456	2,288,839

Figure 1.1a: Annual number of bovine carcasses with suspected TB lesions detected at routine slaughter in GB submitted to the APHA for confirmatory diagnosis between 2013 and 2022. Positive submissions are those from which *M. bovis* was identified in the laboratory by bacteriological culture or (from 30 March 2022) PCR testing.

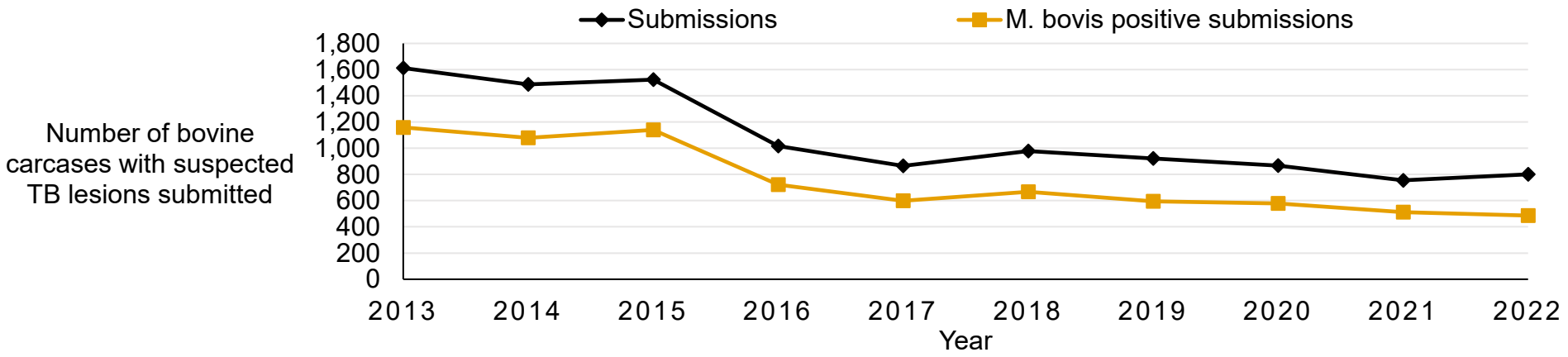


Figure 1.1a description: There is one orange and one black line showing the number of bovine carcasses with suspected TB lesions submitted in the slaughterhouse between 2013 and 2022. The black line represents the number of overall submissions and the orange the number of submissions that were confirmed with *M. bovis*. The black line is always higher than the orange line. Both lines show a decrease between 2013 and 2022, with a steep drop between 2015 and 2017, a slight increase between 2017 and 2018, and then an overall slight decreasing trend until the end of 2022.

Figure 1.1b: Number of bovine carcasses with suspected TB lesions detected at routine slaughter in GB submitted to the APHA for confirmatory diagnosis between 2013 and 2022, by risk region of origin of the slaughtered animals in England and Scotland (above) and in Wales (below).

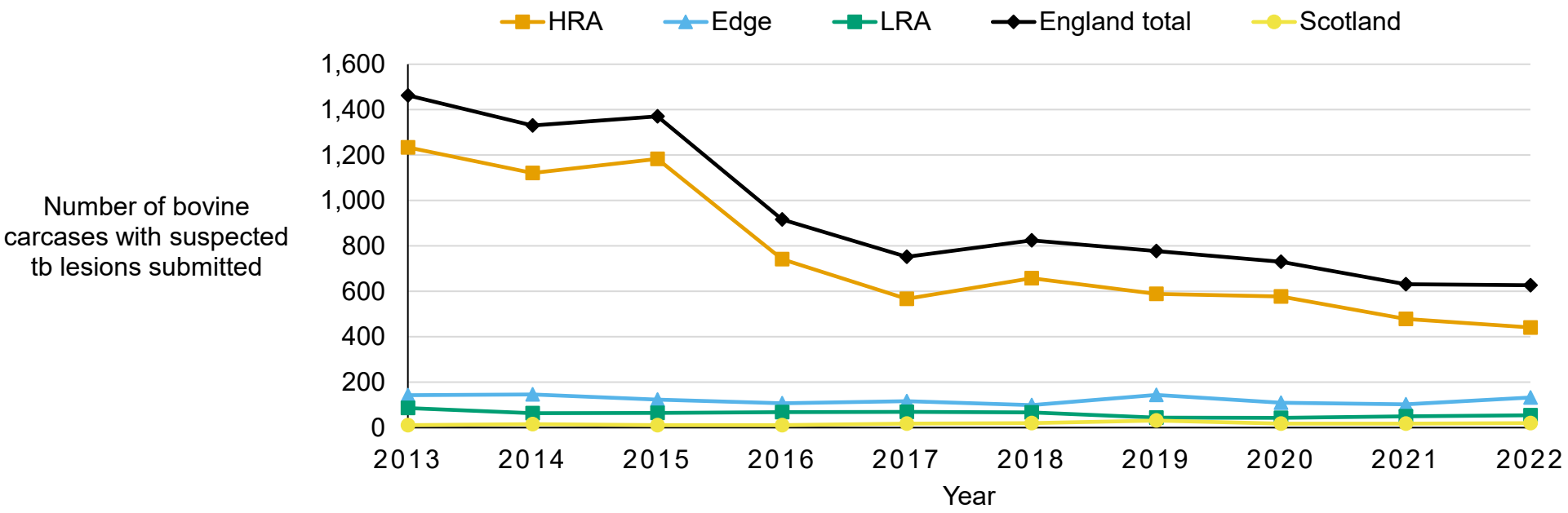


Figure 1.1b, graph 1 description: There are 5 lines, one orange, one black, one blue, one green and one yellow showing the number of bovine carcasses with suspected TB lesions submitted in the slaughterhouse between 2013 and 2022, by region. Each line shows a risk area, with black representing England, orange showing the HRA, blue showing the Edge Area, green showing the LRA and yellow representing Scotland. The number of cases in England (black line) is higher than all the other areas, and the HRA (orange) is just below the black line and follows its shape. Both England and the HRA show an overall decrease between 2013 and 2022, from 1,500 cases and 1,200 cases respectively in 2013 to just above 800 and 400 respectively in 2022. The blue, green and orange lines remain consistent

under 200 suspect slaughterhouse cases between 2012 and 2022. The number of cases in the Edge Area (blue line) is always higher than the LRA (green line) and Scotland (yellow line).

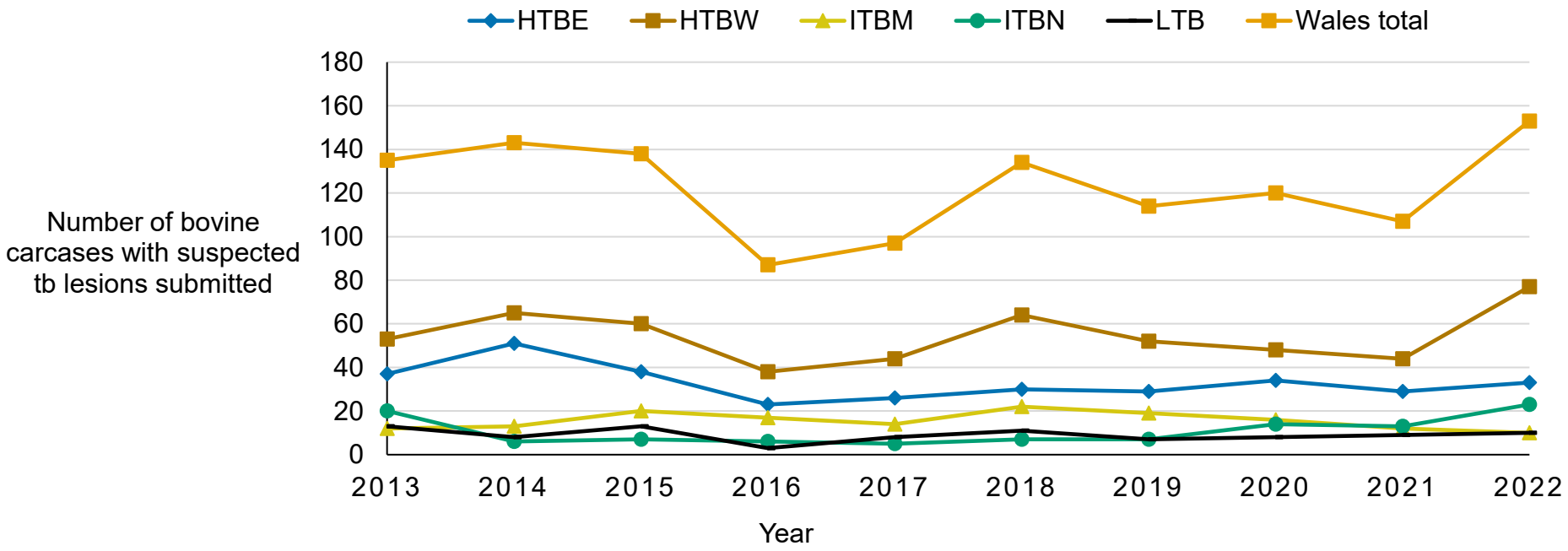


Figure 1.1b graph 2 description: There are 6 lines, one orange, one brown, one blue, one yellow, one green and one black showing the number of bovine carcasses with suspected TB lesions submitted in the slaughterhouse between 2013 and 2022, by region. Each line shows a risk area, with orange representing Wales, blue showing the HTBE, brown showing the HTBW, yellow showing the ITBM, green showing the ITBN and black showing the LTB. The number of cases in Wales (orange line) is higher than all the other areas. The HTBW (brown) is below the orange line and follows its shape. The number of submissions in both Wales and the HTBW fluctuate between 2013 and 2022, peaking in 2014 and 2018, before increasing between 2021 and 2022 to 77 and 153, respectively. The HTBE decreases from 51 in 2014 to 23 in 2016, then gradually increases to 33 in 2022. The ITBM (yellow line), ITBN (green line) and LTB (black line) all remain consistent under 25. Between 2018 and 2022, the ITBM (yellow line) decreases and the ITBN (green line) increases.

Slaughterhouse case submission rates

The annual submission rate of total and confirmed (*M. bovis*-positive) slaughterhouse cases per 1,000 animals slaughtered in GB is shown in Figure 1.1c. There was an overall decrease in both the total and the positive slaughterhouse case submission rates between 2013 and 2022, with a particularly sharp decrease observed between 2015 and 2016. In 2022, the submission rate of total slaughterhouse cases increased slightly compared to 2021, though this was still the second lowest rate since 2013.

Figure 1.1c: Rate of slaughterhouse cases in GB submitted to the APHA for confirmatory diagnosis, per 1,000 animals slaughtered between 2013 and 2022. Positive submissions are those from which *M. bovis* was identified in the laboratory by bacteriological culture or (from 30 March 2022) PCR testing.

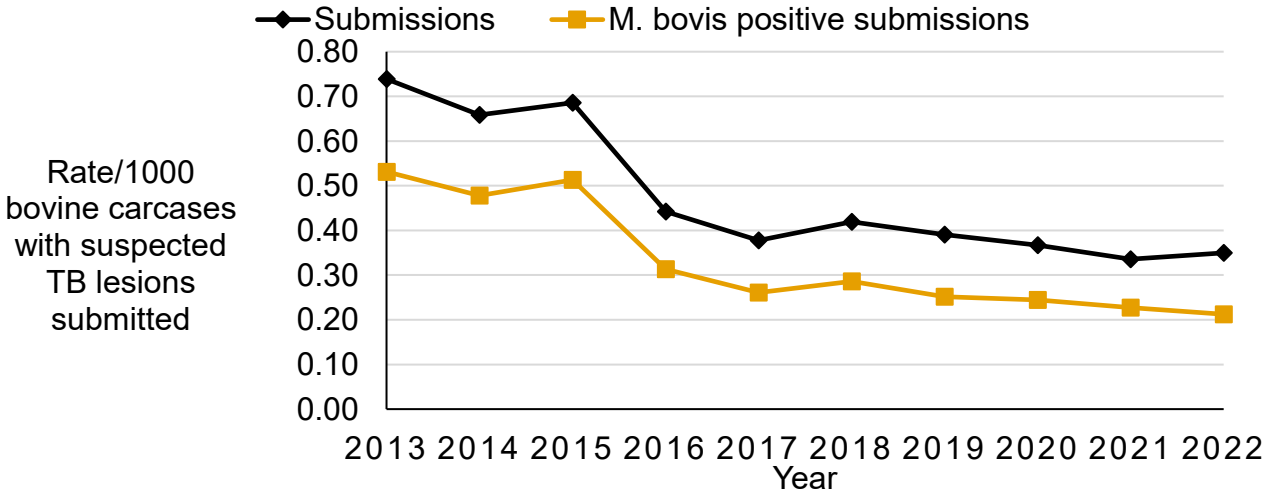


Figure 1.1c description: There is one orange and one black line showing the rate per 1,000 bovine carcasses with suspected TB lesions submitted in the slaughterhouse between 2013 and 2022. The black line represents the rate of overall submissions and the orange the rate of submissions that were confirmed with *M. bovis*. The black line is always higher than the orange line. Both lines show a decrease between 2013 and 2022, with a steep drop between 2015 and 2017 and a slight increase between 2017 and 2018. The overall rate (black line) shows a gradual decrease between 2018 and 2021, followed by a minor increase in 2022. The rate of confirmed submissions (orange line) gradually decreases between 2018 and 2022.

There was strong regional variation in submission rates, as would be expected given the heterogeneous geographic distribution of bovine TB risk (Figure 1.1d, Tables 1.1e and 1.1f). Except for 2022, the highest submission rates were from herds in the HRA. However, the rate in the HRA decreased substantially in 2016 and has since declined at a much slower rate. In 2019, submission rates in the HRA were only marginally greater than

the rate in the ITBM. In 2022, the rate in the HRA and the ITBN of Wales were the same, and both lower than the rate in the HTBW region. The rate in the HRA plateaued between 2013 to 2015 decreased considerably between 2015 and 2016, before continuing to decrease steadily from 2016 onwards. Elsewhere in GB, submission rates were comparatively stable since 2013. However, the rate has tripled in the intermediate TB Area North (ITBN) region between 2019 and 2022, while the rate has halved in the intermediate TB Area Mid (ITBM) region.

In the HRA, the reduced submission rate since 2016 was due to fewer bovine carcasses presenting with visible lesions of TB at routine slaughter, as illustrated in Fig 1.1b. It is not possible to definitively identify the factors that have led to the reduced submission rate in this region of England. However, it is likely that falling TB herd incidence in parts of the HRA and/or a reduced level of disease progression in infected cattle have occurred. If infection is detected earlier on the farm, microscopic lesions of TB would not have the time to develop into lesions detected at slaughter. Enhanced quality assurance and training for OVs carrying out tuberculin skin testing in the field, and several policy changes aimed at improving detection and removal of infected cattle from herds with TB incidents may have influenced the declining trend. The badger control policy in the HRA and Edge Area of England, initially launched in 2013 and markedly expanded from 2016, is likely to have been another contributing factor through a reduced *M. bovis* infection pressure on cattle herds from the wildlife reservoir (Birch and ., 2024). Relevant cattle TB testing policy changes implemented in the HRA since 2016 include:

- a more stringent skin testing regime for herds with lesion and culture-negative (OTF-S) TB incidents (that is to say 2 consecutive short interval tests with negative results at the severe interpretation before movement restrictions can be restored
- most herds in the HRA were moved from an annual surveillance testing regime to a six-monthly testing frequency between 2020 and 2021
- supplementary interferon-gamma (IFN-γ) blood testing of herds with a new OTF-W incidents in badger culling areas until July 2021, replaced thereafter by mandatory testing of herds experiencing a recurrent or persistent OTF-W incident

Figure 1.1d: Rate of total slaughterhouse cases in GB submitted to the APHA for confirmatory diagnosis, per 1,000 animals slaughtered between 2013 and 2022, by risk region of origin of the slaughtered animals in England and Scotland (above) and in Wales (below). For the equivalent rates of culture-positive submissions only, see Figure 1.7.

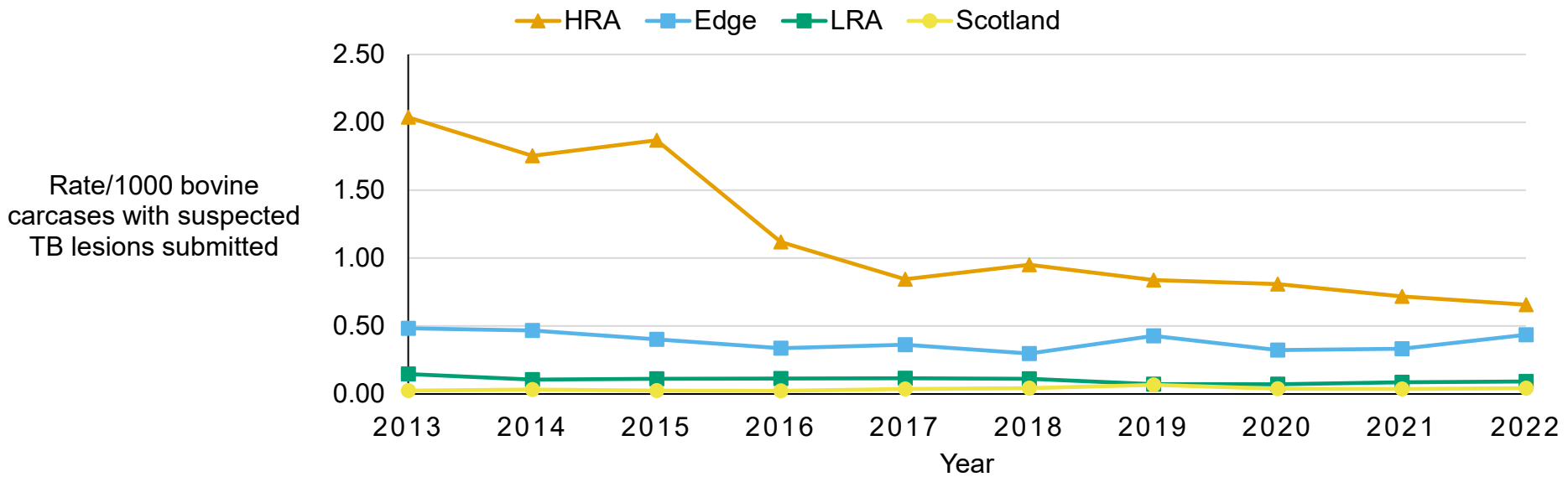


Figure 1.1d, graph 1 description: There are 4 lines, one red, one blue, one green and one yellow showing the rate of bovine carcasses with suspected TB lesions submitted in the slaughterhouse between 2013 and 2022, by region. Each line shows a risk area, with red showing the HRA, blue showing the Edge Area, green showing the LRA and yellow representing Scotland. The number of cases in the HRA (red line) is higher than all the other areas. The HRA shows an overall decrease between 2013 and 2022, from 2.04 per 1,000 carcasses submitted to 0.66 per 1,000 carcasses submitted in 2022. The blue, green and yellow lines remain constant below 0.5 per

1,000 carcasses submitted, the blue line is closer to 0.5 per 1,000 carcasses and the green and yellow lines are closer to 0.0 per 1,000 carcasses submitted.

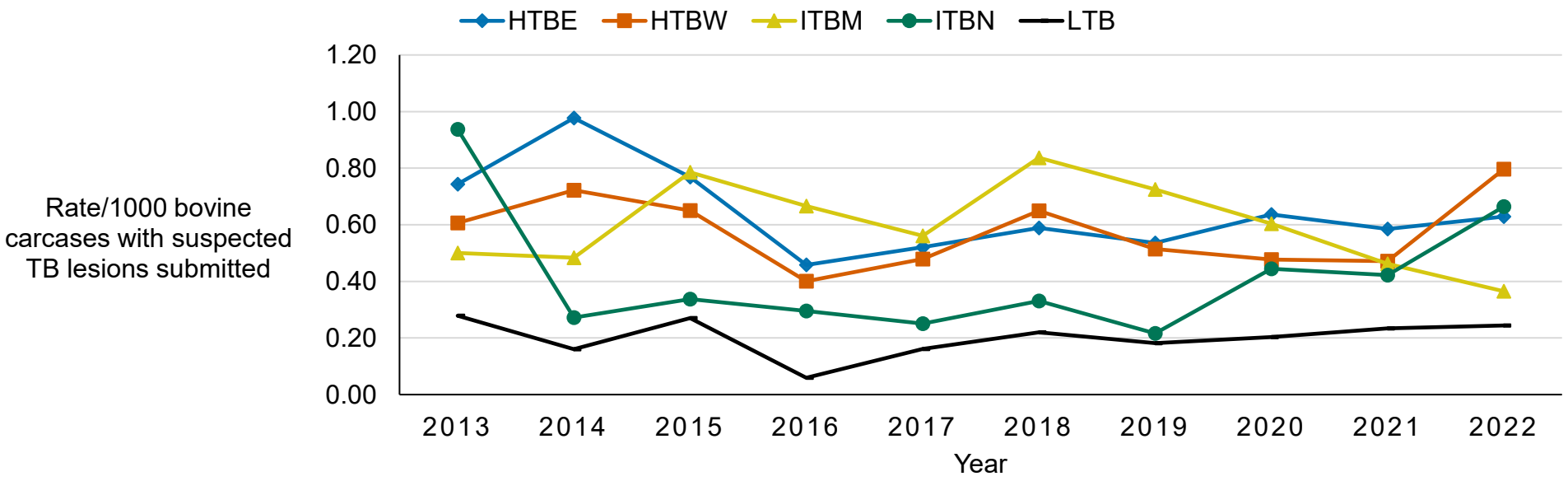


Figure 1.1d, graph 2 description: There are 5 lines, one blue, one brown, one yellow, one green and one black showing the rate of bovine carcasses with suspected TB lesions submitted in the slaughterhouse between 2013 and 2022, by region. Each line shows a risk area, with blue showing the HTBE, brown showing the HTBW, yellow showing the ITBM, green showing the ITBN and black showing the LTB. The rate of carcass submissions fluctuates in all regions between 2013 and 2022. The LTB (black line) is always the lowest, fluctuating between 2013 to 2019, before steadily increasing between 2019 and 2022. The ITBN (green line) decreases from 0.94 in 2013 and 0.27 in 2014, fluctuates between 2014 and 2019, then increases from 0.22 in 2019 to 0.66 in 2022. The IBTM (yellow line)

peaks in 2015 (0.79) and 2018 (0.84), then decreases to 0.36 in 2022. The HTBW (brown line) fluctuates between a rate of 0.4 and 0.8, peaking in 2014, 2018 and 2022. The HTBE (blue line) increases between 2013 to the highest rate in 2014 (0.98), decreases between 2014 and 2016, then steadily increases to 2022.

Table 1.1e: Annual rate of slaughterhouse case submissions to APHA between 2019 and 2022, per 1,000 animals slaughtered. The data include submissions from OTF herds irrespective of culture results, stratified by region of the herd of origin.

	2019	2020	2021	2022
England				
HRA	0.84	0.81	0.72	0.66
Edge	0.43	0.32	0.33	0.44
LRA	0.07	0.07	0.09	0.09
Total	0.47	0.44	0.41	0.40
Scotland	0.07	0.04	0.04	0.04
Wales				
HTBE	0.54	0.64	0.59	0.63
HTBW	0.51	0.48	0.47	0.80
ITBM	0.73	0.60	0.46	0.36
ITBN	0.22	0.44	0.42	0.66
LTB	0.18	0.20	0.23	0.24
Total	0.45	0.48	0.45	0.61
Total	0.39	0.37	0.34	0.35

Table 1.1f: Annual rate of slaughterhouse case submissions to APHA between 2019 and 2022, per 1,000 animals slaughtered. The data only includes submissions from OTF herds with *M. bovis*-positive culture results, stratified by region of the herd of origin.

	2019	2020	2021	2022
England				
HRA	0.61	0.60	0.53	0.44
Edge	0.24	0.20	0.22	0.28
LRA	0.01	0.01	0.02	0.02
Total	0.31	0.30	0.28	0.25
Scotland	0.02	0.01	0.01	0.01
Wales				
HTBE	0.41	0.37	0.42	0.46
HTBW	0.32	0.37	0.34	0.51
ITBM	0.46	0.34	0.27	0.22
ITBN	0.06	0.29	0.20	0.17
LTB	0.05	0.03	0.05	0.07
Total	0.28	0.30	0.29	0.35
Total	0.25	0.24	0.23	0.21

Overall, of the 243 slaughterhouses where cattle were processed during the report period, only 45 (19%) had a submission rate of suspected cases greater than 0.5 per 1,000 animals slaughtered. Twenty-nine per cent of slaughterhouses in the Edge Area (with an annual throughput of more than 40) had a submission rate greater than 0.5 per 1,000 animals, compared with 58% of slaughterhouses in the HRA and 9% in the LRA.

In Scotland, no slaughterhouses had a submission rate greater than 0.5 per 1,000 animals and an annual throughput of more than 40. The equivalent proportion for slaughterhouses in Wales overall was 47%, though varied across the risk areas. In the HTBE, 50% (1/2) of slaughterhouses had a submission rate greater than 0.5 per 1,000 animals slaughtered, followed by 33% in ITBM and 25% in ITBN. One hundred percent of slaughterhouses with an annual throughput of more than 40 had a submission rate greater than 0.5 per 1,000 animals in the HTBW (2/2) and LTB (1/1) areas. For slaughterhouses with a throughput greater than 40 animals per year, the highest median submission rate was in the HRA (0.85 per 1000, Interquartile Range (IQR) 0.1, 5.8), followed by the Edge Area (0.34, IQR 0.0, 1.4) and the LRA (0.12, IQR 0.0, 1.7). The median submission rate for Wales and Scotland was around zero.

Geographic variation in submission numbers and rates

Figures 1.2 to 1.4 display the geographical distribution of slaughterhouses in GB according to their bovine animal throughput and case submission rate.

Figure 1.2a shows the locations of the 167 slaughterhouses that processed cattle between 2019 and 2021 and that had an average throughput of greater than 40 animals per year. Figure 1.2b shows the locations for the 167 slaughterhouses that processed animals in 2022 with a throughput greater than 40 animals. These 2 maps show that there has been changes in the throughput for some slaughterhouses between the periods of 2019 to 2021 and 2022, with throughput varying in both directions depending on location throughout GB.

The geographic distribution of submissions per 1,000 animals slaughtered between 2019 and 2021 is shown in Figure 1.3a. In the previous reporting period (2016to 19) there were 16 slaughterhouses with a submission rate of greater than 2.0 (and a throughput of more than 40 animals/year) in the HRA and Wales. Between 2019 to 2022 there were no slaughterhouses with a submission rate of greater than 2.0.

Figures 1.4a and 1.4b show the distribution of the positive slaughterhouse submission rate per 1,000 animals slaughtered in 2019-2021 and in 2022 respectively. As expected, slaughterhouses with high positive submission rates are mainly located in regions with a high herd incidence of TB.

Figure 1.2a: The locations of the 167 slaughterhouses where more than 40 animals per year were processed between 2019 and 2021 categorised by slaughterhouse throughput (animals/year).

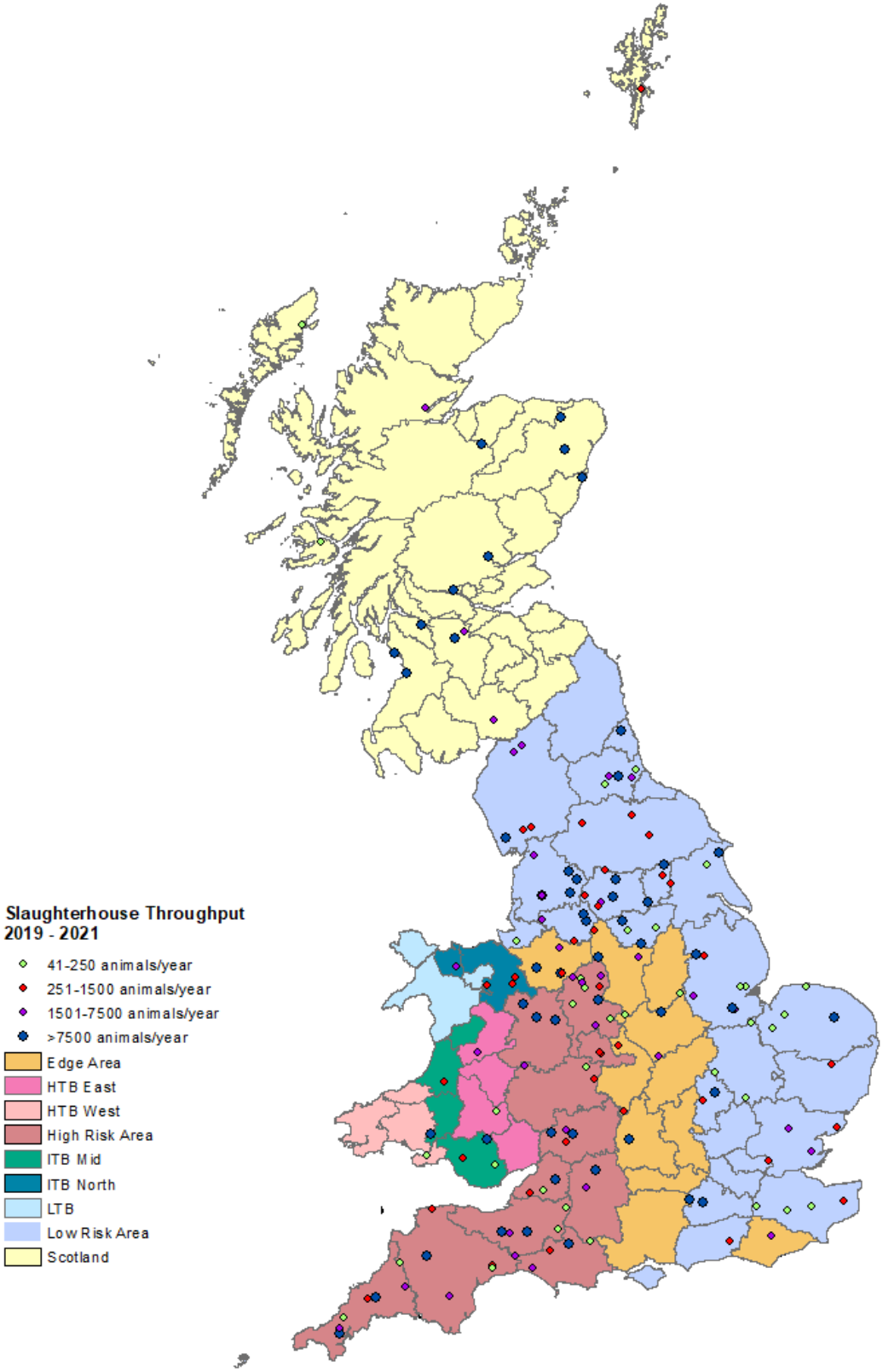


Figure 1.2a description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of average animal throughput between 2019 and 2021, with the maximum category of more than 7,500 animals per year. Scotland mostly has slaughterhouses with a very high throughput (over 7,500 animals per year), and only two with a high throughput of between 1,501 and 7,500 animals per year. There is a relatively even distribution of slaughterhouses categories across England, with the smallest number of slaughterhouses in the Edge Area. In Wales, there are only 12 slaughterhouses, with most of them falling in the medium category (251 to 1,500).

Figure 1.2b: The locations of the 167 slaughterhouses where more than 40 animals per year were processed in 2022 categorised by slaughterhouse throughput (animals per year).

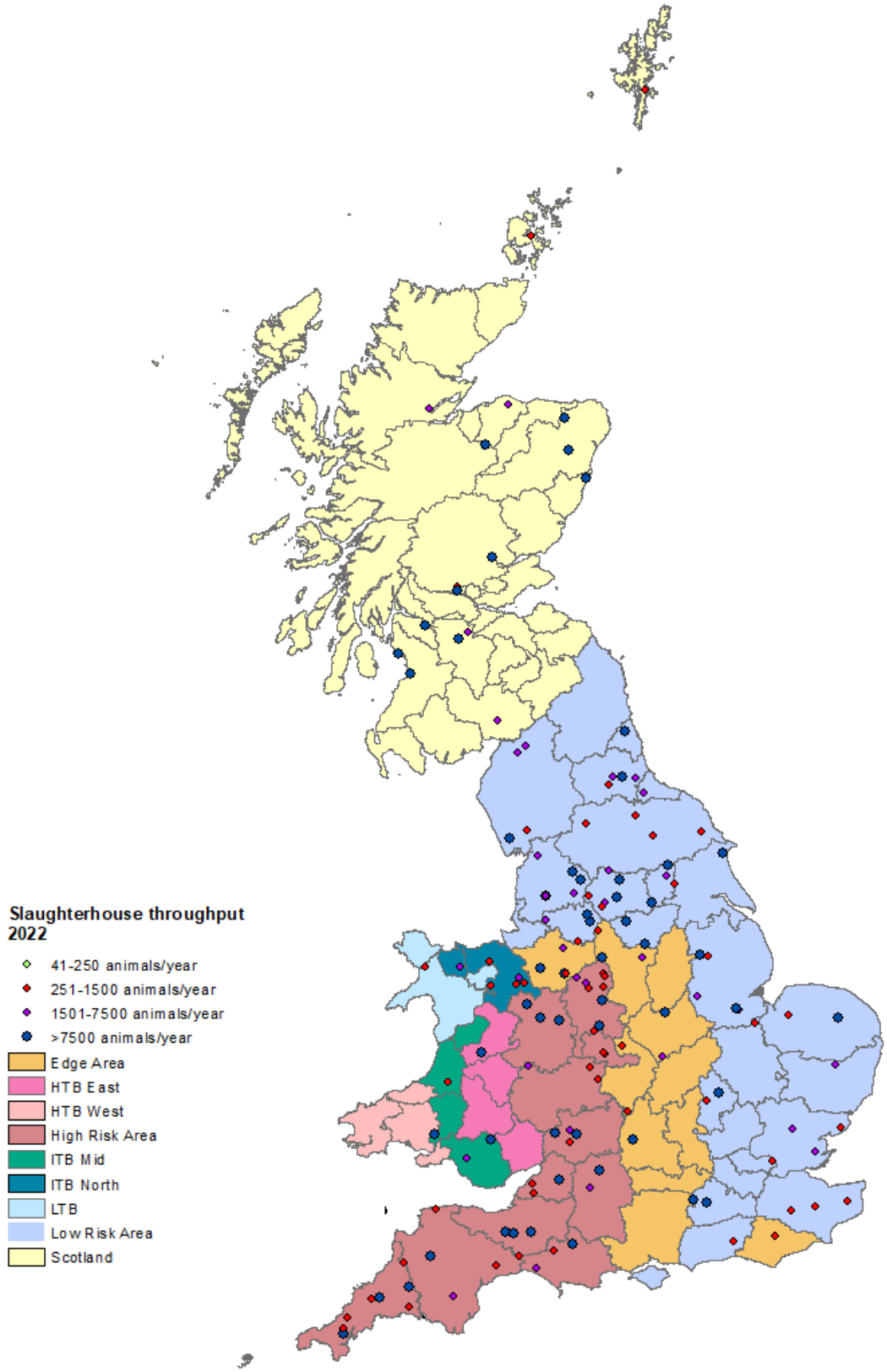


Figure 1.2b description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year in 2022. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of average animal throughput in 2022, with the maximum category of more than 7,500 animals per year. Scotland has ten slaughterhouses with a very high throughput (over 7,500 animals per year), four with a high throughput which deal with between 1,501 and 7,500 animals per year, and two with a medium throughput of between 251 to 1,500 animals per year. There is a relatively even distribution of slaughterhouses categories across England, with the fewest number of slaughterhouses in the Edge Area. In Wales, there are only 12 slaughterhouses, with most of them falling in the medium category (251 to 1,500 animals per year).

Figure 1.3a: Rates of total slaughterhouse case samples submitted per 1,000 animals slaughtered, by slaughterhouse location (includes only 167 slaughterhouses where more than 40 animals per year were processed) between 2019 and 2021.

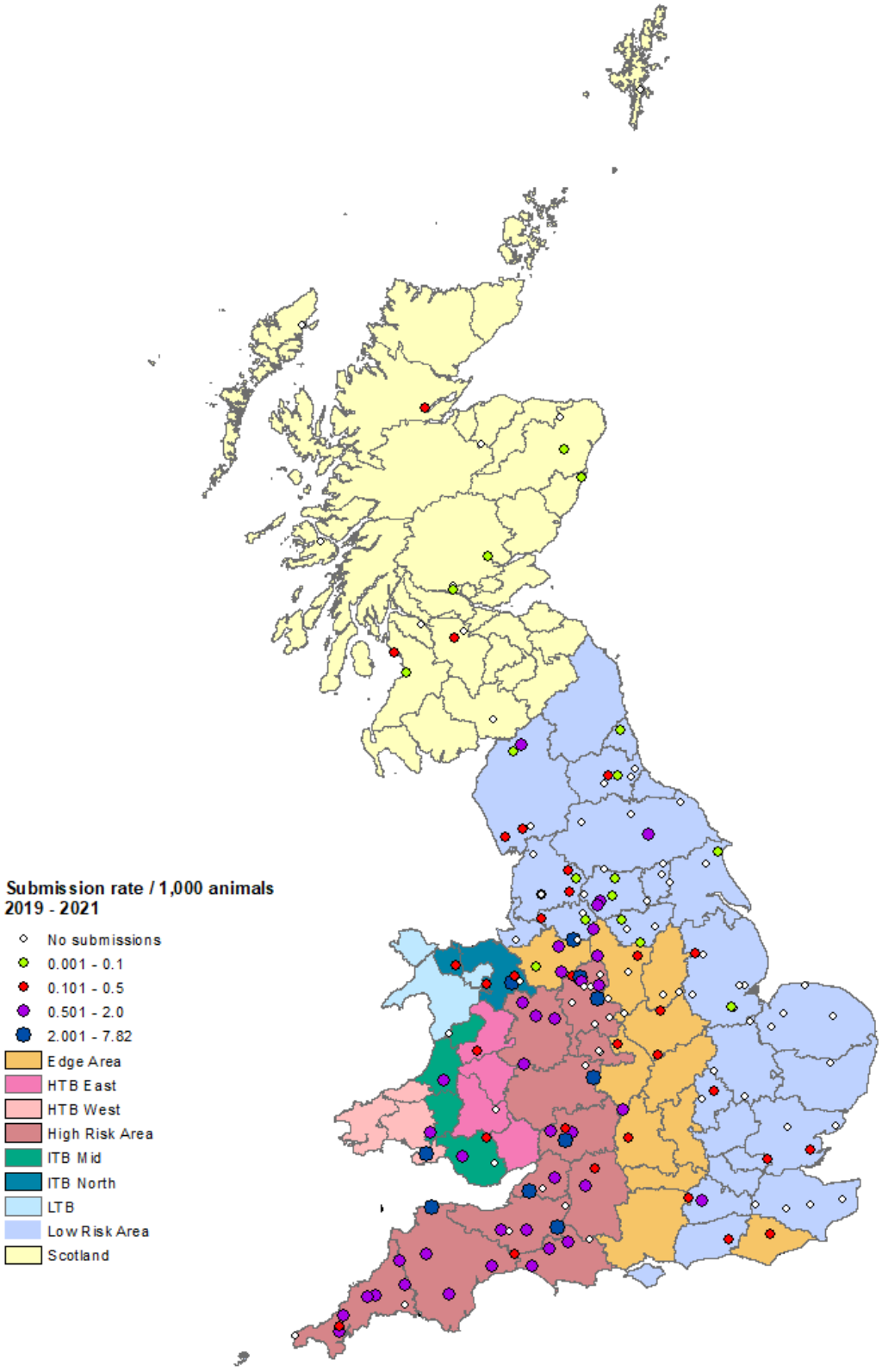


Figure 1.3a description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of the submission rate of carcasses with suspected TB lesions per 1,000 animals between 2019 and 2021, with the maximum submission rate shown as 7.82 submissions per 1,000 animals. Scotland mostly has slaughterhouses with no submissions, a very low (0.001 to 0.1 submissions per 1,000 animals), or a low (0.101 to 0.5 submissions per 1,000 animals). In the LRA (eastern England), most slaughterhouses had no, very low or low submissions rates. In the Edge Area (central England), most slaughterhouses are in the northern Edge counties and had a low or medium (0.501 to 2.0 submissions per 1,000 animals) submission rate, with only one in the medium-high submission rate category (2.001 to 7.82 submissions per 1,000 animals). The HRA (western and southwest England) had mostly medium and some medium-high slaughterhouses, though there were a handful of slaughterhouses which had no submissions throughout the risk area. In Wales, the slaughterhouses were mostly in the no, low or medium submission rate categories, bar two with a medium-high rate.

Figure 1.3b: Rates of total slaughterhouse case samples submitted per 1,000 animals slaughtered, by slaughterhouse location (includes only 167 slaughterhouses where more than 40 animals per year were processed) in 2022.

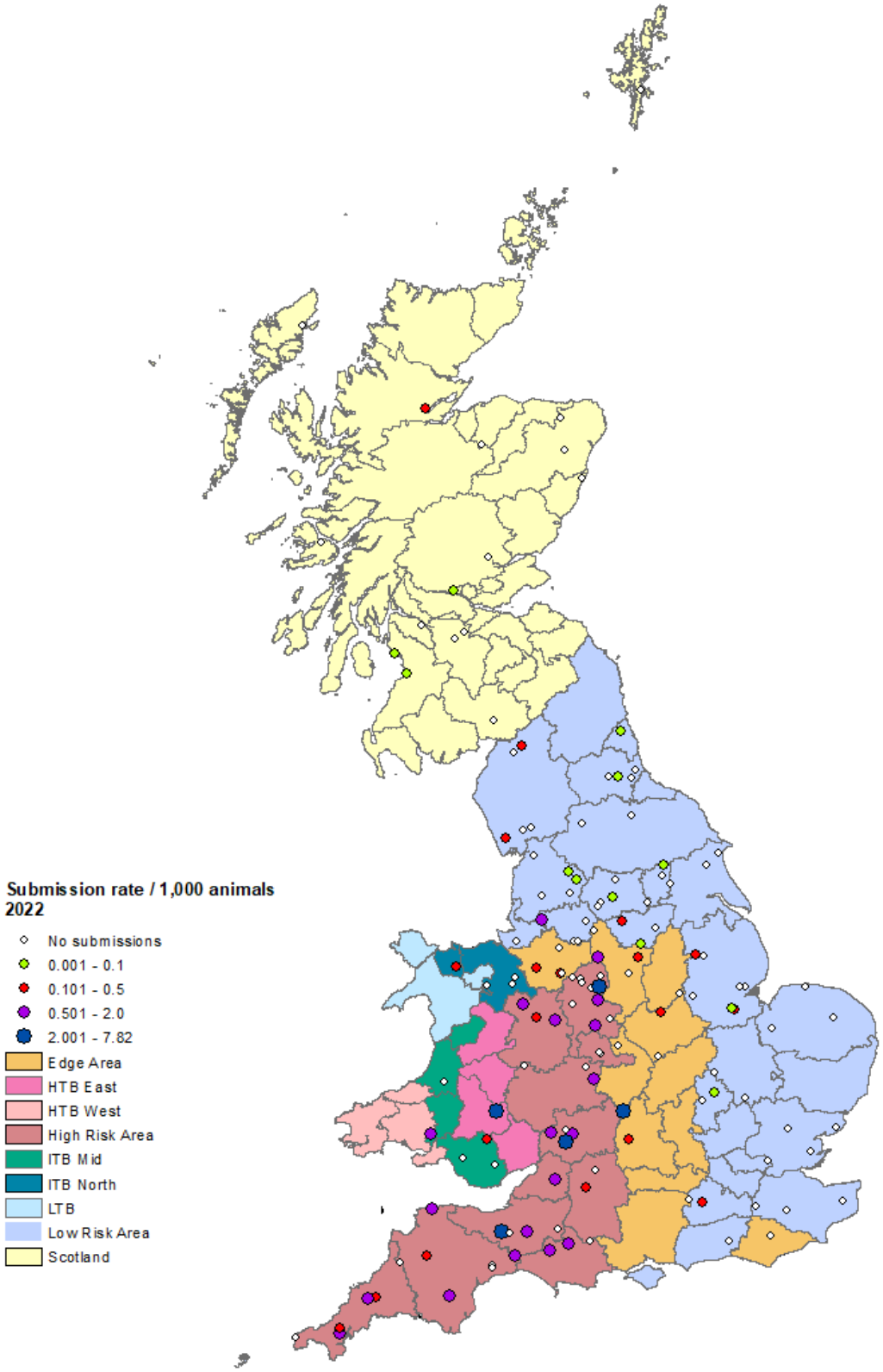


Figure 1.3b description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of the submission rate of carcasses with suspected TB lesions per 1,000 animals between 2019 and 2021, with the maximum submission rate shown as 7.82 submissions per 1,000 animals. Scotland mostly has slaughterhouses with no submissions, bar three with a very low (0.001 to 0.1 submissions per 1,000 animals) rate and one slaughterhouse with a low (0.101 to 0.5 submissions per 1,000 animals) rate. In the LRA (eastern England), most slaughterhouses had no submissions, and a few with very low or low submissions rates. In the Edge Area (central England), most slaughterhouses are in the northern Edge counties and had a low or medium (0.501 to 2.0 submissions per 1,000 animals) submission rate, with only one in the medium-high submission rate category (2.001 to 7.82 submissions per 1,000 animals). The HRA (western and southwest England) had mostly medium and some medium-high slaughterhouses, though there were a handful of slaughterhouses which had no submissions throughout the risk area. In Wales, most slaughterhouse had no submissions, with two with a low submission rate, one with a medium submission rate and one with a medium-high rate.

Figure 1.4a: Rates of positive slaughterhouse case samples submitted per 1,000 animals slaughtered (includes only 167 slaughterhouses where more than 40 animals were processed) between 2019 and 2021.

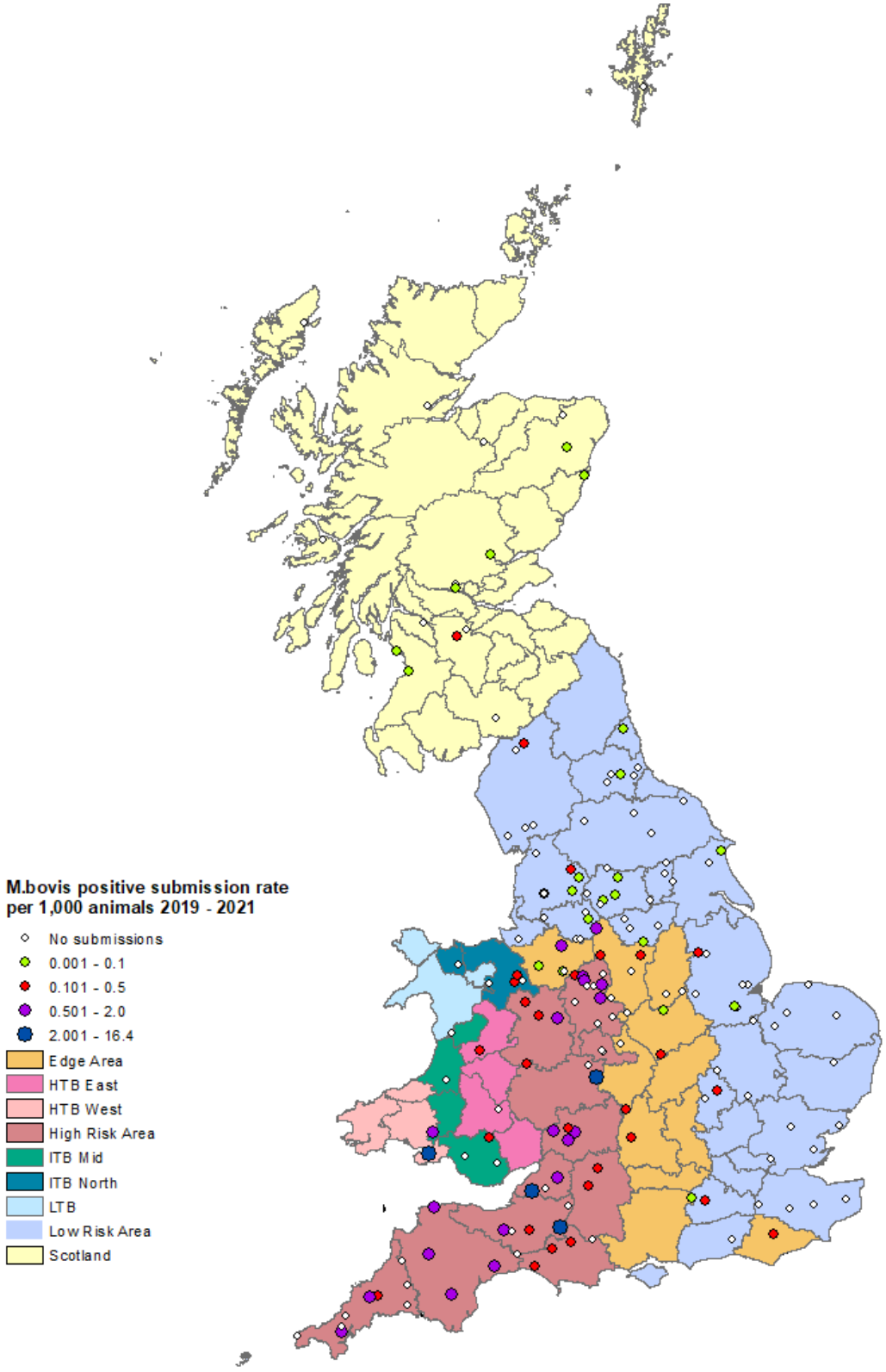


Figure 1.4a description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of the number of carcasses submitted which had TB confirmed (*M. bovis* positive submission rate) per 1,000 animals between 2019 and 2021, with the maximum submission rate shown as 16.4 *M. bovis* positive submissions per 1,000 animals. Scotland mostly has slaughterhouses with either no or a very low positive submission rate (0.001 to 0.1 *M. bovis* positive submissions per 1,000 animals). One slaughterhouse in the region had a low positive submission rate between 2019 to 2021 (0.101 to 0.5 *M. bovis* positive submissions per 1,000 animals). In the LRA (eastern England), most slaughterhouses had no positive submissions, and a few with very low or low positive submissions rates. In the Edge Area (central England), most slaughterhouses had no positive in the northern Edge counties and had a very low or low submission rate, bar two with a medium positive submission rate (0.501 to 2.0 *M. bovis* positive submissions per 1,000 animals). The HRA (western and southwest England) had mostly low or medium positive submission rates, with three having a high positive submission rate (2.01 to 16.4 *M. bovis* positive submissions per 1,000 animals). There were also a handful of slaughterhouses which had no submissions throughout the risk area. In Wales, most slaughterhouse had no submissions, with four with a low submission rate, one with a medium submission rate and one with a high rate.

Figure 1.4b: Rates of positive slaughterhouse case samples submitted per 1,000 animals slaughtered (includes only 167 slaughterhouses where more than 40 animals were processed) between 2019 and 2021 (left) and 2022 (right).

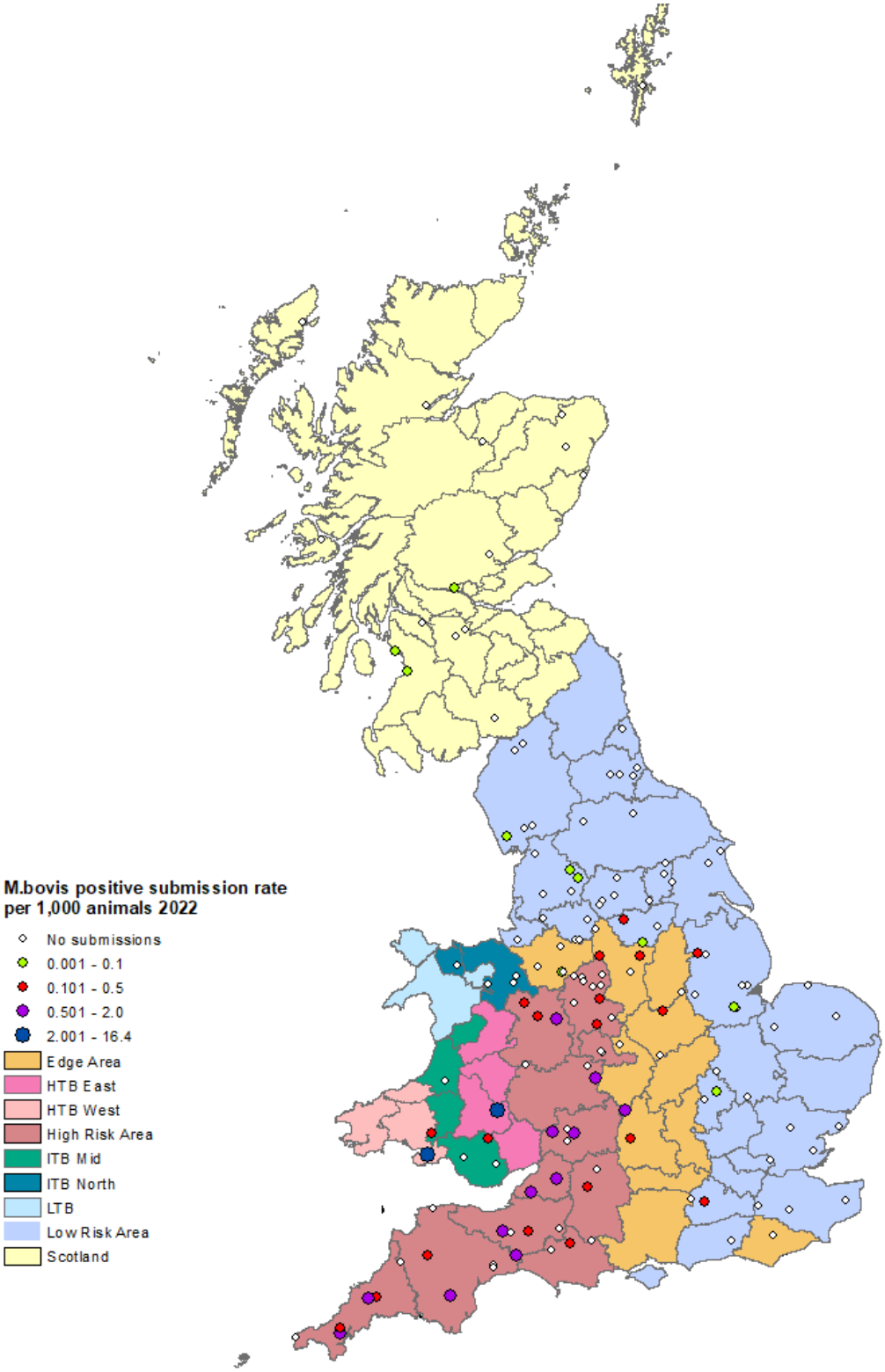


Figure 1.4b description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of the number of carcasses submitted which had TB confirmed (*M. bovis* positive submission rate) per 1,000 animals in 2022, with the maximum submission rate shown as 16.4 *M. bovis* positive submissions per 1,000 animals. Scotland mostly has slaughterhouses with no positive submissions in 2022, bar three with a very low positive submission rate (0.001 to 0.1 *M. bovis* positive submissions per 1,000 animals). In the LRA (eastern England), most slaughterhouses had no positive submissions, with a very low (6 slaughterhouses) or low (0.101 to 0.5 *M. bovis* positive submissions per 1,000 animals, 2 slaughterhouses) positive submissions rates. In the Edge Area (central England), most slaughterhouses had no positive submissions, with only four having a low and one with a very low positive submission rate. The HRA (western and southwest England) had a relatively even mix of slaughterhouses with a medium positive submission rate (0.501 to 2.0 *M. bovis* positive submissions per 1,000 animals) or no positive submissions at all. Nine slaughterhouses in the HRA had a low submission rate. In Wales, most slaughterhouse had no submissions, bar two having a low positive submission rate, and two with a high positive submission rate (2.01 to 16.4 *M. bovis* positive submissions per 1,000 animals).

Positive slaughterhouse cases

Of the 3,345 total TB slaughterhouse cases detected between 2019 and 2022, *M. bovis* was confirmed by positive laboratory test results from 2,171 (65%) samples, leading to a positive submission rate of 0.23 per 1,000 animals slaughtered in GB. This is a significant drop in the total positive submission rate compared to the last reporting period (in 2016 to 2019 0.28 per 1,000 animals slaughtered, incidence rate ratio, p=0.0026). Over the 4-year period (2019 to 2022), there was a decrease in the positive submission rate, from 0.25 to 0.21 per 1,000 animals slaughtered, Figure 1.1c and Table 1.1f. This decrease is also statistically significant (incidence rate ratio, p<0.0001). The geographical distribution of *M. bovis* positive submissions per 1,000 animals slaughtered between 2019 and 2021 is shown in Figure 1.4a, and data for 2022 is shown in Figure 1.4b.

The total number of slaughterhouse cases submitted to the APHA in the reporting period by herd and slaughterhouse region is shown in Table 1.2. The figures varied by region of the herd of origin, with more samples submitted from herds located in the HRA than in any other region (n=2,085), as expected and consistent with previous reports. Farms frequently submit animals to slaughterhouses outside their own TB risk region. This is particularly the case in herds for the Edge Area of England, most likely a result of the size and shape of the Edge Area itself. More slaughterhouse cases for animals originating in Wales were submitted by slaughterhouses in the HRA than from slaughterhouses in Wales, most notably for herds located in the ITBN (71%) (Table 1.2).

Table 1.2: Number (N) and proportion (%) of slaughterhouse case samples submitted to APHA between 2019 and 2022, by herd and slaughterhouse region.

		Herd Origin Region									
Slaughterhouse region			**England**		**Scotland**			**Wales**			
Slaughterhouse region		**HRA**	**Edge**	**LRA**		**High TB East**	**High TB West**	**Intermediate Tb Mid**	**Intermediate TB North**	**Low TB**	**Total**
HRA	**N**	1,872	243	53	12	79	88	34	40	23	2444
	%	89.78	49.69	27.75	13.95	63.2	39.82	59.65	70.18	67.65	73.06
Edge	**N**	45	67	16	7	3	0	0	3	3	144
	%	2.16	13.7	8.38	8.14	2.4	0	0	5.26	8.82	4.3
LRA	**N**	81	138	114	18	4	26	0	3	3	387
	%	3.88	28.22	59.69	20.93	3.2	11.76	0	5.26	8.82	11.57
Scotland	**N**	0	0	3	48	0	0	0	0	0	51
	%	0	0	1.57	55.81	0	0	0	0	0	1.52
High TB East	**N**	0	0	0	0	2	1	0	0	1	4
	%	0	0	0	0	1.6	0.45	0	0	2.94	0.12
High TB West	**N**	15	3	2	0	3	31	0	5	3	62
	%	0.72	0.61	1.05	0	2.4	14.03	0	8.77	8.82	1.85
Intermediate Tb Mid	**N**	69	37	3	1	33	75	23	1	0	242
	%	3.31	7.57	1.57	1.16	26.4	33.94	40.35	1.75	0	7.23
Intermediate TB North	**N**	3	1	0	0	1	0	0	4	1	10
	%	0.14	0.2	0	0	0.8	0	0	7.02	2.94	0.3
Low TB	**N**	0	0	0	0	0	0	0	1	0	1
	%	0	0	0	0	0	0	0	1.75	0	0.03
Total	**N**	2,085	489	191	86	125	221	57	57	34	3345

Slaughterhouses with no submissions in the reporting period

Between 2019 and 2022, 137 of the 243 slaughterhouses that slaughtered at least one bovine animal did not submit a suspected slaughterhouse case sample to APHA (56%) (Table 1.3). However, this dropped to 35% (57 out of 163) for slaughterhouses with a throughput of more than 40 animals. Some of the 137 slaughterhouses with no submissions may have notified APHA of a suspected slaughterhouse case where sample submission was not required. For example, when a slaughterhouse case is identified in a herd already restricted due to an ongoing OTF-W TB incident.

No samples were submitted from 28.8% (10 out of 48) of slaughterhouses with a throughput more than 40 animals in the HRA. In the HRA 33.3% (19 out of 57) of the slaughterhouses that slaughtered at least one bovine animal between 2019 and 2022, did not submit a slaughterhouse case sample to APHA, and less than half of these (47.4%, 9 out of 19) were slaughterhouses with very low throughput.

None of the 45 CPHHs that were final destinations for animals but did not have a slaughterhouse ID submitted a sample. All of these had a throughput of 40 or fewer animals and notably 38% of these final destination CPHHs were in the HRA. The number of animals passing through these slaughterhouses was 431, which represents less than 0.01% of the overall GB throughput in the reporting period, so their contribution to overall trends is very small.

Six slaughterhouses with a very high annual throughput (more than 7500) did not submit a sample; three were located in Scotland and three in the LRA. The absence of samples from the slaughterhouse with high throughputs is of concern even if the cattle slaughtered are predominantly from low TB risk regions. This is because active TB test surveillance frequency is much lower than in high-risk regions. Also, TB surveillance is predominately passive in these regions, and therefore dependent on slaughterhouse inspection.

Section 5 specifically aims to identify slaughterhouses that submitted fewer than the expected number of samples during the reporting period.

Table 1.3: Regional distribution of the 243 slaughterhouses that did not submit any samples between 2019 and 2022, by slaughterhouse throughput categories (animals per year). Slaughterhouses registered at least one bovine animal slaughter.

Region	Throughput category <1	1-40	41-250	251-1500	1501-7500	>7500	Total	Region Total	% with no submissions
England High Risk Area	1	8	5	3	2	0	19	57	33.3%
England Edge Area	3	4	0	0	0	0	7	21	33.3%
England Low Risk Area	3	7	18	11	5	3	47	79	59.5%
Scotland	2	4	2	1	2	3	14	22	63.6%
Wales High TB Area East	0	0	0	0	0	0	0	2	0.0%
Wales High TB Area West	0	0	0	0	0	0	0	2	0.0%
Wales Intermediate TB Area Mid	1	1	1	0	0	0	3	8	37.5%
Wales Intermediate TB Area North	1	0	0	0	0	0	1	5	20.0%
Wales Low TB Area	0	1	0	0	0	0	1	2	50.0%
Total slaughterhouses sending no submissions	11	25	26	15	9	6	92	198	46.5%
% sending no submissions	39%	48%	74%	38%	25%	11%	38%		
Total slaughterhouses	28	52	35	39	36	53	243		

Note: There were no slaughterhouses sending no submissions in the HTBE and HTBW regions of Wales.

Proportion of confirmed slaughterhouse case submissions and results of genetic characterisation

The proportions of slaughterhouse cases that were positive for *M. bovis* on laboratory testing are shown in Figures 1.5a (2019to2021) and b (2022). The number of slaughterhouses where this proportion exceeded 0.80 decreased in 2022 compared to the 2019to 21 period. In both periods these slaughterhouses were mainly found in the HRA.

The median rate of *M. bovis*-positive slaughterhouse cases per 1000 slaughtered cattle, for slaughterhouses that submitted at least one sample, was 0.32 (IQR 0.08-0.94). Bacteriological culture was replaced by PCR testing as the primary confirmation method from 30 March 2022, and the impact of PCR testing is discussed in Section 5.

Whole Genome Sequencing (WGS) fully replaced genotyping (spoligo- and VNTR-typing) of *M. bovis* isolates in GB as of April 2021. The slaughterhouse case submission rate by different WGS clades of *M. bovis* is given in Table 1.4. In all years between 2019 and 2022, clades B6-11, B6-85 and B3-11 were the most frequently isolated from positive slaughterhouse cases, consistent with the isolates from cattle removed from farms as TB test reactors.

Table 1.4: Annual number (N) and rate (per 1,000 animals slaughtered) of laboratory positive slaughterhouse cases in GB submitted to APHA, by WGS clade. WGS clades are listed in order of decreasing overall frequency. Note: the annual rate of laboratory positive slaughterhouse cases is lower in this table compared to Table 1.1f because there were 388 OTF-W cases between 2019 and 2022 that have no WGS clade yet.

	2019		2020		2021		2022		Total	
WGS clade	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**	**N**	**Rate**
B6-11	105	0.0444	92	0.0389	124	0.0551	106	0.0463	427	0.0461
B6-85	81	0.0343	73	0.0308	61	0.0271	69	0.0301	284	0.0306
B3-11	65	0.0275	58	0.0245	63	0.0280	55	0.0240	241	0.0260
B6-83	27	0.0114	29	0.0123	34	0.0151	38	0.0166	128	0.0138
B6-62	30	0.0127	22	0.0093	30	0.0133	41	0.0179	123	0.0133
B6-14	23	0.0097	22	0.0093	23	0.0102	38	0.0166	106	0.0114
B4-11	23	0.0097	28	0.0118	26	0.0116	23	0.0100	100	0.0108
B6-42	15	0.0063	13	0.0055	7	0.0031	12	0.0052	47	0.0051
B1-11	13	0.0055	10	0.0042	10	0.0044	12	0.0052	45	0.0049
B6-51	7	0.0030	10	0.0042	15	0.0067	11	0.0048	43	0.0046
B6-13	7	0.0030	8	0.0034	14	0.0062	10	0.0044	39	0.0042
B6-91	10	0.0042	10	0.0042	8	0.0036	7	0.0031	35	0.0038
B6-87	11	0.0047	9	0.0038	8	0.0036	5	0.0022	33	0.0036
B6-52	12	0.0051	7	0.0030	7	0.0031	6	0.0026	32	0.0035
B6-15	5	0.0021	3	0.0013	11	0.0049	5	0.0022	24	0.0026
B2-11	7	0.0030	4	0.0017	6	0.0027	2	0.0009	19	0.0021
B6-86	2	0.0008	2	0.0008	2	0.0009	4	0.0017	10	0.0011
B6-82	1	0.0004	0	0.0000	2	0.0009	5	0.0022	8	0.0009
B6-16	5	0.0021	1	0.0004	1	0.0004	0	0.0000	7	0.0008
B6-84	3	0.0013	1	0.0004	1	0.0004	1	0.0004	6	0.0006
B5-11	1	0.0004	2	0.0008	2	0.0009	0	0.0000	5	0.0005
B6-22	3	0.0013	1	0.0004	1	0.0004	0	0.0000	5	0.0005
B6-41	0	0.0000	1	0.0004	1	0.0004	3	0.0013	5	0.0005
B6-71	1	0.0004	1	0.0004	2	0.0009	0	0.0000	4	0.0004
B6-31	3	0.0013	0	0.0000	0	0.0000	0	0.0000	3	0.0003
B6-81	0	0.0000	0	0.0000	2	0.0009	1	0.0004	3	0.0003
B6-12	0	0.0000	0	0.0000	0	0.0000	1	0.0004	1	0.0001
Total	460	0.1947	407	0.1719	461	0.2049	455	0.1988	1,783	0.1924

Figure 1.5a: The proportion of *M. bovis*-positive slaughterhouse case submissions for the 167 slaughterhouses with a throughput of more than 40 animals per year between January 2019 and December 2021.

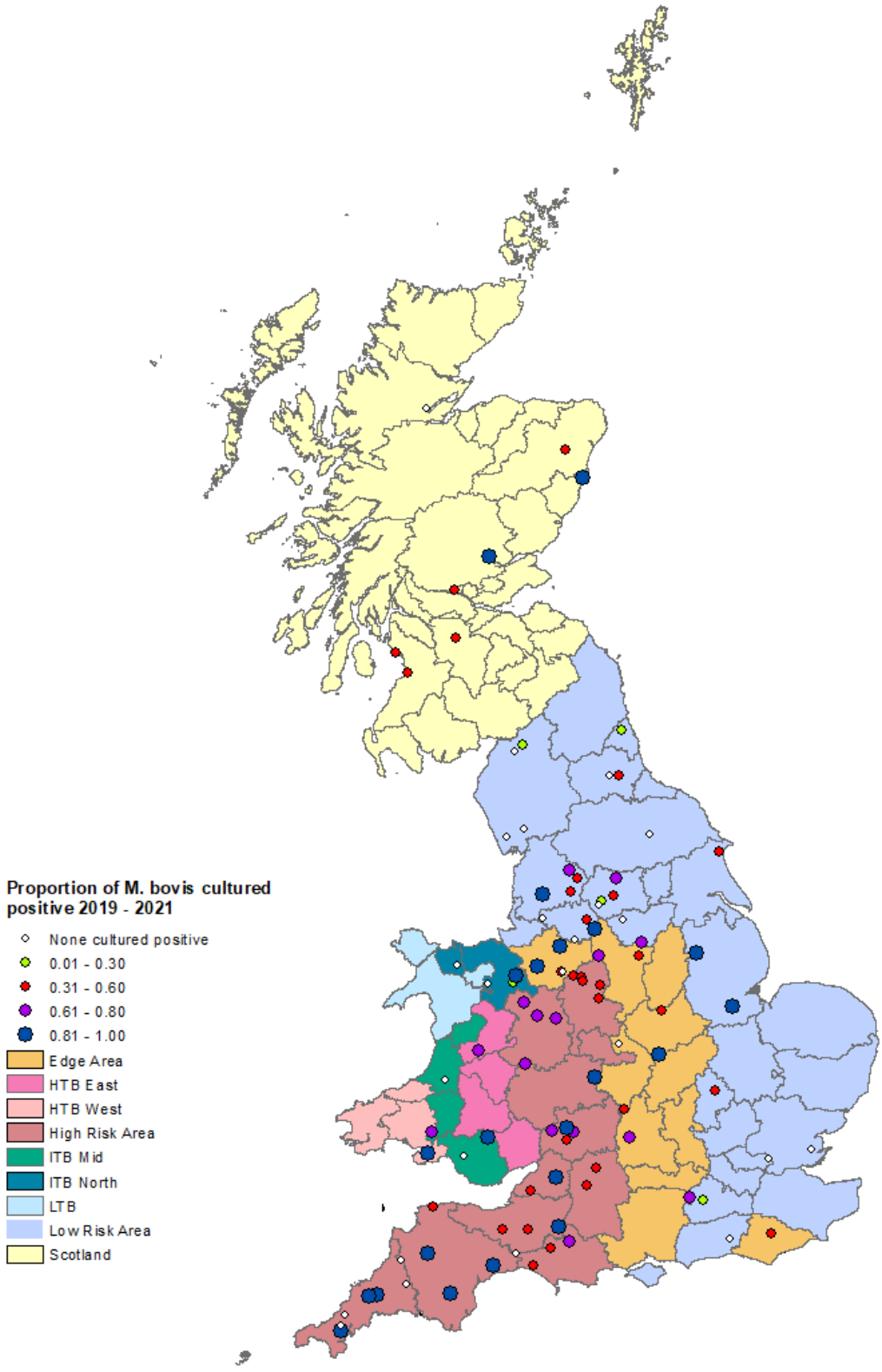


Figure 1.5a description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of the proportion of *M. bovis* culture positive cases between 2019 and 2021, with the maximum category showing as 81% to 100% of cases being culture positive. In Scotland, five slaughterhouses had a proportion of culture positive cases between 31% to 61%. The proportion across England is more variable, with a relatively even mix of all categories bar the lowest (1% to 30%) in the HRA (western and southwest England). The Edge Area (central England) had mostly high proportions of culture submissions (81% to 100%), with only three slaughterhouses having a low (1% to 30%) proportion, and only one with a medium (61% to 80%) proportion. The LRA had a mix of all categories throughout the risk area, including some where none cultured positive. In Wales, five slaughterhouses did not have any cases that were culture positive, three which had a medium (61% to 80%) and two high (81% to 100%) proportions.

Figure 1.5b: The proportion of *M. bovis*-positive slaughterhouse case submissions for the 167 slaughterhouses with a throughput of more than 40 animals per year between January to December 2022.

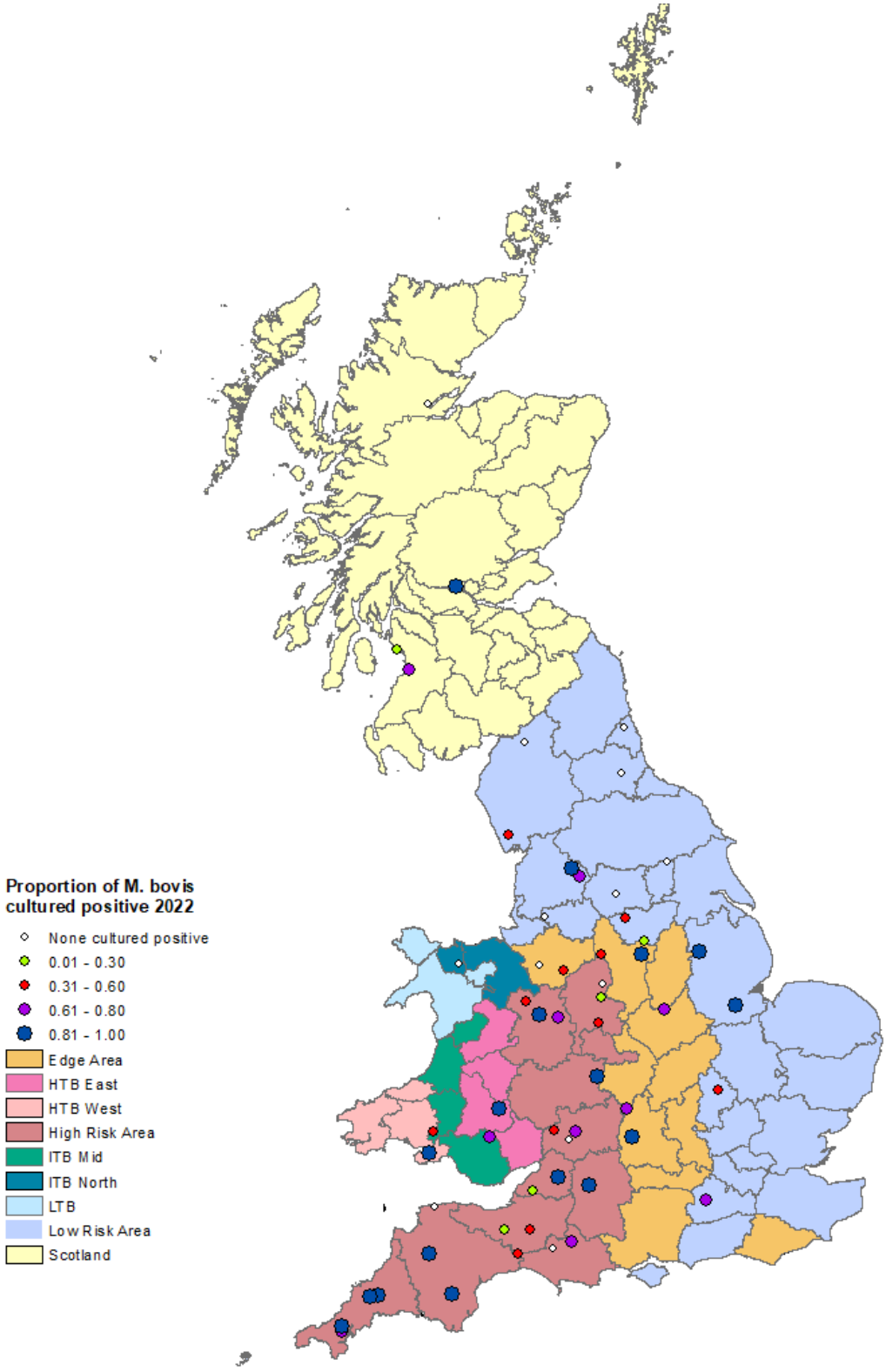


Figure 1.5b description: A map of GB showing the locations of 167 slaughterhouses with a throughput of over 40 animals per year. Each slaughterhouse is shown on the map as a circle, with different colours used to represent the categories of the proportion of *M. bovis* culture positive cases between 2019 and 2021, with the maximum category showing as 81% to 100% of cases being culture positive. In Scotland, only two slaughterhouses had culture positive submissions, with one having a high (81 to 100%) and one a medium (61 to 80%) proportion of culture positive submissions. In the LRA in England (eastern England), most slaughterhouse did not have any culture positive submissions in 2022. Three had a high proportion (81% to 100%), another three had a low proportion (31 to 60%), two had a medium proportion (61 to 80%) and one had a very low proportion (0.1 to 1%).

In Wales, most slaughterhouses had no positive submissions. Only two slaughterhouses had a high proportion of culture positive submissions, as well as one with medium (61% to 80%) and one with low (31% to 60%) proportions.

Slaughterhouse case and TB test reactor detection rates

The annual rate of *M. bovis*-positive slaughterhouse case submissions per 1,000 animals slaughtered was compared to the rate of skin and IFN-γ test reactors detected per 1,000 skin and IFN- γ tests performed on animals in GB. The annual rate of laboratory positive slaughterhouse cases decreased between 2013 and 2022 (Figure 1.6). The largest decrease occurred in 2016, and the rate has continued to slowly decrease since then. In contrast, the annual rate of TB test reactors, excluding short-interval tests, fluctuated between 2013 and 2022, with a peak of 2.1 in 2017 and a gradual decrease to 1.7 in 2022 (Figure 1.6). The number of reactors is sensitive to changes in policies on TB control and can therefore vary temporally and spatially. The rate of TB cases detected at routine slaughter of cattle may provide a more constant measure of TB risk, although there are other factors which can affect sensitivity of detection, such as animal throughput.

In 2022, over 80% of herds in the HRA, Edge Area and all five TB regions in Wales received a herd-level TB test. In the LRA the same percentage was 25%, followed by Scotland (11%) (GB data report – E3, 2022). Routine TB herd testing intervals vary between (and within) regions of GB. Parts of the Wales HTBW and Edge Area in England carried out six-monthly testing in 2022. In other parts of the Edge Area and the remainder of Wales, routine testing is carried out annually. Most herds in the HRA are under a 6-monthly testing TB regime which was introduced during this reporting period over 2020to 2021. For the LRA and Scotland, the default herd testing frequency is every 4 years.

For slaughterhouse surveillance, the rate of *M. bovis*-positive TB slaughterhouse case submissions per 1,000 animals slaughtered in the HRA and ITBM decreased between 2019 and 2022. This was likely due to the reduction in overall submission rate observed in both risk areas during this period. The rate in the other regions was more stable during these years, with the exception of the Edge Area and HTBW, where the rates increased since 2019 (Figure 1.7). For live animal testing, there was an overall decrease in the number and the rate of TB test reactors detected in GB in the last 2 years of the report period (2021 and 2022). This has been due specifically to decreases in the HRA, and HTBW, while in other regions the rate was more stable (Figure 1.8). The decrease in the rate of TB test reactors detected in the HRA, in combination with the declining positive slaughterhouse rate, suggests that there is a true reduction in the prevalence of *M. bovis*-infected cattle in this area of England, and that the change is not solely an artefact of changing TB surveillance strategies. In the Edge Area the number of reactors increased since 2013, when annual surveillance testing was introduced. This increase is not reflected in the annual rate of positive slaughterhouse cases, which has remained stable until 2019.

In Scotland the number of reactors increased between 2021 and 2022 while the number of positive submissions detected by slaughterhouse surveillance has remained stable since 2012.

Figure 1.6: Rate of TB test reactors detected per 1,000 skin and IFN- γ tests completed on animals in a TB surveillance test (excluding short interval tests), and rate of positive slaughterhouse case submissions per 1,000 animals slaughtered in GB, between 2013 and 2022.

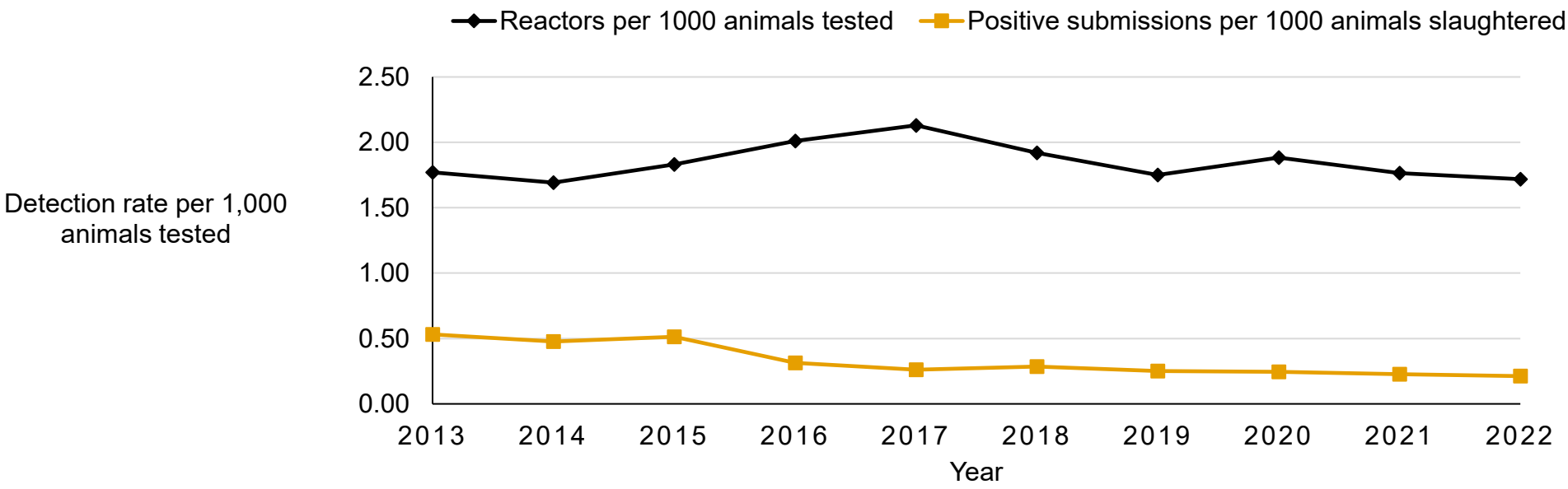


Figure 1.6 description: There is one orange and one black line showing the detection rate per 1,000 animals tested between 2013 and 2022. The black line represents the rate of reactors per 1,000 animals tested and the orange the rate of positive submissions per 1,000 animals slaughtered. The black line is always higher than the orange line. The rate of reactors (black line) decreases slightly from 1.77 in 2013 to 1.69 in 2014, increases to a peak of 2.13 in 2017, then gradually decreases to 1.72 in 2022. The rate of positive submissions (orange line) remains stable around 0.5 between 2013 and 2015, then steadily decreases between 2015 to 0.21 in 2022.

Figure 1.7a: Rates of positive slaughterhouse cases detected per 1,000 animals slaughtered between January 2013 and December 2022, by risk region of the herd of origin in England and Scotland. and in Wales (below).

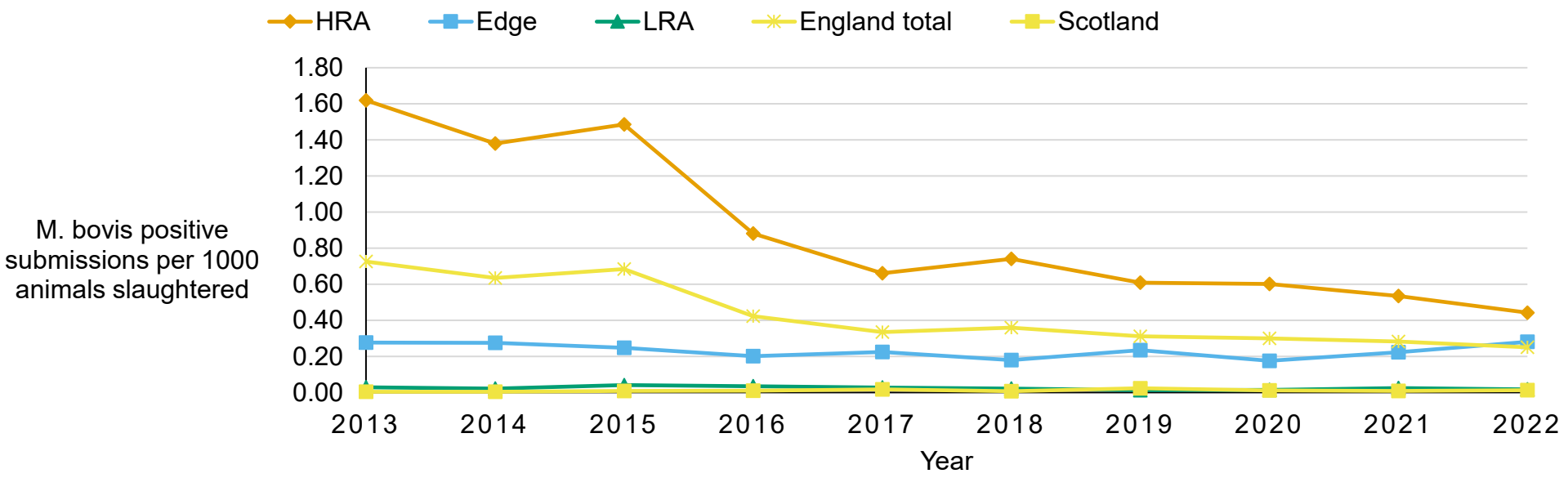


Figure 1.7a description: There are 5 lines, one orange, one black, one blue, one green and one yellow showing the rate of positive submissions per 1,000 animals slaughtered between 2013 and 2022, by region. Each line shows a risk area, with black representing England, orange showing the HRA, blue showing the Edge Area, green showing the LRA and yellow representing Scotland. The rate in the HRA (orange line) is higher than all the other areas, decreasing from 1.62 in 2013 to 0.44 in 2022, with a small increase between 2014 and 2014, then again between 2017 and 2018. The rate in England (black line) decreased from 0.73 in 2013 to 0.25 in 2022, with a greater decrease between 2015 and 2017. The rate in England was the second highest rate every year, except in 2022 when the rate in

the Edge Area was greater. The rate in the Edge Area (blue line) remained stable ranging from 0.18 and 0.28 between 2013 and 2022. The LRA (green line) and Scotland (yellow line) remained on or near a rate of 0.0 between 2013 and 2022.

Figure 1.7a: Rates of positive slaughterhouse cases detected per 1,000 animals slaughtered between January 2013 and December 2022, by risk region of the herd of origin in Wales.

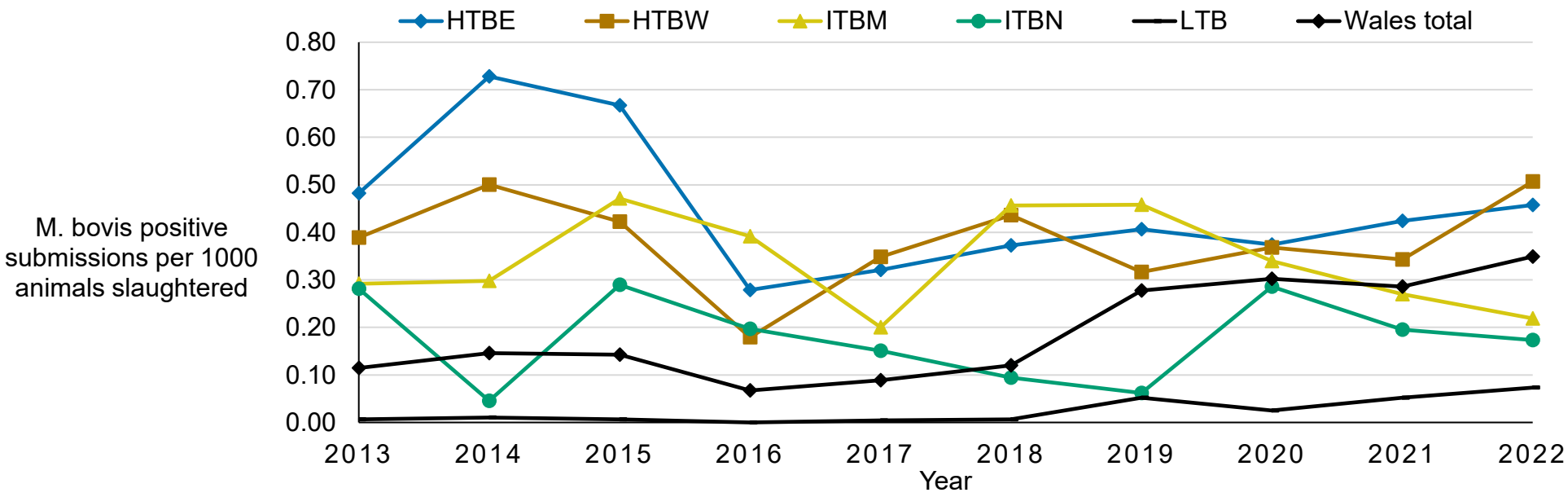


Figure 1.7b description: There are 6 lines, one blue, one brown, one yellow, one green, one black and one red showing the rate of positive submissions per 1,000 animals slaughtered between 2013 and 2022, by region. Each line shows a risk area, with blue showing the HTBE, brown showing the HTBW, yellow showing the ITBM, green showing the ITBN, black showing the LTB and red representing Wales. The HTBE (blue line) the rate increases between 2013 and 2014, decreases to 2016, then steadily increases to 2022. The HTBW fluctuates between 2013 and 2022, decreasing to 0.18 in 2016, then gradually increasing to 0.51 in 2022. The ITBM (yellow line) fluctuated between 0.20 and 0.50, ultimately decreasing from 0.46 in 2019 to 0.22 in 2022. The ITBN (green line) fluctuated between 2013 and 2015, steadily decreased between 2015 and 2019, increased in 2020, then decreased between 2020 and 2022. The LTB was the lowest rate between 2013 and 2022, remaining stable near 0.0 between 2013 and 2018, then increased between 2018 and 2022.

The rate in Wales (red line) gradually increased between 2013 and 2022, with a slight decrease between 2015 and 2016 and increasing thereafter to a peak of 0.35 in 2022.

Figure 1.8a: The number of TB test reactors per 1,000 animals tested between January 2013 and December 2022, by risk region in England and Scotland.

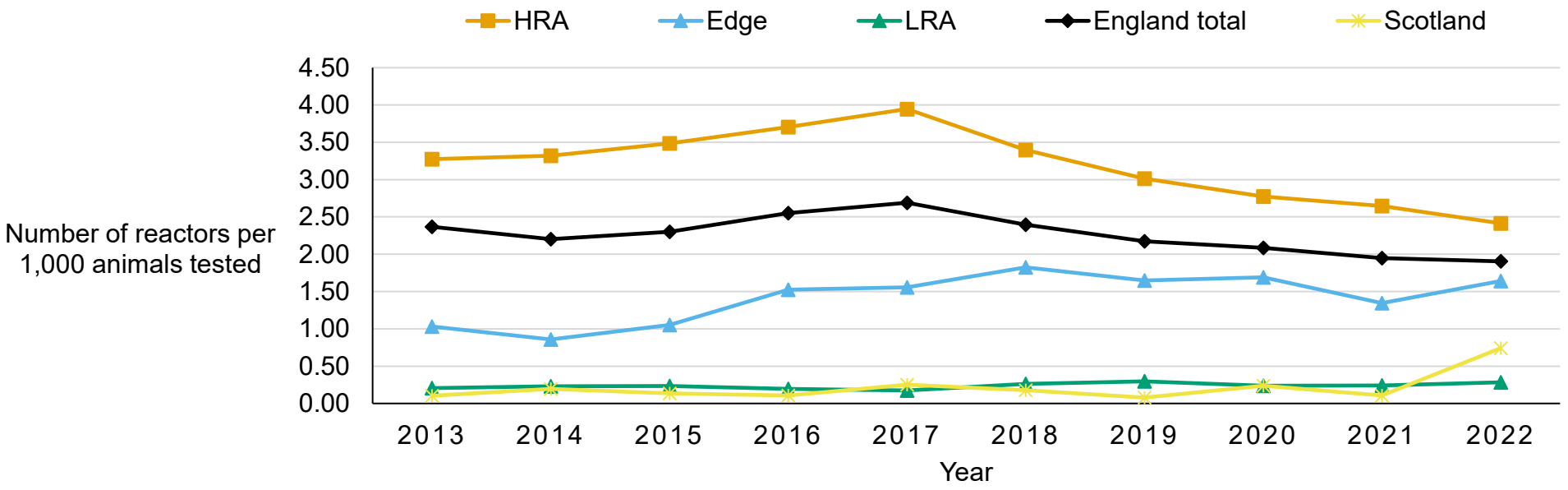


Figure 1.8a description: There are 5 lines, one orange, one black, one blue, one green and one yellow showing the number of reactors per 1,000 animals tested between 2013 and 2022, by region. Each line shows a risk area, with black representing England, orange showing the HRA, blue showing the Edge Area, green showing the LRA and yellow representing Scotland. The HRA (orange line) is higher than all the other areas, increasing from 3.27 in 2013 to 3.95 in 2017 then decreasing to 2.41 in 2022. The number of reactors in England (black line) is the second highest and follows a similar trend as the HRA, except with a slight decrease from 2.37 in 2013 to 2.20 in 2014, followed by an increase to 2.69 in 2017 then decreasing to 1.90 in 2022. The Edge Area (blue line) has a slight decrease from 1.03 in 2013 to 0.86 in 2014, followed by an increase to 1.82 in 2018, decreases to 1.34 in 2021, then increasing to 1.64 in 2022. The

LRA (green line) and Scotland (yellow line) remain stable below 0.50, except in 2022 the number of reactors increased to 0.74 in Scotland.

Figure 1.8b: The number of TB test reactors per 1,000 animals tested between January 2013 and December 2022, by risk region in Wales.

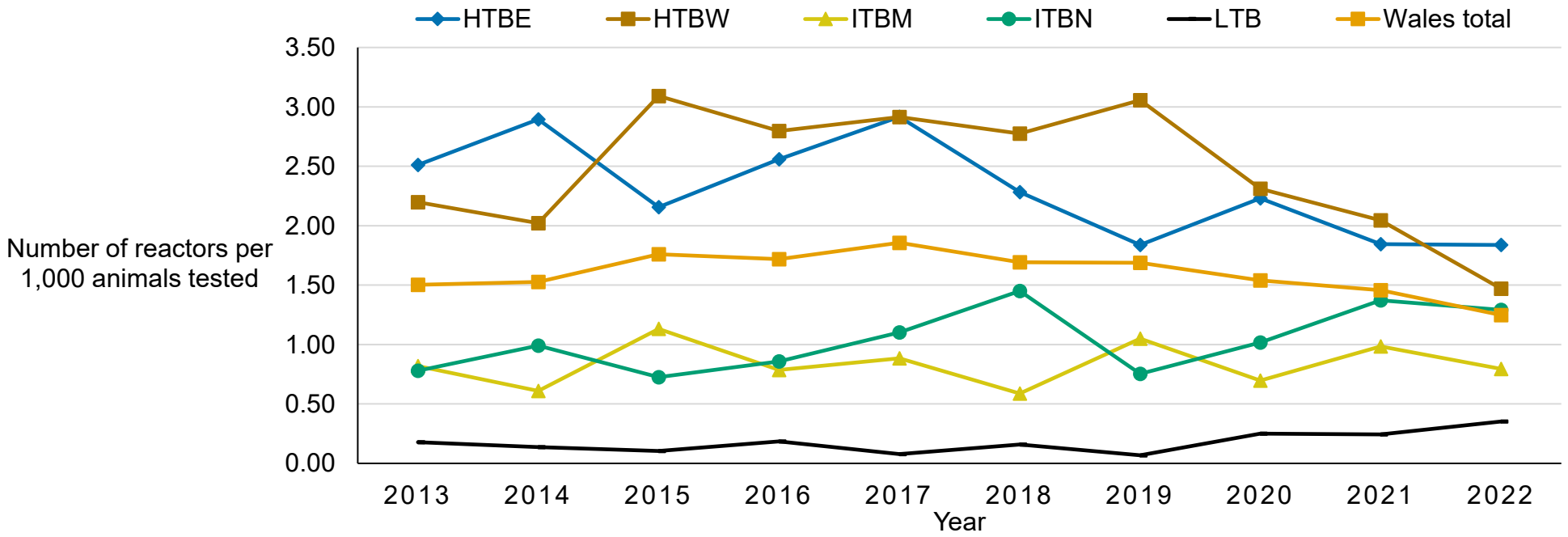


Figure 1.8b description: there are 6 lines, one blue, one brown, one yellow, one green, one black and one red showing the rate of positive submissions per 1,000 animals slaughtered between 2013 and 2022, by region. Each line shows a risk area, with blue showing the HTBE, brown showing the HTBW, yellow showing the ITBM, green showing the ITBN, black showing the LTB and red representing Wales. The HTBE (blue line) fluctuates between 2.00 and 3.00 in 2013 and 2017 then decreases to 1.84 in 2022. The HTBW (brown line) increases between 2013 and 2015 and plateaus around 3.00 reactors between 2015 and 2019 then decreases to 1.47 in 2022. Wales (red line) increases from 1.50 in 2013 to a peak of 1.86 in 2017 then decreases to 1.25 in 2022. The ITBM (yellow line) fluctuates between 2013 and 2022 ranging from 0.59 to 1.13. The ITBN (green line) increases between 2013 to a peak of 1.45 in 2018, decreases in 2019 then increases. The LTB (black line) remains stable below 0.50 between 2013 and 2022, increasing between 2019 and 2022.

Section 2: proportion of laboratory positive slaughterhouse cases between 2019 and 2022

The aim of this section is to investigate the proportion of TB slaughterhouse cases that were confirmed following *M. bovis*-positive results on bacteriological culture or PCR testing, and to identify the factors significantly associated with a positive slaughterhouse case result.

Descriptive statistics

Between 2013 and 2022, 10,830 samples from TB slaughterhouse cases were submitted to APHA for confirmatory laboratory diagnosis. Of these, 8,424 were from cattle in OTF herds (that is to say, herds that were not under TB movement restriction at the time of detection). For the period of the current report (2019 to 2022), 3,345 TB slaughterhouse case samples were submitted to APHA laboratories and 2,741 of these samples were from cattle in OTF herds. When comparing the current with the previous period (2016 to 2019), the numbers have decreased by 12% (3,784 samples and 3,189 of these from OTF herds). An overall decreasing, 3-yearly cyclical trend seems to be occurring in both total slaughterhouse case submissions and submissions from OTF herds, with submissions decreasing over a 2-year period and a slight uptick in submissions on the third year (as observed in 2015, 2018 and 2022, Figure 2.1). It should be noted, however, that the decrease seen in the cyclical trend is becoming less extreme over time.

Figure 2.1a: Annual number of slaughterhouse case samples in GB submitted to APHA for laboratory diagnosis between 2013 and 2022, in total (all herds irrespective of their TB status) and from officially TB-free herds only.

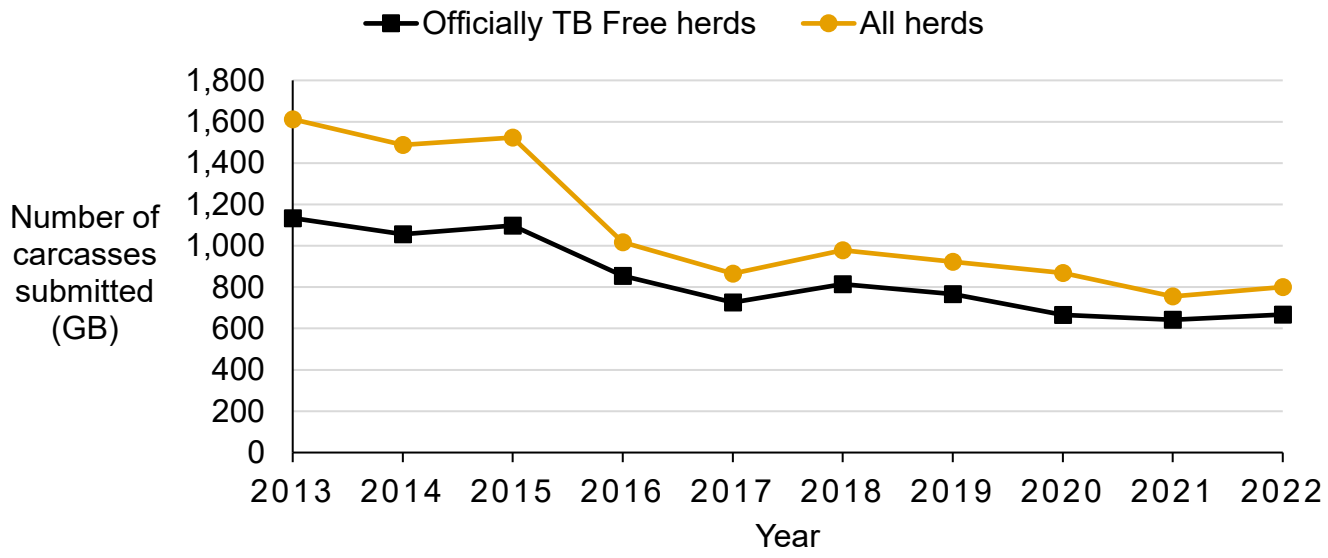


Figure 2.1a description: There is one orange and one black line showing the number of carcasses submitted to slaughterhouses in GB between 2013 and 2022. The black line represents the number of submissions from OTF herds and the orange the submissions from all herds. The orange line is always higher than the black line. Both lines show a decrease between 2013 and 2022, with a steep drop between 2015 and 2017 and a slight increase between 2017 and 2018.

Figure 2.1b: Annual number of slaughterhouse case samples in England submitted to APHA for laboratory diagnosis between 2013 and 2022, in total (all herds irrespective of their TB status) and from officially TB free herds only.

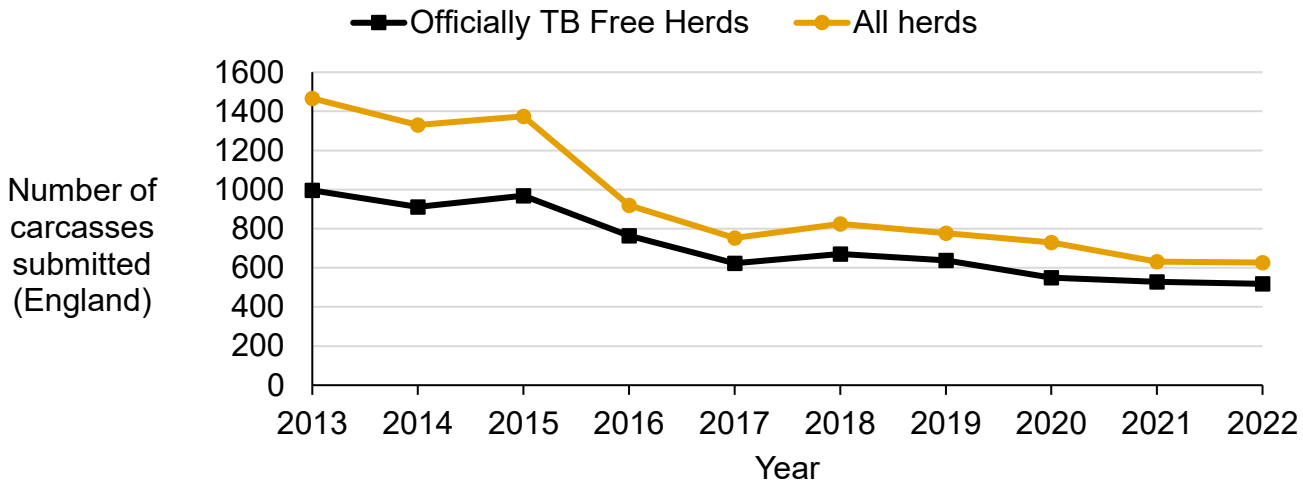


Figure 2.1b description: There is one orange and one black line showing the number of carcasses submitted to slaughterhouses in England between 2013 and 2022. The black line represents the number of submissions from OTF herds and the orange the submissions from all herds. The orange line is always higher than the black line. Both lines show a decrease between 2013 and 2022, with a steep drop between 2015 and 2017 and a slight increase between 2017 and 2018.

Figure 2.1c: Annual number of slaughterhouse case samples in Scotland submitted to APHA for laboratory diagnosis between 2013 and 2022, in total (all herds irrespective of their TB status) and from officially TB free herds only.

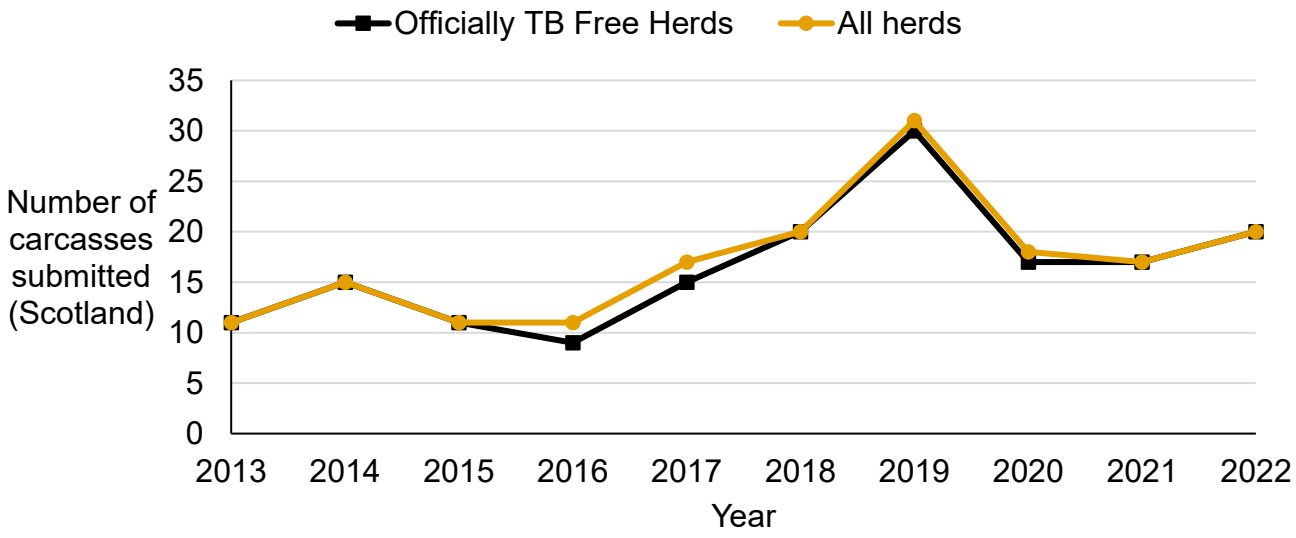


Figure 2.1c description: There is one orange and one black line showing the number of carcasses submitted to slaughterhouses in Scotland between 2013 and 2022. The black line represents the number of submissions from OTF herds and the orange the submissions from all herds. Both lines follow the same trend, increasing between 2013 and 2014, decreasing between 2014 and 2016 and increasing to a peak in 2019 of 31 in all herds (orange line) and 17 in OTF herds (black line). The number of carcasses then decreases between 2019 and 2021, before increasing again in 2022.

Figure 2.1d: Annual number of slaughterhouse case samples in Wales submitted to APHA for laboratory diagnosis between 2013 and 2022, in total (all herds irrespective of their TB status) and from officially TB-free herds only.

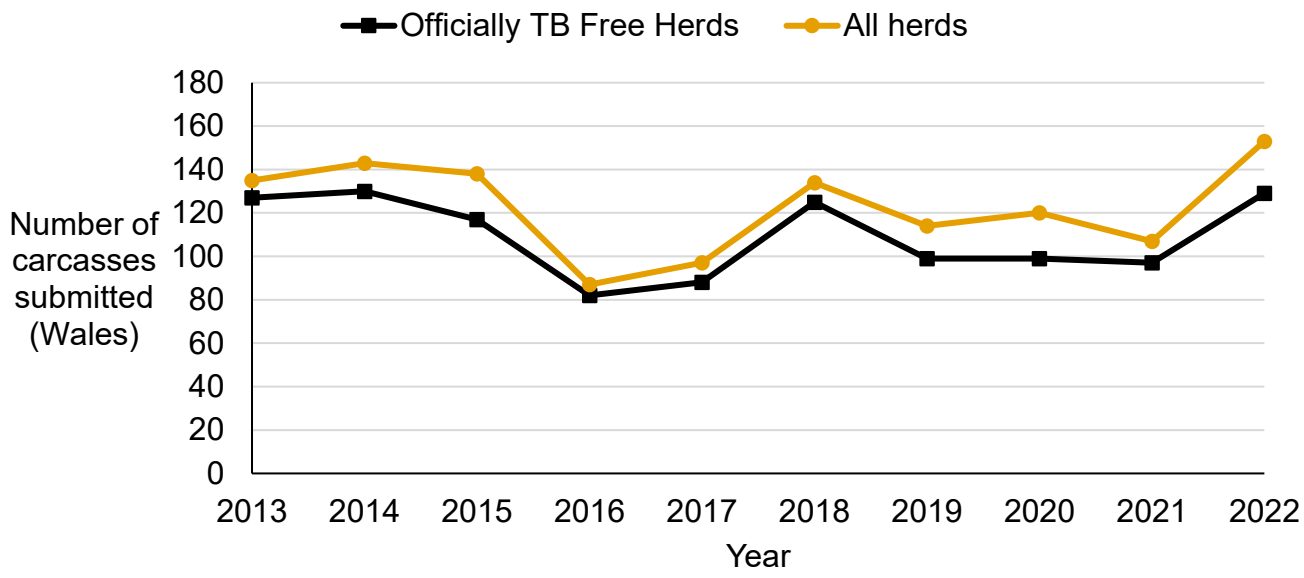


Figure 2.1d description: There is one orange and one black line showing the number of carcasses submitted to slaughterhouses in Wales between 2013 and 2022. The black line represents the number of submissions from OTF herds and the orange the submissions from all herds. The orange line is always higher than the black line. Both lines show a decrease between 2013 and 2016, an increase between 2016 and 2018, decreases between 2018 and 2021, then increases between 2021 and 2022.

Between 2019 and 2022, the overall proportion of slaughterhouse case samples submitted from OTF herds that were positive for *M. bovis* on laboratory testing was 57% (Table 2.1) and 47% for samples submitted from all slaughterhouse cases, including herds under TB restrictions. This proportion of laboratory-positive samples from OTF herds has fluctuated slightly between 2009 and 2022 with no obvious upward or downward trend (range = 57% in 2019 to 68% in 2010) (Figure 2.2a).

Prior to 2022, all slaughterhouse cases were submitted for histology if sufficient material was available (although culture was the priority). Following the adoption by APHA of rapid *M. bovis* PCR testing as the primary diagnostic laboratory method for TB slaughterhouse cases from 30 March 2022, histological examination of those submissions became largely redundant and was phased out. PCR-positive samples are now sent for culture and WGS analysis, whereas PCR-negative ones are reported as such without further testing. More

detail on the number of samples that underwent PCR testing in 2022 and their outcomes are provided in Section 5 of this report.

The overall proportion of submissions undergoing histological examination with positive results in the reporting period was 69%. Although this percentage had been declining since 2010 (see previous reports), this proportion rose steeply in 2015 and 2016, before continuing to slowly decline (Figure 2.2a).

The proportion of all submissions with positive histology results was 43% between 2019 and 2022. Histology-positive cases amongst all submissions did rise between 2015 and 2017, before falling until 2019. An increase in histology positive submissions was seen in 2020 and 2021, but this has fallen sharply in 2022 to only 10%. This was due to the introduction of PCR testing in slaughterhouse carcasses in 2022.

Table 2.1: Histology and culture results from slaughterhouse case samples from OTF herds submitted to APHA between 2019 and 2022, where both culture and histology were performed. Culture-positive samples are those where *M. bovis* was isolated in bacteriological culture. Histology positive samples are those where histopathology was typical of a mycobacterial infection, with or without detection of acid-fast bacteria.

		Culture		
		Positive	**Negative**	**Total**
Histology	**Positive**	850	113	1,337
	Negative	89	487	202
	No test	628	574	1,202
	Total	1,567	1,174	2,741

The annual proportion of slaughterhouse case samples that were positive by laboratory testing over the period 2013 to 2022 varied regionally. In the HRA, the percentage of *M. bovis*-positive submissions remained stable at around 70% (range 67.2% to 73.5%; Figure 2.2b). In the other risk regions, the percentage of *M. bovis*-positive submissions fluctuated more markedly from year to year, but has always been lowest in the LRA, LTB and Scotland, as would be expected given the much lower prevalence of bovine TB in those regions (and hence the lower positive predictive value of reports of suspected TB lesions at routine PMMI).

The percentage of slaughterhouse case submissions that were positive upon histological examination (among those tested) also varied between regions between 2013 and 2022 (Figure 2.2c).

In the HRA and Edge Area, the proportion of histology-positive submissions increased between 2013 and 2017, to 10-year highs of 84% and 73% respectively. Both regions have seen a generally consistent decreasing trend since, bar a spike in both risk regions in 2021. In 2022, the proportion of histology positives fell to their lowest proportion since 2009 of 64% in the HRA and 41% in the Edge Area in 2022.

The proportion of histology positive submissions has been far more variable in all other regions of England, Scotland, and Wales over the time period. This proportion decreased in 2022 in the LRA, Scotland, and the HTBE and the ITBM in Wales. In contrast, the proportion of histology positives increased in the LTB and HTBW regions in Wales and remained the same in the ITBN in Wales.

The numbers of histology positive submissions in Wales were also low in 2022, with the highest numbers of histology positive submissions in the HTBW (n=10, a 44% decrease from 2021) and the HTBE (n=4, a 76% decrease from 2021).

Overall, the number of submissions positive upon histological examination was lowest in Scotland (n=0), the ITBM and ITBN in Wales (n=1 respectively), the LTB in Wales (n=2), and the England LRA (n=3).

The proportion of slaughterhouse cases that were considered positive on either histology or culture are broadly similar. The overall sensitivity and specificity of histology relative to culture was 91% (95% in previous reporting period) and 81% (82% in previous reporting period), respectively (Table 2.1). Histological diagnosis is more subjective than bacteriological culture: organisms other than *M. bovis* (for example, *M. terrae*, *M. microti* or *M. sinensis*) can appear similar in histological appearance and cause a false positive result. The degree of agreement between culture and histology (kappa-statistic measure) was estimated at 87%. In April 2022, PCR was introduced as the default testing in slaughterhouses – the comparison between PCR, culture and histology is discussed in Section 5.

Figure 2.2a: Proportion of slaughterhouse case submissions processed between 2013 and 2022 in GB that were positive by histological examination (out of those tested for histology, or among all submissions), or by culture and that originated from officially TB free herds. Please note that culture-positive samples also include PCR-positive samples that were subsequently sent for culture to generate a WGS clade. From 2022, histology was only performed in cases were PCR failed and there was insufficient material for culture.

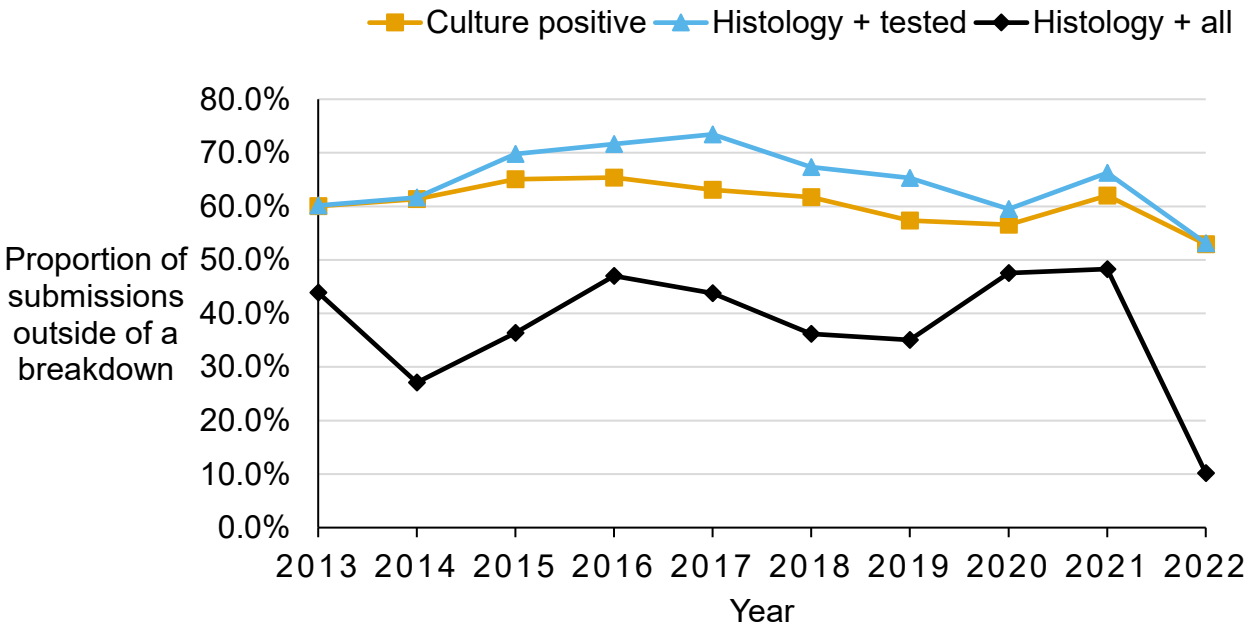


Figure 2.2a description: There are 3 lines, one orange and one blue and one black line showing the proportion of submissions outside of a breakdown between 2013 and 2022. The orange line represents culture positive submissions, the blue line shows submissions positive by histological examination out of those tested for histology and the black line shows the submissions positive by histological examination out of all submissions. The blue line is above the orange and black lines, except in 2013, 2014 and 2022 where the percentages were the same as the orange line. The proportion of positive submissions by histology in those tested by histology (blue line) increases from 60.1% in 2013 to a peak of 73.4% in 2017 then decreases to 53.1% in 2022. The culture-positive submissions increases slightly between 2013 and 2016 to 65.4%, decreases between 2016 and 2020 to 56.5%, increases in 2021 to 62.0%, then decreases in 2022. The proportion of positive histological submissions in all submissions fluctuates ranging from 27.1% and 48.3% between 2013 and 2021, then steeply decreases to 10.2% in 2022.

Figure 2.2b: Proportion of slaughterhouse case submissions processed between 2013 and 2022 that were positive by culture and that originated from OTF herds, by risk region in England and Scotland (above) and in Wales (below). NB: Culture positive samples also include PCR positive samples that were subsequently sent for culture to generate a WGS clade.

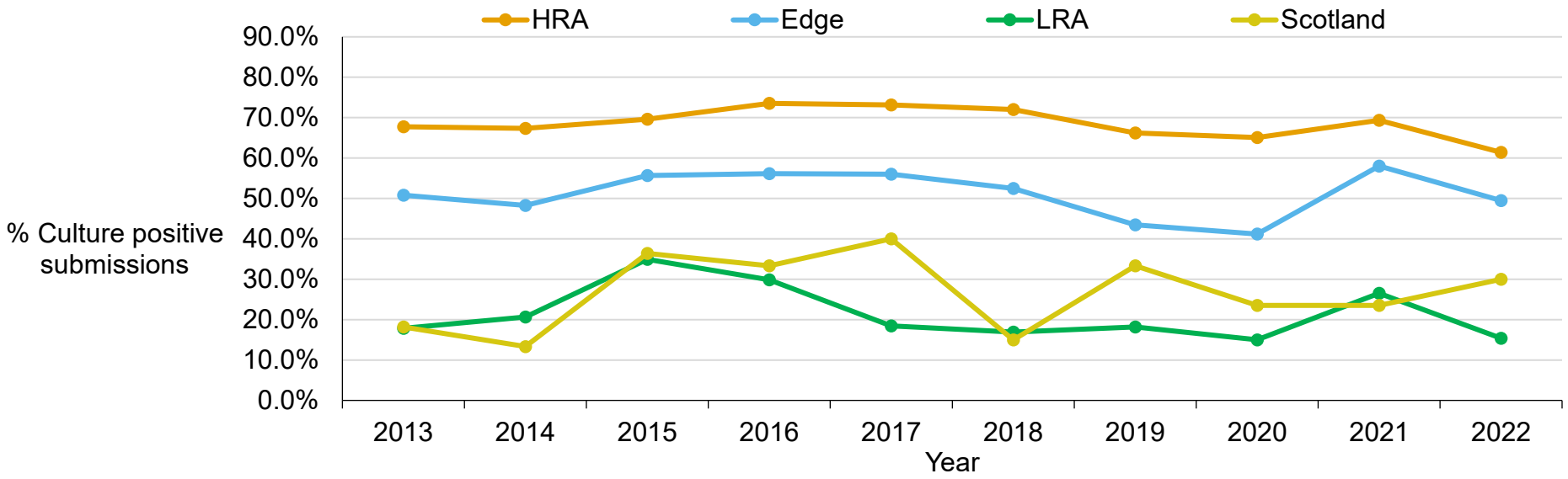


Figure 2.2b, graph 1 description: There are 4 lines, one orange, one blue, one green and one yellow showing the percentage of culture positive submissions between 2013 and 2022, by region. Each line shows a risk area, orange showing the HRA, blue showing the Edge Area, green showing the LRA and yellow representing Scotland. The number of cases in the HRA (orange line) is higher than all the other areas, and the Edge Area (blue) is below the HRA and follows a similar shape. Both the HRA and Edge Area remain stable between 2013 and 2017, decrease between 2017 and 2020, increase between 2020 and 2021, then decrease between 2021 and 2022.

The LRA (green line) ranges between 15.0% and 34.9%, increasing between 2013 and 2015, decreases between 2015 and 2020, increases in 2021 and decreases in 2022. Scotland (yellow line) fluctuates between 2013 and 2022, ranging from 13.3% and 40.0%.

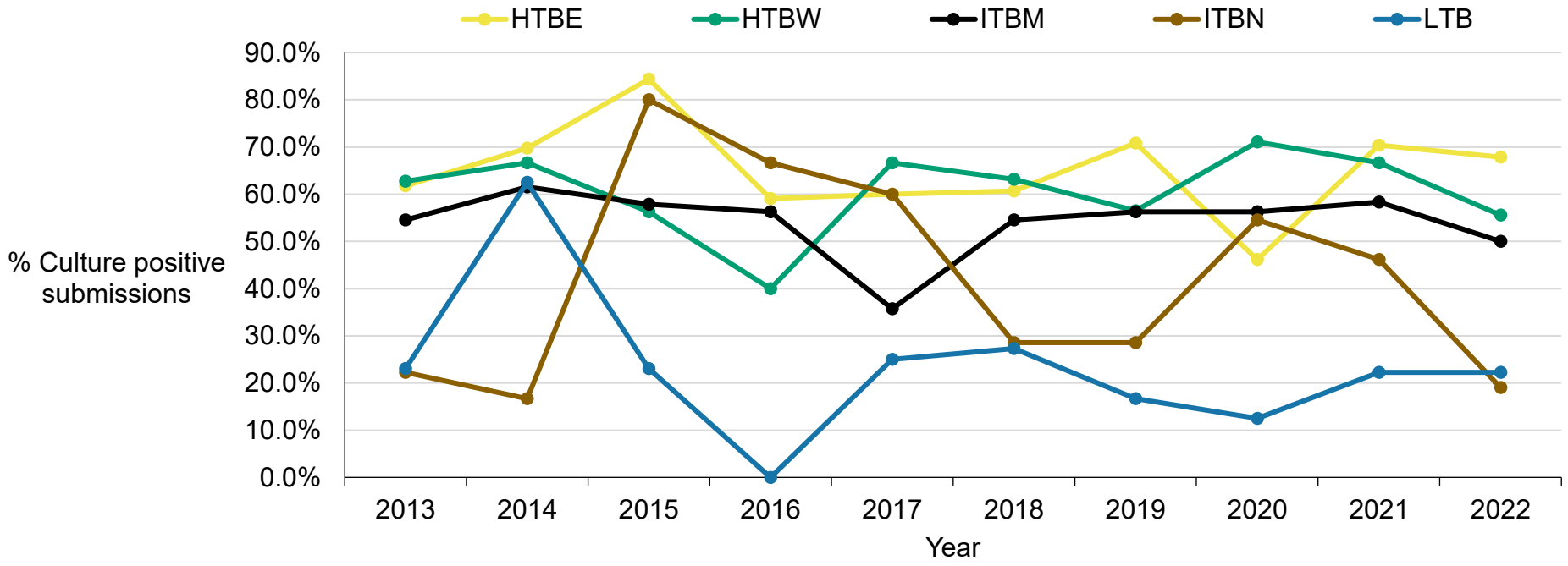


Figure 2.2b, graph 2 description: There are 5 lines, one blue, one brown, one yellow, one green and one black showing the percentage of culture positive submissions between 2013 and 2022, by region. Each line shows a risk area, with yellow showing the HTBE, green showing the HTBW, black showing the ITBM, brown showing the ITBN and blue showing the LTB. The percentage of culture positive submissions fluctuates in all regions between 2013 and 2022. The HTBE (yellow line) fluctuates between 2013 and 2022, ranging from 46.2% to 84.4%. The HTBW (green line) decreases from 62.7% in 2013 to 40.0% in 2016, increases to 71.1% in 2020, then decreases to 55.6% in 2022. The ITBM (black line) fluctuates between 50.0% and 60.0%, with the exception of a decrease to 35.7% in 2017. The

ITBN (brown line) decreases slightly between 2013 and 2014, has a steep increase from 16.7% in 2014 to 80.0% in 2015, decreases to 28.6% in 2018 and 2019, increases to 54.5% in 2020, then decreases to 19.0% in 2022. The LTB (blue line) increases from 23.1% in 2013 to 62.5% in 2014, decreases to 0.0% in 2016, then fluctuates between 12.5% in 2017 and 27.3% in 2022.

Figure 2.2c: Proportion of slaughterhouse case submissions from OTF herds that underwent histological examination and determined to be positive between 2013 and 2022, by risk region in England and Scotland (above) and in Wales (below).

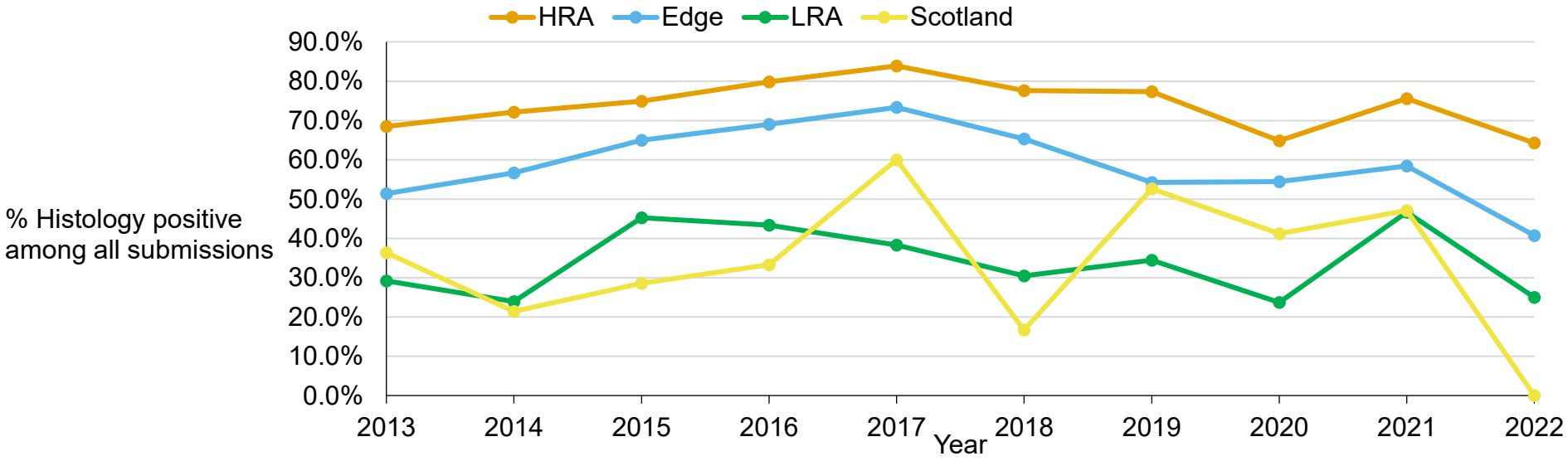


Figure 2.2c, graph 1 description: There are 4 lines, one orange, one blue, one green and one yellow showing the percentage of histology positive submissions, out of all submissions, between 2013 and 2022, by region. Each line shows a risk area, orange showing the HRA, blue showing the Edge Area, green showing the LRA and yellow representing Scotland. The percentage of positive submissions in the HRA (orange line) is higher than all the other areas, and the Edge Area (blue) is below the HRA and follows a similar shape. Both the HRA and Edge Area increase between 2013 and peak in 2017 of 83.9% and 73.3%, respectively, then decrease until 2020, increase slightly in 2021, then decrease in 2022. The LRA (green line) fluctuates between 23.7% and 25.0%, increasing in 2015, decreasing steadily between 2015 and 2020, increasing to the peak of 25.0% in 2021, then decreasing again in 2022. Scotland (yellow line) fluctuates between 2013 and 2022, increasing from 36.4% in 2013 to 60.0% in 2017, has a sharp decrease to 16.7% in 2018, increases in 2019 to 52.6% in 2019, then decreases to 0.0% in 2022.

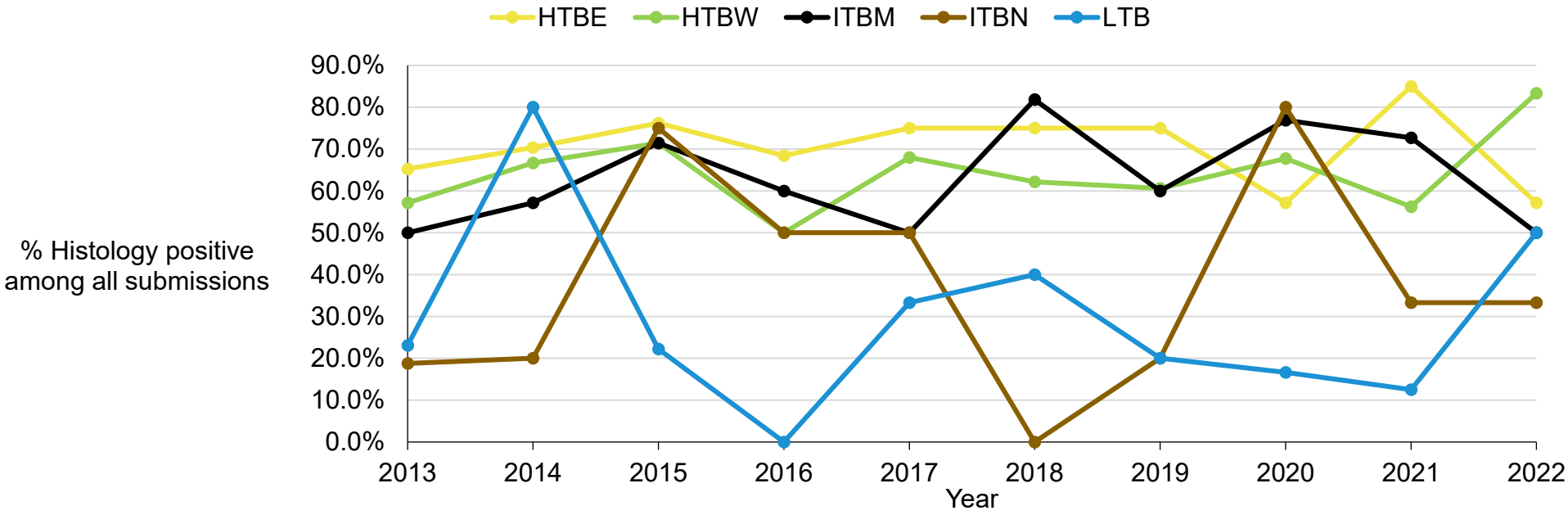


Figure 2.2c, graph 2 description: There are 5 lines, one yellow, one green, one black, one brown and one blue showing the percentage of histology positive submissions, out of all submissions, between 2013 and 2022, by region. Each line shows a risk area, with yellow showing the HTBE, green showing the HTBW, black showing the ITBM, brown showing the ITBN and blue showing the LTB. The HTBE (yellow line) fluctuates between 60.0% and 80.0% between 2013 and 2019, decreases below 60.0% in 2020, increases to a peak of 85.0% in 2021 then decreases to below 60.0% in 2022. The HTBW (green line) fluctuates between 50.0% and 70.0% between 2013 and 2021, then increases to 83.3% in 2022. The ITBM (black line) ranges between 50.0% and 80.0%, except in 2018 where the percentage positive was greater than 80.0%. The ITBN (brown line) and LTB (blue line) fluctuate greatly between 2013 and 2022. The ITBN increases from 18.8% in 2013 to 75.0% in 2015, decreases to 0.0% in 2018, increases again to 80.0% in 2020 and decreases to 33.3% in 2022. The LTB increases from 23.1% in 2013 to 80.0% in 2014, decreases to 0.0% in 2016, increases to 40.0% in 2018, decreases to 12.5% in 2021 and increases to 50.0% in 2022.

Analysis of risk factors for confirmation of slaughterhouse cases leading to OTF-W incidents

Multivariable logistic regression was used to investigate risk factors for confirmation of slaughterhouse cases by bacteriological culture or, from 2022, by PCR. TB incidents disclosed by culture-negative slaughterhouse cases (where skin herd tests are performed and disclose reactors before the slaughterhouse case returns a negative culture result) or culture-positive (OTF-W) slaughterhouse cases were categorised from animal level data. Slaughterhouse cases that occurred in herds already experiencing a TB incident were excluded from this analysis.

OTF-W incidents initiated by laboratory-confirmed slaughterhouse cases were generated by grouping *M. bovis* positive slaughterhouse cases that had the same breakdown ID. Herds with unconfirmed slaughterhouse case submissions were also recorded. Where more than one submission from the same CPHH was recorded, all samples that were detected within seven days of each other were classified as the same TB incident (herds with culture-confirmed slaughterhouse cases) or 'non-incident' (herds with unconfirmed slaughterhouse cases).

For this analysis, herd-level data were obtained for 1,468 OTF-W and 1,144 'non-incidents' (slaughterhouse cases that were negative for *M. bovis* by laboratory testing) that occurred between 2019 and 2022. The number and percentage of non-incidents and OTF-W incidents triggered by slaughterhouse cases, categorised by slaughterhouse and herd risk region, TB history, slaughter year, herd type, herd size, and number of submissions to the slaughterhouse are shown in Table 2.2.

The final multivariable model of the factors associated with the odds of TB incident confirmation following the identification of a slaughterhouse case is shown in Table 2.3. Standard errors were adjusted for 68 clusters in slaughterhouse ID. The model correctly classified 68% of the outcome variable (herds investigated) and was an adequate description of the data (Hosmer-Lemeshow χ^2 (8 d.f.) = 4.66, P=0.7931) and the area under the ROC curve was 0.73.

M. bovis was less likely to be confirmed in slaughterhouse case samples from herds that were in regions other than the HRA.

The slaughterhouse region and herd region displayed collinearity and it was not possible to include them both in the same model. The inclusion of herd region reduced the AIC more than slaughterhouse region, so it was retained in the model.

The odds of confirmation for a slaughterhouse case coming from a dairy herd was 70% higher than in cases detected from beef herds (95% CI: 8% to 128% increase in odds, Table 2.3). This contrasts to an increase in odds of 30% in dairy versus beef herds from in the previous report between 2016 and 2019.

An increasing proportion of beef throughput in a slaughterhouse also significantly increased the odds of a case leading to a TB incident. However, when adjusted for other variables in the model this effect was not significant (p=0.388, Table 2.3).

A slaughterhouse sample was 51% less likely to result in an OTF-W incident if a TB herd test had taken place within the previous 90 days (95% CI: 64% to 31% reduction in odds). There was some evidence that time elapsed since the last TB incident was also significantly associated with the odds of a slaughterhouse case being confirmed and resulting in an OTF-W incident (p=0.001, Table 2.3).

The animal throughput of the slaughterhouse in which a case was detected was significant in the model, with higher throughput levels associated with the odds of a confirmed slaughterhouse case (p=0.023, Table 2.3).

The number of cattle movements into the herd of origin of the slaughterhouse case in the previous twelve months was also found to be significantly associated with the odds of a confirmed slaughterhouse case (p<0.0001, Table 2.3).

The size of the herd was included in previous models (2013 to 2016 and 2016 to 2019), and thus tested in this reporting period as well. As in the previous report (2016-2019), it did not improve the AIC or provide a good fit for the 2019 to 22 data and was therefore excluded from the final model.

The year of submission was not significantly associated with the confirmation of *M. bovis* in a slaughterhouse sample, so it was not included in the model.

In summary, herd region, herd type, time since the last TB test and TB incident, the number of cattle movements onto the farm, and the annual throughput of the slaughterhouse were all found to be significant risk factors affecting the odds of a slaughterhouse case being confirmed in the laboratory and leading to a new OTF-W incident.

Table 2.2: Number and percentage of OTF herds with unconfirmed (test-negative) slaughterhouse cases ('non-incidents') and OTF-W TB incidents triggered by test-positive slaughterhouse cases, by slaughterhouse region, herd of origin region, TB history, death year, herd type and size and number of submissions, between 2019 and 2022.

			Non-incidents N (%)	OTF-W Incidents N (%)	Total N (%)
SLH region	**England**				
	HRA		782 (68%)	1151 (78%)	1933 (74%)
	Edge		53 (5%)	59 (4%)	112 (4%)
	LRA		176 (15%)	114 (8%)	290 (11%)
	Scotland		29 (3%)	19 (1%)	48 (2%)
	Wales				
	HTBE		1 (0%)	3 (0%)	4 (0%)
	HTBW		30 (3%)	16 (1%)	46 (2%)
	ITBM		65 (6%)	104 (7%)	169 (6%)
	ITBN		7 (1%)	2 (0%)	9 (0%)
	LTB		1 (0%)	0 (0%)	1 (0%)
		Total	1,144	1,468	2,612
Herd Region	**England**				
	HRA		563 (49%)	1,020 (69%)	1583 (61%)
	Edge		188 (16%)	170 (12%)	358 (14%)
	LRA		147 (13%)	34 (2%)	181 (7%)
	Scotland		58 (5%)	21 (1%)	79 (3%)
	Wales				
	HTBE		37 (3%)	64 (4%)	101 (4%)
	HTBW		70 (6%)	109 (7%)	179 (7%)
	ITBM		23 (2%)	29 (2%)	52 (2%)
	ITBN		32 (3%)	15 (1%)	47 (2%)
	LTB		26 (2%)	6 (0%)	32 (1%)
		Total	1,144	1,468	2,612
Previous OTFW	**no breakdown**		691 (60%)	633 (43%)	1324 (51%)
TB breakdowns within last 4 years	**1 to 2 breakdowns**		424 (37%)	769 (52%)	1193 (46%)
	3 or more breakdowns		29 (3%)	66 (4%)	95 (4%)
		Total	1,144	1,468	2,612
Previous OTFS	**no breakdown**		691 (60%)	633 (43%)	1324 (51%)
TB breakdowns within last 4 years	**1 to 2 breakdowns**		424 (37%)	769 (52%)	1193 (46%)
	3 or more breakdowns		29 (3%)	66 (4%)	95 (4%)
		Total	1,144	1,468	2,612

Table 2.2 (continued): Number and percentage of OTF herds with unconfirmed (test-negative) slaughterhouse cases ('non-incidents') and OTF-W TB incidents triggered by slaughterhouse cases, by slaughterhouse region, herd of origin region, TB history, death year, herd type and size and number of submissions, between 2019 and 2022.

		Non-incidents	OTF-W Incidents	Total
		N percentage	N percentage	N percentage
Death Year	**2019**	311 (27%)	410 (28%)	721 (28%)
	2020	285 (25%)	353 (24%)	638 (24%)
	2021	240 (21%)	370 (25%)	610 (23%)
	2022	308 (27%)	335 (23%)	643 (25%)
	Total	1,144	1,468	2,612
Herd Type	**Beef**	758 (66%)	776 (53%)	1,534 (59%)
	Dairy	370 (32%)	684 (47%)	1,054 (40%)
	Other or Mixed	5 (0%)	0 (0%)	5 (0%)
	Not Known	11 (1%)	8 (1%)	19 (1%)
	Total	1,144	1,468	2,612
Herd Size	**0 or No data**	85 (7%)	49 (3%)	134 (5%)
	1 to10	32 (3%)	19 (1%)	51 (2%)
	11 to 50	73 (6%)	107 (7%)	180 (7%)
	51 to 100	87 (8%)	157 (11%)	244 (9%)
	101 to 200	211 (18%)	301 (21%)	512 (20%)
	201 to 300	185 (16%)	218 (15%)	403 (15%)
	301 to 500	194 (17%)	275 (19%)	469 (18%)
	501 to 1000	193 (17%)	252 (17%)	445 (17%)
	More than 1000	84 (7%)	90 (6%)	174 (7%)
	Total	1,144	1,468	2,612
Submissions	**1**	1115 (97%)	1,394 (95%)	2,509 (96%)
	More than 1	29 (3%)	74 (5%)	103 (4%)
	Total	1,144	1,468	2,612
Proportion of beef	**0% to25%**	126 (11%)	71 (5%)	197 (8%)
	25.1% to 50%	414 (36%)	691 (47%)	1,105 (42%)
	50.1% to 75%	257 (22%)	302 (21%)	559 (21%)
	75.1% to 100%	347 (30%)	404 (28%)	751 (29%)
	Total	1,144 (100%)	1,468 (100%)	2,612 (100%)
SLH throughput per year	**41 to 250 animals per year**	4 (0%)	6 (0%)	10 (0%)
	251 to 1500 animals per year	55 (5%)	23 (2%)	78 (3%)
	1501 to 7500 animals per year	78 (7%)	55 (4%)	133 (5%)
	More than 7500 animals per year	1,007 (88%)	1,384 (94%)	2,391 (92%)
	Total	1,144 (100%)	1,468 (100%)	2,612 (100%)
Number of cattle movements	**0 or No data**	171 (15%)	327 (22%)	498 (19%)
	1 to 28.4	322 (28%)	486 (33%)	808 (31%)
	28.5 to 163.4	265 (23%)	388 (26%)	653 (25%)
	163.5 to 6,853	386 (34%)	267 (18%)	653 (25%)
	Total	1,144 (100%)	1,468 (100%)	2,612 (100%)

Table 2.3: Results of uni- and multivariable logistic regression analyses to identify significant risk factors for confirmation of slaughterhouse cases by culture, in officially TB free herds between 2019 and 2022. (OR: Odds Ratio; aOR: adjusted OR). Risk factors with significant adjusted ORs are highlighted in bold. Note: *Herd type observations categorised as 'unknown' were excluded from the model because there were zero unknown herds in the OTF-W submissions category, and so an OR was not calculated. For time since last incident, number of on movements and SLH throughput per year, the OR result when rounded became 1.0. Where the P-value is under 0.05, the OR is significant.

Risk factor		N	crude OR	P-value	95% CI	aOR	P-value	95% CI
Herd region		2,478						
	England							
	HRA	1,536	1.0 (Ref)			1.0 (Ref)		
	Edge	**316**	**0.52**	**<0.0001**	**0.36 0.75**	**0.57**	**0.032**	**0.34 - 0.95**
	LRA	**169**	**0.13**	**<0.0001**	**0.09 - 0.19**	**0.15**	**0.001**	**0.05 - 0.48**
	Scotland	62	0.24	<0.0001	0.13 - 0.42	0.37	0.057	0.13 - 1.03
	Wales							
	HTBE	96	0.90	0.653	0.55 - 1.45	1.05	0.882	0.54 - 2.06
	HTBW	170	0.85	0.533	0.5 - 1.43	1.10	0.783	0.54 - 2.24
	ITBM	52	0.68	0.291	0.33 - 1.39	1.09	0.86	0.4 - 2.95
	ITBN	**46**	**0.24**	**0.001**	**0.1 - 0.55**	**0.19**	**0.006**	**0.06 - 0.61**

Risk factor		N	crude OR	P-value	95% CI	aOR	P-value	95% CI
	LTB	31	0.13	<0.0001	0.05 - 0.32	0.46	0.468	0.05 - 3.8
Herd Type*		2,478						
	Beef	1,410	1.0 (Ref)			1.0 (Ref)		
	Dairy	**1,049**	**1.72**	**<0.0001**	**1.28 - 2.32**	**1.57**	**0.018**	**1.08 - 2.28**
>1 submissions		2,615						
	No	2,381	1.0 (Ref)			1.0 (Ref)		
	Yes	**234**	**2.21**	**0.005**	**1.22 - 3.41**	**2.91**	**0.006**	**1.36 - 6.24**
Last test within 90 days		2,615						
	No	1,863	1.0 (Ref)			1.0 (Ref)		
	Yes	**752**	**0.71**	**0.001**	**0.58 - 0.86**	**0.49712**	**<0.0001**	**0.36 -0.69**
Time since last breakdown		**938**	**0.999764**	**<0.0001**	**1.0-1.0**	**0.99981**	**0.001**	**1.0-1.0**
SLH Throughput per year		**2,615**	**1.000012**	**<0.0001**	**1.0-1.0**	**1.00001**	**0.023**	**1.0-1.0**
Number of cattle movements (previous 12 months)		**2,478**	**0.999206**	**<0.0001**	**1.0-1.0**	**0.99919**	**<0.0001**	**1.0-1.0**
Proportion of beef		2,615	0.76	0.677	0.21 - 2.72	1.62905	0.388	0.54 - 4.94

Section 3: proportion of new TB herd incidents initiated by slaughterhouse cases between 2019 and 2022

The aimn of this section is to examine the proportion of TB herd incidents that were detected by slaughterhouse surveillance (PMMI at routine slaughter) over time and to investigate significant risk factors for a TB incident to be detected in the slaughterhouse compared to tuberculin skin testing.

Between January 2019 and December 2022, there were 14,907 new TB herd incidents in GB, of which 8,361 were OTF-W (they involved at least one *M. bovis* laboratory tested positive animal, or one skin test reactor with visible lesions of TB at slaughter).

Classification of TB incident herds as OTF-W due to epidemiological risk alone, as applied in Wales, is not used within this report. Of the 14,907 incidents, 1,673 were disclosed by slaughterhouse surveillance rather than by tuberculin skin testing of cattle on farms. Of these, the vast majority (1,625) were OTF-W. There were 48 incidents awaiting confirmation through PCR or culture and therefore were not yet OTF-W incidents at the end of period studied.

The number and percentage of TB incidents that were detected in the slaughterhouse or by skin testing in 2019 and 2022, by country and bTB risk area of GB, is shown in Table 3.1a, while the same data for OTF-W incidents only are shown in Table 3.1b. The trends over time between 2013 and 2022, for GB and for each bTB risk area, are shown in Figures 3.2a 3.2b respectively. Between 2019 and 2022, the overall proportion of OTF-W incidents detected by slaughterhouse surveillance increased from 18.5% to 21.0%. This increase was significant (z-test, p=0.045). When looking at all TB incidents, there is a slight decrease from 11.8% to 10.3% respectively, which was also statistically significant (z-test, p=0.038). There was an increase in the proportion of the OTF-W incidents detected by slaughterhouse inspection in the LRA, Edge Area and in the HTBW region. Conversely, there was a reduction in the proportion of OTF-W incidents disclosed by slaughterhouse inspection in the LTB and ITBM regions. In Scotland, the proportion of OTF-W incidents detected decreased in the reporting period, though there was a significant peak in 2021, before dropping in 2022.

The annual proportion of OTF-W TB incidents detected by slaughterhouse surveillance by county in 2013, 2019 and 2022 is shown in Figure 3.1. The less than 5% and the more than 75% categories in the LRA and in Scotland are frequently a result of low numbers of TB incidents. Across England and Wales, the number of counties where the proportion of OTF-W incidents initiated by slaughterhouse surveillance was between 15 to 100% has reduced since 2013. This trend is probably a result of the improvements in the sensitivity of the on-farm TB testing programme over the last 10 years. In Scotland, the number of counties in the 15 to 100% category increased in 2019, before reducing again in 2022.

Counties demonstrating increasing proportions of OTF-W incidents that started with slaughterhouse cases in England include Cleveland (0% in 2013, 0% in 2019 and 50% in 2022), and Surrey (0% in 2013, 17% in 2019, and 40% in 2022). In Scotland, Ayrshire (0% in 2013, 50% in 2019, and 25% in 2022) and Wigtown (0s% in 2013, 17% in 2019, 38% in 2022), and South Powys (5% in 2013, 10% in 2019, and 18% in 2022) in Wales. Further investigation may be warranted, given that some of these counties are within the annual testing area. Although these were high proportionally, the total number of incidents in each of these counties was low.

Table 3.1a: Proportion of all TB incidents detected by post-mortem meat inspection in slaughterhouses in 2019 and 2022, by herd region, for skin tests and slaughterhouse tests.

	Skin testing (N)		**Slaughterhouse (N)**		**Total (N)**		**% Detected in slaughterhouse**	
Herd Region	**2019**	**2022**	**2019**	**2022**	**2019**	**2022**	**2019**	**2022**
England								
HRA	2,166	2,064	336	231	2,502	2,295	13.4%	10.1%
Edge	584	443	56	47	640	490	8.8%	9.6%
LRA	138	133	10	12	148	145	6.8%	8.3%
England Total	2,888	2,640	402	290	3,290	2,930	12.2%	9.9%
Scotland	25	27	8	6	33	33	24.2%	18.2%
Wales								
HTBE	194	175	17	22	211	197	8.1%	11.2%
HTBW	281	149	27	36	308	185	8.8%	19.5%
ITBM	64	52	11	4	75	56	14.7%	7.1%
ITBN	52	128	1	4	53	132	1.9%	3.0%
LTB	12	28	3	4	15	32	20.0%	12.5%
Wales Total	603	532	59	70	662	602	8.9%	11.6%
Total	3,516	3,199	469	366	3,985	3,565	11.8%	10.3%

Table 3.1b: Proportion of OTF-W TB incidents detected by post-mortem meat inspection in slaughterhouses in 2019 and 2022 by herd region for skin tests (ST) and slaughterhouse tests (SLH).

	Skin testing (N)		Slaughterhouse (N)		Total (N)		% Detected in slaughterhouse	
Herd region	**2019**	**2022**	**2019**	**2022**	**2019**	**2022**	**2019**	**2022**
England								
HRA	1,300	860	326	229	1,626	1,089	20.0%	21.0%
Edge	325	186	52	47	377	233	13.8%	20.2%
LRA	28	29	8	11	36	40	22.2%	27.5%
England total	1,653	1,075	386	287	2,039	1,362	18.9%	21.1%
Scotland	9	14	8	6	17	20	47.1%	30.0%
Wales								
HTBE	128	106	16	21	144	127	11.1%	16.5%
HTBW	150	75	26	34	176	109	14.8%	31.2%
ITBM	21	20	11	4	32	24	34.4%	16.7%
ITBN	20	51	1	4	21	55	4.8%	7.3%
LTB	5	14	3	4	8	18	37.5%	22.2%
Wales total	324	266	57	67	381	333	15.0%	20.1%
Total	1,986	1,355	451	360	2,437	1,715	18.5%	21.0%

Figure 3.1a: The proportion of new TB incidents that were detected by slaughterhouse surveillance in each county in GB, in 2013.

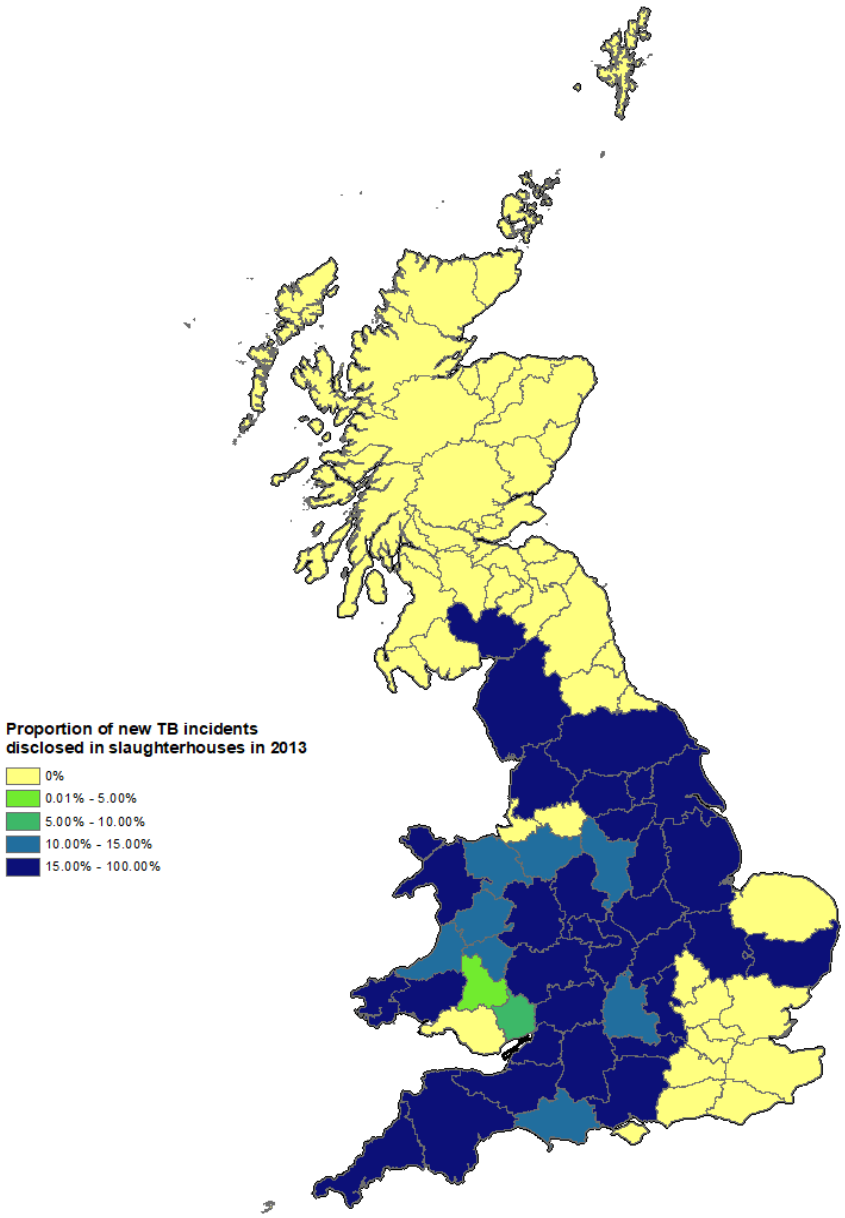


Figure 3.1a description: Shows a map of GB with the proportion of new incidents disclosed in slaughterhouses in 2013. The map uses colours to describe the range of proportions, from 0% in yellow, to very low (0.01% to 5%) in light green, low (5% to 10%) in dark green, medium (10% to 15%) in light blue and high (15% to 100%) in dark blue. Much of England is covered in dark blue, showing a high proportion of incidents disclosed in the slaughterhouse. Most of Wales is covered in light blue, showing up to 15% of incidents across Wales were disclosed in the slaughterhouse. Scotland is entirely in yellow, with no incidents disclosed in the slaughterhouse in 2013.

Figure 3.1b: The proportion of new TB incidents that were detected by slaughterhouse surveillance in each county in GB, in 2019.

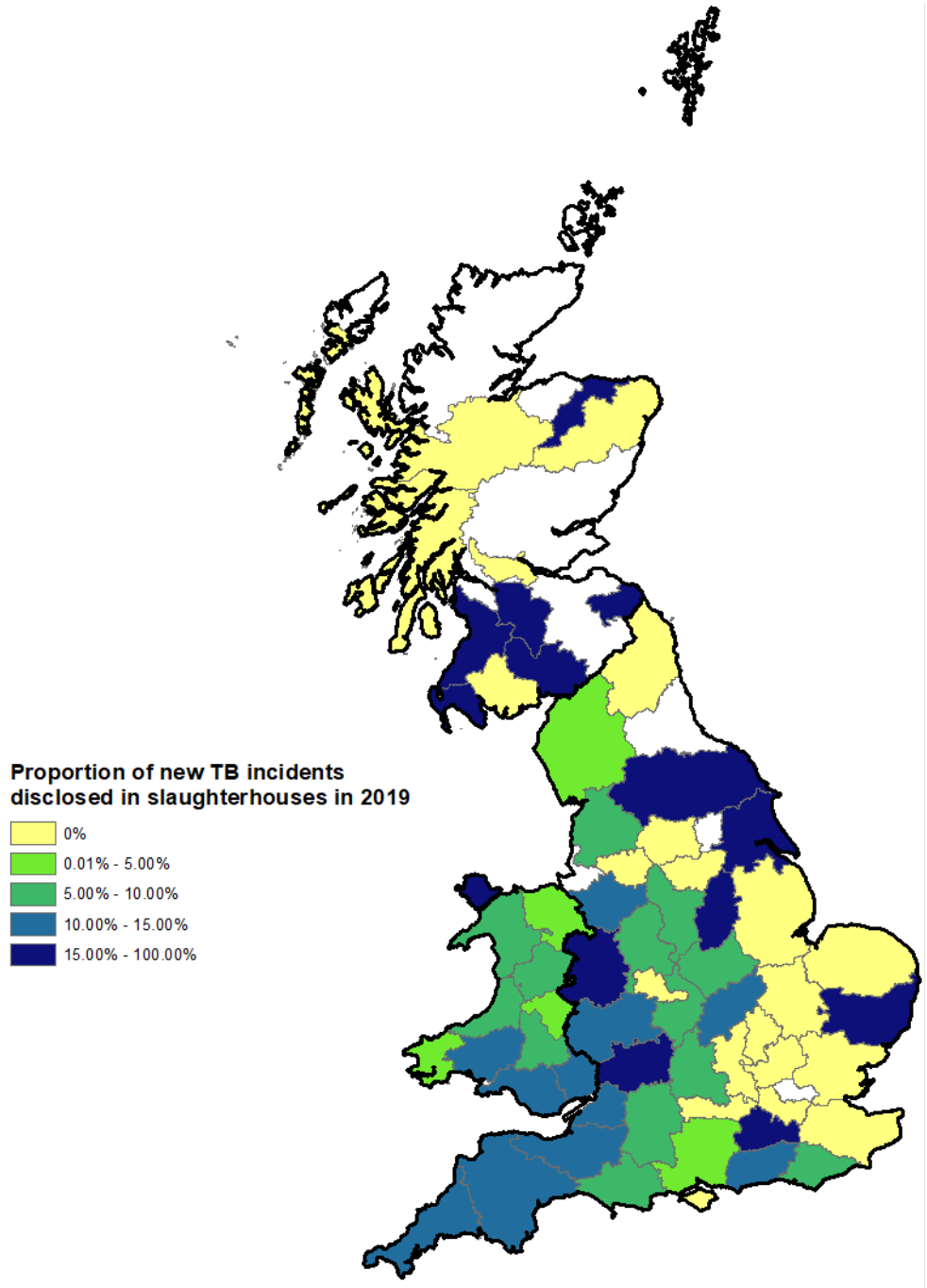


Figure 3.1b description: Shows a map of GB with the proportion of new incidents disclosed in slaughterhouses in 2019. The map uses colours to describe the range of proportions, from 0% in yellow, to very low (0.01% to 5%) in light green, low (5% to 10%)

in dark green, medium (10% to 15%) in light blue and high (15% to 100%) in dark blue. The colours are heterogenous across GB.

Figure 3.1c: The proportion of new TB incidents that were detected by slaughterhouse surveillance in each county in GB, in 2022.

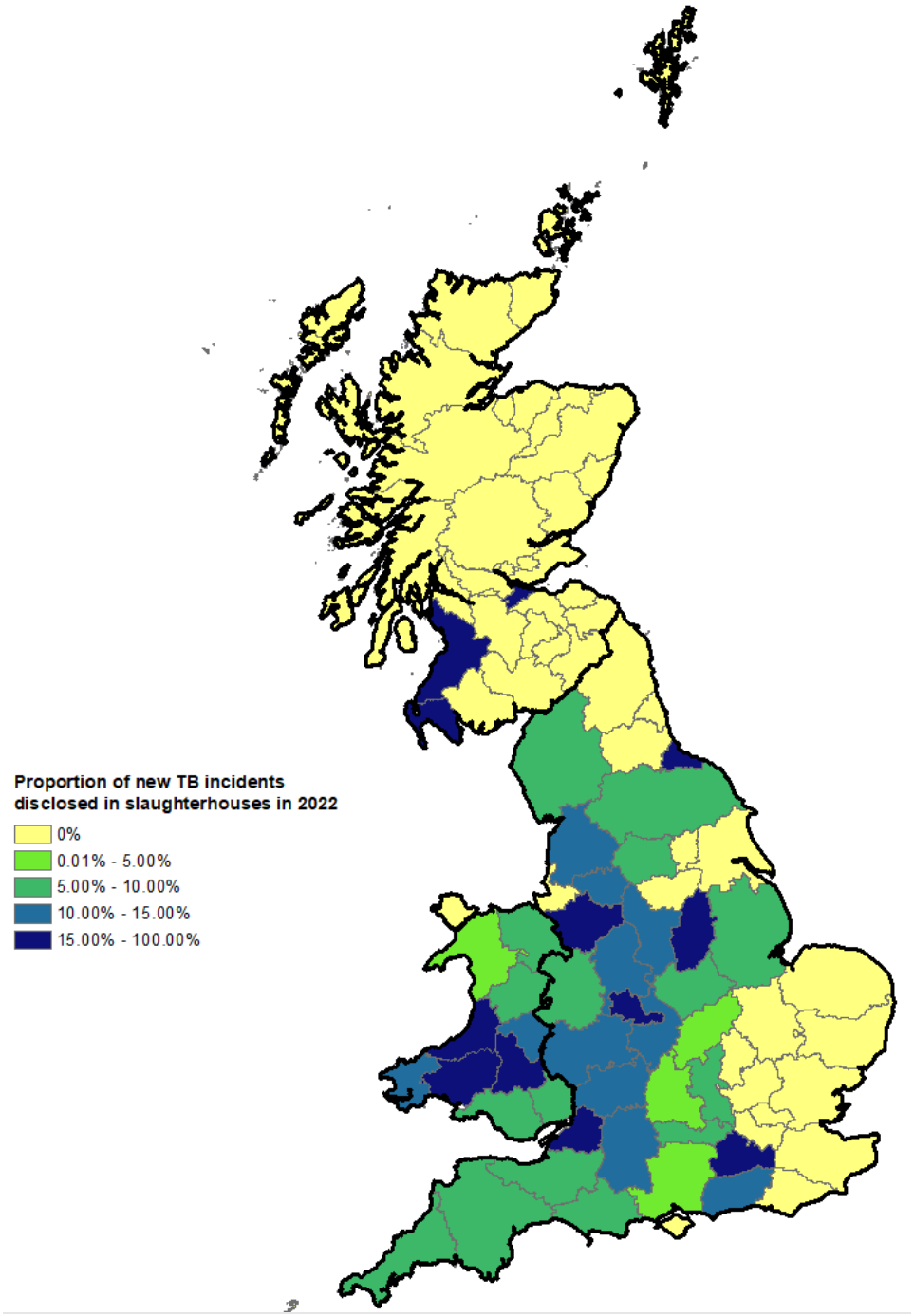


Figure 3.1c description: Shows a map of GB with the proportion of new incidents disclosed in slaughterhouses in 2022. The map uses colours to describe the range of proportions, from 0% in yellow, to very low (0.01% to 5%) in light green, low (5% to 10%) in dark green, medium (10% to 15%) in light blue and high (15% to 100%) in dark blue. The colours are heterogenous across GB, with only Scotland being almost completely yellow.

Historically, after fluctuations caused by the 2001 FMD epidemic, the proportion of OTF-W and all TB incidents that were detected in the slaughterhouse increased, with a peak in 2011 then decreased until 2017 (OTF-W incidents=15%; all TB incidents=10%, Figure 3.2a). Thereafter, the proportion of OTF-W incidents increased to 21% in 2022 whereas the proportion of all TB incidents increased slightly, plateaued until 2021 then subsequently decreased again to 10% in 2022.

Figure 3.2a: The proportion of TB incidents (OTF-W and total) detected in GB by slaughterhouse surveillance between 2013 and 2022.

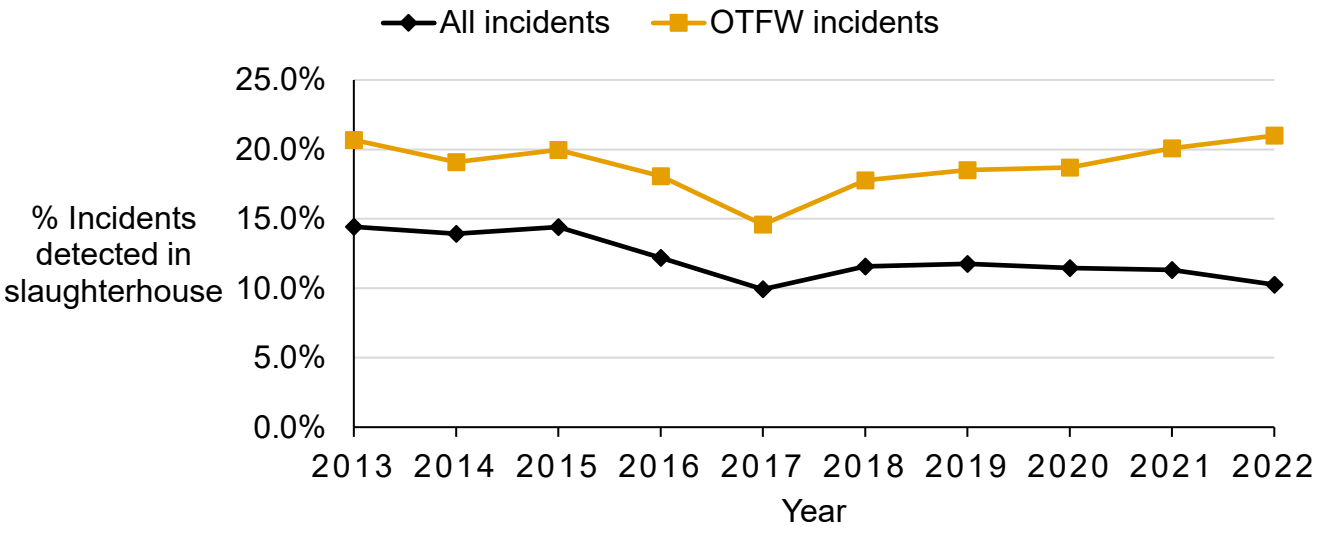


Figure 3.2a description: There is one orange and one black line showing the percentage of incidents detected in the slaughterhouse between 2013 and 2022. The black line represents the percentage of all incidents and the orange the percentage of OTF-W incidents. The orange line is always higher than the black line. Both lines show a decrease between 2013 and 2017. The percentage of OTF-W incidents (orange line) increases between 2017 and 2022. The percentage of all incidents increases slightly between 2017 and 2019 then decreases between 2019 and 2022.

Figure 3.2b: The proportion of OTF-W incidents identified in the slaughterhouse in England and Scotland (above) and in Wales (below) from 2012 to 2022.

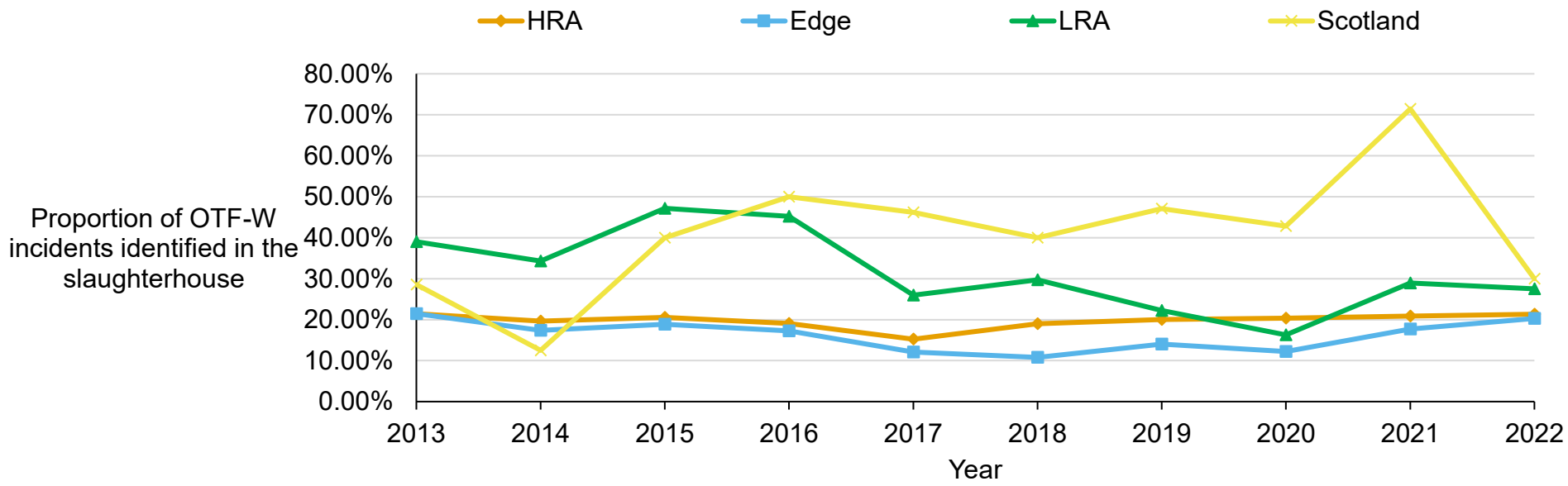


Figure 3.2b, graph 1 description: There are 4 lines, one orange, one blue, one green and one yellow showing the proportion of OTF-W incidents identified in the slaughterhouse between 2013 and 2022, by region. Each line shows a risk area, with orange showing the HRA, blue showing the Edge Area, green showing the LRA and yellow representing Scotland. The proportion of incidents in the HRA (orange line) and the Edge Area (blue line) follow a similar trend, decreasing between 2013 to 2017 and 2018, respectively, then increasing to 2022. The LRA (green line) increases between 2013 and 2015, decreases between 2015 and 2020, then increases between 2020 and

2022. In Scotland (yellow line) decreases between 2013 and 2014, then increases between 2014 and 2021 where the proportion peaks, then decreases in 2022.

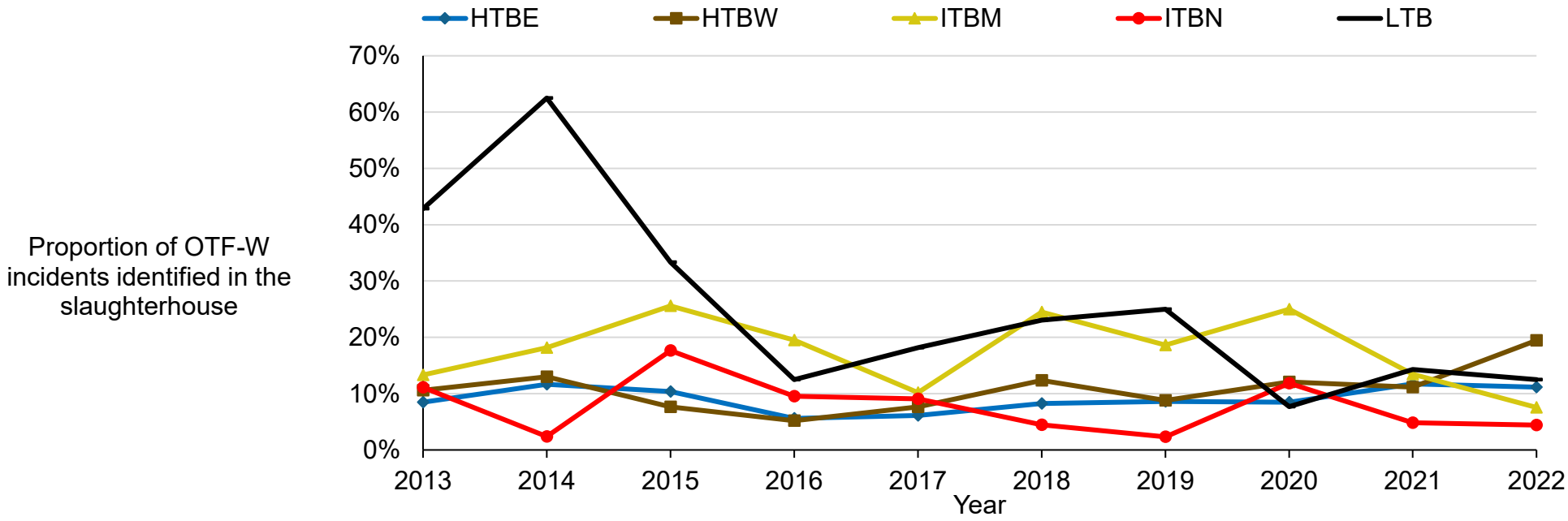


Figure 3.2b, graph 2 description: There are 5 lines, one blue, one brown, one yellow, one red and one black showing the proportion of OTF-W incidents identified in the slaughterhouse between 2013 and 2022, by region. Each line shows a risk area, with blue showing the HTBE, brown showing the HTBW, yellow showing the ITBM, red showing the ITBN and black showing the LTB. The HTBE (blue line) and HTBW (brown line) follow a similar trend, fluctuating between 20.0% and 5.0%. The HTBE plateaus at 11.2% in 2022 and the HTBW gradually increases to 19.5% in 2022. The ITBM (yellow line) fluctuates between 10.2% and 25.6%, with peaks in 2015, 2018 and 2020, then decreases in 2022 to 7.6%. The ITBN (red line) ranges between 2.4% and 17.7%, peaking in 2015, then decreasing to 4.4% in 2022. The LTB (black line) increases from 42.9% in 2013 to 62.5% in 2014, has a steep decline to 12.5% in 2016, increases to 25.0% in 2019 then decreases to 12.5% in 2022.

When considering the proportion of all TB incidents detected by slaughterhouse surveillance, slaughterhouse cases were more common in larger herds and in herds in Scotland, the ITBM region and HRA, compared to other regions (Table 3.2). The very high percentage of incidents initiated by slaughterhouse cases where herd size was either zero or unknown is because many were detected in finishing units without routine testing to generate a herd size. Some OTF-S cases are disclosed in the slaughterhouse. This may occur when *M. bovis* has not been isolated from the original slaughterhouse submission, but check testing discloses reactors in the herd.

The proportion of all TB incidents triggered by slaughterhouse cases between 2019 and 2022 in Wales was lower than in the other countries of GB (Wales 10.0%. England 11.4%, Scotland 19.2%). This was similar in the previous report.

Proportionately, over the reporting period, more OTF-W incidents were detected by slaughterhouse surveillance in Scotland, the ITBM and LTB regions in Wales.

At country level, the lowest rate of OTF-W incidents detected at slaughterhouse was in Wales (17.3%), followed by England (19.7%) and Scotland (43.1%). As was seen for all TB incidents, the proportion of OTF-W slaughterhouse incidents increased with increasing herd size (Table 3.3).

Table 3.2: All TB incidents first detected by skin testing and in the slaughterhouse by year, confirmation status, herd size, herd region and herd type, between 2019 and 2022.

		Skin testing		Slaughterhouse		Total
		N	Percentage	N	Percentage	N
Year						
	2019	3,516	88.2%	469	11.8%	3,985
	2020	3,379	88.5%	437	11.5%	3,816
	2021	3,140	88.7%	401	11.3%	3,541
	2022	3,199	89.7%	366	10.3%	3,565
OTF status						
	OTFW	6,736	80.6%	1,625	19.4%	8,361
	OTFS	6,492	99.3%	48	0.7%	6,540
	Other*	6	100.0%	0	0.0%	6
Herd size						
	1 to 50	2,177	93.7%	147	6.3%	2,324
	51 to 100	2,417	93.6%	164	6.4%	2,581
	101 to 200	3,294	90.3%	353	9.7%	3,647
	201 to 300	1,957	89.0%	243	11.0%	2,200
	more than 300	3,385	82.7%	710	17.3%	4,095
	0 or no data	4	6.7%	56	93.3%	60
Region						
	England					
	HRA	8,153	87.6%	1,154	12.4%	9,307
	Edge	2,178	91.6%	199	8.4%	2,377
	LRA	509	92.4%	42	7.6%	551
	Scotland	105	80.8%	25	19.2%	130
	Wales					
	HTBE	706	90.5%	74	9.5%	780
	HTBW	889	88.2%	119	11.8%	1,008
	ITBM	213	87.3%	31	12.7%	244
	ITBN	384	95.5%	18	4.5%	402
	LTB	97	89.8%	11	10.2%	108
Herd type						
	Beef	7,520	89.3%	898	10.7%	8,418
	Dairy	5,608	88.0%	765	12.0%	6,373
	Other	106	91.4%	10	8.6%	116
Total		13,234	88.8%	1,673	11.2%	14,907

Note: This includes 0 unclassified TB incidents in 2019. Herd sizes categories are derived from quintiles of herd sizes in all TB incidents.

Table 3.3: OTF-W TB incidents first detected by skin testing or in the slaughterhouse by confirmation year, region, herd type, and herd size between 2019 and 2022.

		Skin testing		Slaughterhouse		Total
		N	percentage	N	percentage	N
Year						
	2019	1,986	81.5%	451	18.5%	2,437
	2020	1,847	81.3%	425	18.7%	2,272
	2021	1,548	79.9%	389	20.1%	1,937
	2022	1,355	79.0%	360	21.0%	1,715
Herd size						
	1 to 50	1,039	87.8%	145	12.2%	1,184
	51 to 100	1,202	88.2%	161	11.8%	1,363
	101 to 200	1,638	82.7%	342	17.3%	1,980
	201 to 300	990	80.8%	236	19.2%	1,226
	More than 300	1,864	73.1%	685	26.9%	2,549
	0 or no data	3	5.1%	56	94.9%	59
Region						
	England					
	HRA	4,366	79.5%	1,128	20.5%	5,494
	Edge	1,058	84.6%	192	15.4%	1,250
	LRA	120	76.4%	37	23.6%	157
	Scotland	33	56.9%	25	43.1%	58
	Wales					
	HTBE	442	86.2%	71	13.8%	513
	HTBW	443	79.7%	113	20.3%	556
	ITBM	77	71.3%	31	28.7%	108
	ITBN	165	90.7%	17	9.3%	182
	LTB	32	74.4%	11	25.6%	43
Herd type						
	Beef	3,960	82.1%	866	17.9%	4,826
	Dairy	2,723	78.4%	749	21.6%	3,472
	Other	53	84.1%	10	15.9%	63
Total		6,736	80.6%	1,625	19.4%	8,361

Time between last skin test and slaughterhouse detection

A comparison of the number of days elapsed between the last recorded herd-level test (regardless of test outcome) and the next TB herd incident detected by skin testing or slaughterhouse surveillance is shown in Tables 3.4 (for all incidents) and 3.5 (for OTF-W incidents only). It was over 2 times as common for a herd with a TB slaughterhouse case to have been tested within 190 days prior to disclosure, than over 190 days. It should be noted that there may be fewer opportunities to identify a TB incident through skin testing within the 190-day period following a skin test due to TB testing schedule of cattle herds. This continues to support the hypothesis that some infections evade detection by field skin testing. It also is continued evidence that slaughterhouse surveillance plays a useful role in the detection of infected herds.

In the absence of another method to distinguish herds exempt from testing, herds that had not had a skin test in 51 months prior to the TB incident (allowing three months for herds in a four-yearly testing regime to be tested) and those that had no recorded test on Sam database were assumed to be 'exempt herds'. However, this does not account for herds which are officially exempt from routine TB surveillance testing but can undergo targeted, reactive skin testing, such as tracings. The proportion of OTF-W incidents that were detected in the slaughterhouse was higher in 'Exempt' herds (81 out of 214 = 37.9%) than in herds that received routine skin testing (1,625 out of 8,361= 19.4%) (Table 3.5). The vast majority (96.6%) of OTF-W incidents detected by skin testing had a previous test within the past 15 months, reflecting the targeting of annual or more frequent testing to higher risk regions.

Table 3.4: Time since the last recorded herd-level test in herds experiencing any TB incident between 2019 and 2022 that was detected through skin testing or in the slaughterhouse.

Time since last herd level test	Skin testing N (percentage)	Slaughterhouse N (percentage)	Total N
No prior test recorded	205 (1.5%)	61 (3.6%)	266
1 to 90 days	269 (2%)	435 (26%)	704
91 to 190 days	2,473 (18.7%)	551 (32.9%)	3,024
191 days to 15 months	9,745 (73.6%)	568 (34%)	10,313
15 to 27 months	236 (1.8%)	11 (0.7%)	247
27 to 39 months	62 (0.5%)	17 (1%)	79
39 to 51 months	186 (1.4%)	8 (0.5%)	194
over 51 months	58 (0.4%)	22 (1.3%)	80
Total	13,234 (100%)	1,673 (100%)	14,907
'Exempt' herds	265 (2%)	83 (5%)	348

Note: Scotland has been exempting low risk herds since 2013 but, as they are low risk, they should not have any TB incidents. ‘skin testing’ and ‘slaughterhouse’ percentage represents percentage of total (above).

Table 3.5: Time since the last recorded herd-level test in herds experiencing an OTF-W TB incident between 2019 and 2022 that was detected through skin testing or in the slaughterhouse.

Time since last herd level test	Skin testing N (percentage)	Slaughterhouse N (percentage %)	Total N
No test recorded	104 (1.5%)	61 (3.8%)	165
1 to 90 days	118 (1.8%)	429 (26.4%)	547
91 to 190 days	1,337 (19.8%)	530 (32.6%)	1,867
191 days to 15 months	5,008 (74.3%)	549 (33.8%)	5,557
15 to 27 months	84 (1.2%)	11 (0.7%)	95
27 to 39 months	16 (0.2%)	17 (1%)	33
39 to 51 months	41 (0.6%)	8 (0.5%)	49
over 51 months	28 (0.4%)	20 (1.2%)	48
Total	6,736 (100%)	1,625 (100%)	8,361
"Exempt" herds	133 (2%)	81 (5%)	214

Note: ‘Skin testing’ and ‘Slaughterhouse’ percentage represents percentage of total (above).

TB incidents disclosed in the slaughterhouse, by whole genome sequencing clade.

Whole Genome Sequencing (WGS) of *M. bovis* replaced genotyping in April 2021, and a greater number of isolates may be sequenced from herds with multiple infected cattle, which will increase the level of information available about the genetic diversity of *M. bovis* isolates from herds with TB incidents.

A comparison of the frequency of different WGS clades of *M. bovis* identified in herds with TB incidents detected in the slaughterhouse and those detected by skin testing is shown in Figure 3.3. In total, 29 different clades were isolated between 2019 and 2022. Of those herds with TB incidents detected in the slaughterhouse, 0.9% had multiple WGS clades. In 6 incidents, there were 3 clades detected in each incident. It should be noted than in total 243 TB incidents initiated in the slaughterhouse had more than one sample submitted.

Figure 3.3: The proportion of TB incidents where WGS clades with a frequency greater than 0.1% were first detected, by clade (2019 to 2022).

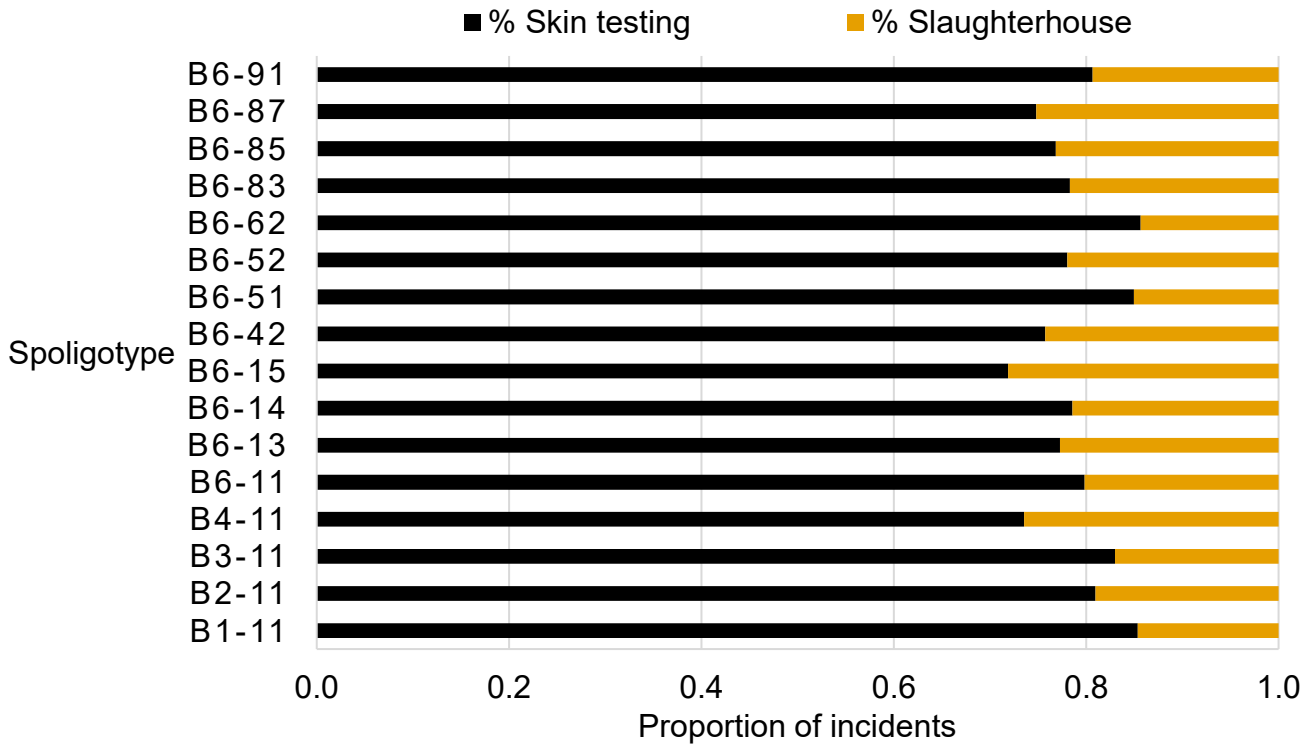


Figure 3.3 description: This shows stacked bars with black and orange, showing the proportion of incidents, by WGS clades with a frequency greater than 0.1%, that were first detected by skin testing (black bar) and in the slaughterhouse (orange bar) in 2019 to 2022. There are 16 bars, each representing different spoligotypes. The frequency of detection by slaughterhouse ranges between 0.14% and 2.79%

Multivariable analysis investigating risk factors for an incident to be detected in the slaughterhouse rather than by tuberculin skin testing.

Multivariable logistic regression was used to investigate risk factors for an OTF-W incident to be detected in the slaughterhouse rather than by tuberculin skin testing on farms (Table 3.6). Only OTF-W incidents were used in the analysis to ensure comparison remained similar, as most incidents triggered by slaughterhouse cases are laboratory positive by definition. The model correctly classified 88% of the data, was a good description of the data (Hosmer-Lemeshow χ^2 (8 d.f.)=2.51, P=0.96), and the area under the ROC curve was 0.87. Standard errors were adjusted for 7,033 clusters within herds (CPHH).

TB incidents in herds located in the ITBM region were more likely to be detected in the slaughterhouse compared with TB incidents in herds in the HRA. TB incidents in the Edge Area, the HTBE and ITBN regions were less likely to have been disclosed in the slaughterhouse than those in the HRA. There was no strong evidence that the odds of herd incident detection at slaughterhouse compared to skin testing differed for any other regions compared to the HRA ($p>0.05$). Results for the Edge Area were more statistically significant than in the previous report. The reasons behind this increase are likely to be multifactorial. One factor may be increased skin testing in the Edge Area through the introduction of 6-monthly testing in 2018, leading to more infection being found on the farm and less by slaughterhouse testing.

The detection of slaughterhouse cases was not influenced by the season of detection in the model.

TB incidents occurring within one to 90 days of a test were 39 times more likely to be disclosed in the slaughterhouse than those that had no test or had been tested more than 15 months previously. This is consistent with previous reports and not unexpected as there would be fewer opportunities for a skin test–disclosed TB incident as another skin test would be unlikely to be conducted within this timescale. Additionally, incidents occurring within 91to 190 days of a test were 4 times more likely to be disclosed in the slaughterhouse. TB incidents where the last test was a control test (see Appendix 2 and (Animal Plant and Health Agency, 2022)) were less likely to be triggered by slaughterhouse cases compared with those where the last test was a routine herd test. Control tests include check tests and short interval tests, are likely to be targeted towards higher risk herds and herds with recent experience of a TB incident. In the previous report, incidents where the last test was VE-12M tests were less likely to be triggered by slaughterhouse cases, which was not the case for 2019 to 2022.

Herd size was positively associated with incident detection in the slaughterhouse, with TB incidents in larger herds more likely to be disclosed in the slaughterhouse. Herds with more than one reactor in an incident were less likely to be disclosed in slaughterhouse inspection. Herds in which the last TB incident was OTF-S were less likely to be detected in a slaughterhouse case compared to those that were OTF-W.

Herds with more than 8 cattle movements onto the farm in the 12 months prior to the TB incident had an increased likelihood of being disclosed in the slaughterhouse and herds with more than 40 movements were almost twice as likely to be disclosed in the slaughterhouse. Time since the last TB incident was associated with slaughterhouse disclosure, with TB incidents in herds where the last TB incident was older having less chance of slaughterhouse disclosure, but this result was not statistically significant.

All *M. bovis* WGS clades that were detected with a frequency higher than 0.1% were more likely to be detected in the slaughterhouse compared to the reference clade B1-11 in the logistic regression analysis (Figure 3.5). However, as the 95% confidence intervals overlapped, no one clade was particularly more likely than the others to be detected at the slaughterhouse rather than at skin testing.

Table 3.6: Results of multivariable logistic regression analysis to identify factors associated with the odds that an OTF-W incident was disclosed by a slaughterhouse case (rather than a skin test), using data from 2019 to 2022. (OR: Odds Ratio; aOR: adjusted OR).

	N	crude OR	P-value	95% CI	aOR	P-value	95% CI
Region	8,361						
England							
HRA	1,250	1.0 (ref)			1.0 (ref)		
Edge	5,494	0.70	<0.0001	0.59 to 0.83	0.39	<0.0001	0.3 to 0.51
LRA	513	1.19	0.371	0.81 to 1.76	0.77	0.64	0.26 to 2.3
Scotland	556	2.93	<0.0001	1.76 to 4.9	1.12	0.92	0.12 to 10.22
Wales							
HTBE	108	0.62	<0.0001	0.48 to 0.81	0.56	0.004	0.37 to 0.83
HTBW	182	0.99	0.913	0.78 to 1.24	0.82	0.24	0.58 to 1.15
ITBN	157	0.40	0.001	0.24 to 0.67	0.37	0.02	0.16 to 0.87
ITBM	43	1.56	0.046	1.01 to 2.41	2.00	0.03	1.07 to 3.74
LTB	58	1.33	0.442	0.64 to 2.76	1.44	0.43	0.59 to 3.51
Season	8,361						
winter	2,246	1.0 (ref)			1.0 (ref)		
spring	2,326	0.96	0.595	0.83 to 1.11	0.92	0.434	0.74 to 1.14
summer	1,729	1.14	0.111	0.97 to 1.33	0.84	0.157	0.65 to 1.07
autumn	2,060	1.06	0.46	0.91 to 1.23	0.87	0.232	0.69 to 1.09
Clades isolated from incident	7,511						
1	7,348	1.0 (ref)			1.0 (ref)		
2	103	1.19	0.444	0.76 to 1.87	0.95	0.885	0.46 to 1.94
3	5	8.01	0.016	1.47 to 43.78	0.66	0.658	0.1 to 4.22
Time since last test	8,361						
No test or > 15 months	390	1.0 (ref)			1.0 (ref)		
1 to 90 days	547	8.48	0	6.29 to 11.44	38.53	<0.0001	16.39 to 90.6
91 days to 190 days	1,867	0.92	0.523	0.73 to 1.17	4.01	0.001	1.79 to 8.97
191 days to 15 months	5,557	0.26	0	0.2 to 0.32	0.85	0.69	0.38 to 1.9

Table 3.6 (continued): Results of multivariable logistic regression analysis to identify factors associated with the odds that an OTF-W incident was disclosed by a slaughterhouse case (rather than a skin test), data from 2019 to 2022. (OR: Odds Ratio; aOR: adjusted OR).

	N	crude OR	P-value	95% CI	aOR	P-value	95% CI
Last test type	8,361						
Routine	3,113	1.0 (ref)			1.0 (ref)		
VE-12M	634	1.25	0.034	1.02 to 1.53	1.15	0.389	0.84 to 1.58
VE-6M	1,504	1.01	0.856	0.87 to 1.18	0.99	0.911	0.76 to 1.28
Area Risk	1,150	0.85	0.078	0.71 to 1.02	0.78	0.114	0.58 to 1.06
Control	1,718	0.78	0.001	0.66 to 0.91	0.47	<0.0001	0.36 to 0.61
Other	77	0.74	0.348	0.4 to 1.38	0.34	0.102	0.1 to 1.23
No last test	165	2.36	<0.0001	1.69 to 3.28	11.04	0.256	0.18 to 694.16
Herd size	8,361						
1 to 50	1,184	1.0 (ref)			1.0 (ref)		
51 to 100	1,363	0.96	0.742	0.75 to 1.23	1.17	0.46	0.77 to 1.76
101 to 200	1,980	1.50	<0.0001	1.2 to 1.86	1.89	0.001	1.31 to 2.73
201 to 300	1,226	1.71	<0.0001	1.35 to 2.16	2.27	<0.0001	1.52 to 3.38
>300	2,549	2.63	<0.0001	2.15 to 3.23	4.09	<0.0001	2.86 to 5.85
0 or no data	59	133.75	<0.0001	41.31 to 433.07			
Reactors	8,361						
No reactors	705	1.0 (ref)			1.0 (ref)		
>1 reactors	7,656	0.03	<0.0001	0.02 to 0.03	0.02	<0.0001	0 to 0
Last breakdown status	8,361						
OTFW	5,050	1.0 (ref)			1.0 (ref)		
OTFS	1,876	0.58	0	0.5 to 0.67	0.61	<0.0001	0.49 to 0.75
Unknown	7	1.45	0.654	0.28 to 7.51	3.40	<0.0001	0.25 to 46.05
No last breakdown	1,428	0.87	0.069	0.75 to 1.01			
Number of on movements	8,361						
No movements	2,255	1.0 (ref)			1.0 (ref)		
1 to 7 movements	1,951	0.99	0.888	0.83 to 1.17	1.05	0.695	0.82 to 1.34
8 to 39 movements	1,750	1.12	0.181	0.95 to 1.34	1.24	0.088	0.97 to 1.59
>=40 movements	2,405	2.16	0	1.86 to 2.51	1.40	0.003	1.12 to 1.74
Time since last breakdown	8,361	1.00	0.084	<0.0001	1.00	0.077	1 - 1

Figure 3.5: Odds ratios and 95% confidence intervals for spoligotype disclosure in the slaughterhouse compared to skin testing, where the statistical significance approaches or is under 0.05. (Note: Results from a logistic regression model as in Table 3.6, clustered by incident).

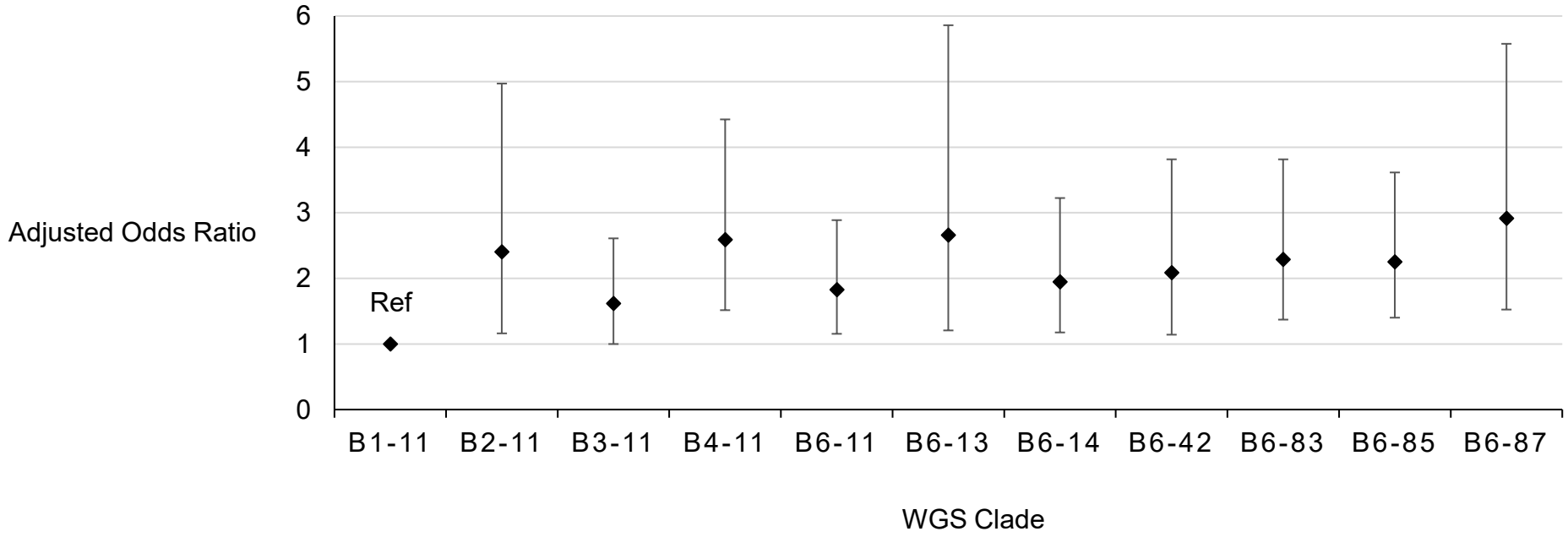


Figure 3.5 description: This shows the odds ratios and 95% confidence intervals for the main clades disclosed in the slaughterhouse, where the statistical significance was less than or equal to 0.05. This figure shows the adjusted odds ratios for the main clade types disclosed at the slaughterhouse that were found to be significantly associated with a slaughterhouse incident. Eleven clades were found to be significantly associated with an increase in the odds of a breakdown in the slaughterhouse. These were B1-11, B2-11, B3-11, B4-11, B6-11, B6-13, B6-14, B6-42, B6-83, B6-85, and B6-87. Of these, seven clades were found to at least double the odds of a slaughterhouse breakdown.

Section 4: identification of test reactors in the source herd following a culture-positive slaughterhouse case between 2019 and 2022

The aim of this section is to examine herds with slaughterhouse cases that have no subsequent TB test reactors at the first skin herd test following detection, compared with those that do have reactors at subsequent interferon-gamma or tuberculin skin tests.

Slaughterhouse disclosed TB incidents with reactors detected at subsequent skin herd tests

Between 2019 and 2022, 63% (1,023 out of 1,625) of OTF-W TB incidents disclosed in the slaughterhouse had reactors at subsequent tuberculin skin herd tests, similar to the proportion disclosed in the last reporting period (years 2016 to 2019; 61.1%; 1,182 out of 1,933).

Summary statistics describing the number and proportion of TB incidents detected in the slaughterhouse that had or did not have subsequent reactors, by year, herd size and type, region and possible exemption status, are shown in Table 4.1.

Reactors at follow-up TB testing appeared more likely when the slaughterhouse case originated from: larger herds from the ITBM in Wales, Scotland or the LRA in England; dairy herds; or ‘non-exempt’ herds (if a herd is exempt from testing, then it is less likely to have check testing, for example, finishing herds).

The annual proportion of TB incidents that were detected in slaughterhouses in GB that had no further reactors at all subsequent skin herd tests during the reporting period was variable (Figure 4.1). In England, the HRA was highest until 2018, when it was surpassed by the LRA. However, since 2020, the Edge Area has had the highest number of TB incidents with no reactors at subsequent herd tests. In Scotland, this proportion has been decreasing since 2019, falling to a ten year low in 2022 (where all TB incidents in herds had at least one reactor at a subsequent herd test). In Wales, the number of herds with no reactors at subsequent skin tests was much more variable between risk areas. It was highest in the ITBM, with an average of 48% between 2013 and 2022 (the average for Wales over the same period was 42%), and lowest in the ITBN with an average of 14%.

Previously, data from Northern Ireland found that 54% of confirmed slaughterhouse-disclosed TB incidents in Northern Ireland had no subsequent reactors in 2016 ((Abernethy and ., 2013) and unpublished data up to 2016). That is compared to 39% in 2016 in GB (Animal Plant and Health Agency, 2021) and 45% in GB in 2022 (Table 4.1). The higher likelihood of finding reactors at subsequent testing in GB relative to NI may be

due in part to the generally smaller herd sizes across the island of Ireland. The mean herd size in 2021 in Ireland is recorded as 82.2 animals (Department of Agriculture, 2023) compared to the mean herd size of 123 in GB in 2022. In GB, in herds with 100 animals or less, the proportion of OTF-W TB incidents disclosed in the slaughterhouse with no reactors rises to 47% and is even higher (71%) when restricted to herds with 50 animals or less (Table 4.1).

Table 4.1: OTF-W TB incidents disclosed in the slaughterhouse that had further reactors at follow-up interferon-gamma or skin testing, compared with those that had no further reactors, between 2019 and 2022. Numbers stratified by year, herd size and type, region and possible routine test exemption status (poss. exempt). (47 TB incidents with no reactors had not had their OTF status restored and could therefore still generate test reactors, by 31 December 2022).

		No reactors N (percentage)	Reactors N (percentage)	Total
Year				
	2019	158 (35%)	293 (65%)	540
	2020	134 (32%)	291 (68%)	450
	2021	148 (38%)	241 (62%)	493
	2022	162 (45%)	198 (55%)	450
Herd size				
	1 to 50	103 (71%)	42 (29%)	172
	51 to 100	75 (47%)	86 (53%)	217
	101 to 200	133 (39%)	209 (61%)	383
	201 to 300	79 (13%)	157 (26%)	319
	>300	159 (23%)	526 (77%)	771
	0 or no data	53 (95%)	3 (5%)	71
CPHH Region				
	England			
	HRA	406 (36%)	722 (64%)	1,432
	Edge	74 (39%)	118 (61%)	204
	LRA	12 (32%)	25 (68%)	52
	Scotland	6 (24%)	19 (76%)	22
	Wales			
	HTBE	38 (54%)	33 (46%)	63
	HTBW	48 (42%)	65 (58%)	103
	ITBM	11 (35%)	20 (65%)	36
	ITBN	2 (12%)	15 (88%)	11
	LTB	5 (45%)	6 (55%)	10
Herd type				
	Beef	420 (48%)	446 (52%)	1,123
	Dairy	178 (24%)	571 (76%)	807
	Other	4 (40%)	6 (60%)	3
Poss exempt				
	No	536 (35%)	1,008 (65%)	1,840
	Yes	66 (81%)	15 (19%)	93
Total		602 (37%)	1,023 (63%)	1,933

Figure 4.1a: The proportion of TB incidents that were detected in the slaughterhouse by risk area in England and Scotland and had no further reactors at all subsequent herd tests until the end of the reporting period (47 TB incidents with no reactors had not had their OTF status restored and could therefore still generate test reactors, between 2013 and 2022).

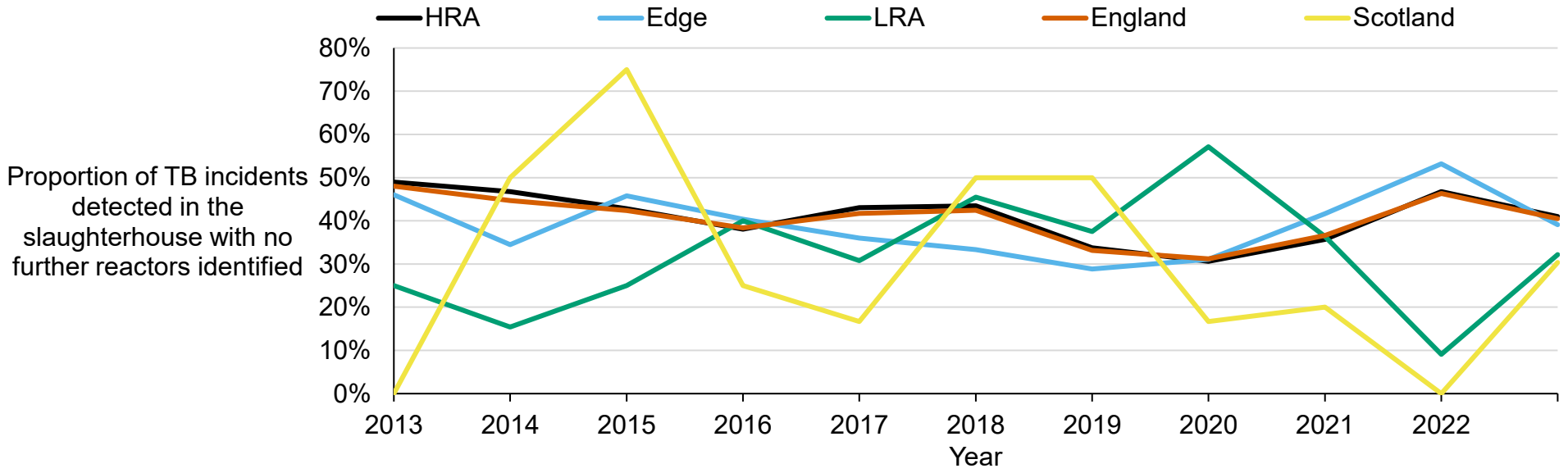


Figure 4.1a description: There are 5 lines, one orange, one black, one blue, one green and one yellow showing the proportion of TB incidents detected in the slaughterhouse with no further reactors identified between 2013 and 2022, by region. Each line shows a risk area, with black representing the HRA, blue showing the Edge Area, green showing the LRA, brown representing England and yellow representing Scotland. The HRA (black line) and England (brown line) follow the same trend, decreasing from 47% and 48% in 2013, respectively, to 46% in 2022. The Edge Area (blue line) decreased from 46% in 2013 to 29% in 2019 then increased to 53% in 2022. The LRA (green line) increased from 25% in 2013 to 57% in 2020, then decreased to 9% in 2022. Scotland (yellow line) increased from 0% in 2013 to a peak of 75% in 2015, then decreased to 0% in 2022.

Figure 4.1b: The proportion of TB incidents that were detected in the slaughterhouse by risk area in Wales and had no further reactors at all subsequent herd tests until the end of the reporting period (47 TB incidents with no reactors had not had their OTF status restored and could therefore still generate test reactors, between 2013 and 2022).

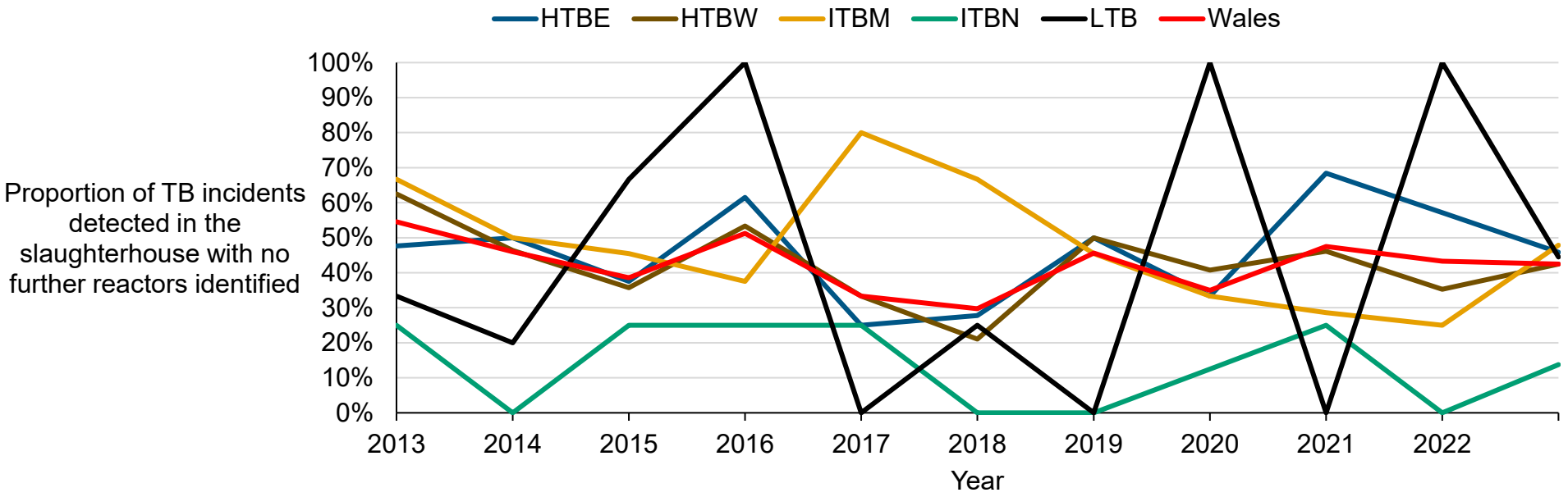


Figure 4.1b description: There are 6 lines, one blue, one brown, one orange, one green, one black and one red showing the proportion of TB incidents detected in the slaughterhouse with no further reactors identified between 2013 and 2022, by region. Each line shows a risk area, with blue showing the HTBE, brown showing the HTBW, orange showing the ITBM, green showing the ITBN, black showing the LTB and red representing Wales. The HTBE (blue line), HTBW (brown line) and Wales (red line) follow a similar trend between 2013 and 2020, decreasing from 48%, 63% and 55% in 2013 respectively, to 35%, 41% and 35%, respectively. The HTBE and Wales then increase to 57% and 43% in 2022, respectively, and the HTBW decreases to 35%. The ITBM (orange line) decreases from 67% in 2013

to 25% in 2022, with a peak of 80% in 2017. The ITBN (green line) fluctuated between 0% and 25%, with a plateau of 25% between 2015 and 2017, and decreased to 0% in 2022.

The mean and median number of reactors disclosed at the first whole herd test for OTF-W TB incidents first detected by skin testing or slaughterhouse surveillance are presented in Table 4.2. Reactor averages are stratified by herd region and year of detection. In GB overall and considering all years (2019 to 2022), the mean number of reactors at the first whole herd test of OTF-W TB incidents detected by skin testing was greater than in those detected in the slaughterhouse (6.1 and 5.0 reactors respectively, Table 4.2).

A small number of TB incidents with a very high number of reactors detected can skew the mean value and so the median number of reactors was also compared. When considering the median number of reactors, OTF-W incidents detected by skin testing found 4 (IQR 2-7) reactors at the first whole herd test, while for OTF-W incidents detected at slaughterhouse, the median number of reactors was 0 (IQR 0-4) (Table 4.2).

The mean number of reactors in OTF-W incidents that were detected by skin testing has remained relatively stable between 2019 and 2022, ranging from 6.1 to 6.2. For OTF-W incidents disclosed in the slaughterhouse, the mean number of reactors at the first whole herd test has increased over time. In 2019, the mean number of reactors detected by slaughterhouse surveillance was the same as the mean number detected by skin testing (3.5) and increased to 5.9 in 2022 (Table 4.2). This is still lower than the mean number of reactors detected by slaughterhouse surveillance in 2016 (6.1, (Animal Plant and Health Agency, 2021)). Reasons for differences in the number of reactors disclosed are complex and likely to be multifactorial.

The mean number of reactors was higher in OTF-W incidents that were detected by skin testing than by slaughterhouse surveillance for most TB herd regions. In the LRA and Scotland, the mean number of reactors in OTF-W incidents detected by skin testing and slaughterhouse cases was very similar. In the HTBE region, OTF-W incidents detected through slaughterhouse surveillance detected almost two additional reactors at the next whole herd test compared to skin testing surveillance.

In the ITBN region, OTF-W incidents detected through skin testing found half the number of reactors at the first whole herd test compared to OTF-W incidents detected through the slaughterhouse (a median of 3 and 6 reactors respectively). This pattern was also seen when looking at the mean number of reactors disclosed by skin or slaughterhouse testing (mean of 4.8 and 15.8 respectively) in the ITBN. The ITBN was the only region in GB where OTF-W incidents detected in slaughterhouse found a greater mean and median reactors at the first whole herd test than OTF-W incidents revealed through skin testing. This may have been due to a pilot study running from June 2021 involving targeted blood testing in clear skin testing herds which created larger numbers of OTF-S incidents with low numbers of reactors.

Table 4.2: The mean, median and interquartile range (IQR) for the number of reactors disclosed at the first whole herd test conducted following an OTF-W TB incident detected by skin testing or slaughterhouse surveillance (SLH) stratified by herd region and year.

	Skin testing OTF-W incidents	Skin testing Mean reactors per incident	Skin testing Median reactors per incident	Skin testing IQR	SLH OTF-W incidents	SLH Mean reactors per incident	SLH Median reactors per incident	SLH IQR
Herd region								
England								
HRA	4,366	6.2	4	2 to 7	1128	4.4	0	0 to 4
Edge	1,058	6.2	3	2 to 6	192	4.3	0	0 to 3
LRA	120	3.6	2	2 to 4	37	3.8	0	0 to 4
Scotland	33	13.9	4	2 to 7	25	14.2	1	0 to 12
Wales								
HTBE	442	5.2	3	2 to 6	71	6.9	0	0 to 2
HTBW	443	6.6	4	2 to 8	113	5.3	0	0 to 8

		Skin testing OTF-W incidents	Skin testing Mean reactors per incident	Skin testing Median reactors per incident	Skin testing IQR	SLH OTF-W incidents	SLH Mean reactors per incident	SLH Median reactors per incident	SLH IQR
	ITBM	77	7.2	3	2 to 6	31	5.9	0	0 to 6
	ITBN	165	4.8	3	2 to 6	17	15.8	6	0 to 12
	LTB	32	4.6	3	2 to 6.5	11	0.6	0	0 to 0
Year									
	2019	1,986	6.1	3	2 to 7	451	3.5	0	0 to 3
	2020	1,847	6.2	4	2 to 7	425	5.7	0	0 to 4
	2021	1,548	6.0	4	2 to 6	389	4.3	0	0 to 4
	2022	1355	6.2	3	2 to 6	360	5.9	0	0 to 4
	Total	6736	6.1	4	2 to 7	1,625	5.0	0	0 to 4

Multivariable analysis to investigate risk factors for TB incidents initiated by a slaughterhouse case to have reactors at subsequent skin tests

A multivariable logistic regression was conducted to investigate risk factors associated with the detection of reactors (to either the interferon-gamma or tuberculin skin test) at subsequent herd tests in closed TB herd incidents that were triggered by slaughterhouse surveillance. During 2019 to 2022, there were 602 such incidents in which no test reactors were detected, and 1,023 in which at least one reactor was disclosed at subsequent testing. A total of 47 TB incidents that were initiated by slaughterhouse surveillance (2.9%) had not had their OTF status restored when the data was extracted for this report (See Methodology section) and were excluded from the analysis since they could have generated test reactors.

The full model is presented in Table 4.3. The model was a poor fit for the data (Hosmer-Lemeshow $\chi^2(8) = 104.91$, $P<0.0001$), and the amount of variation explained by the model was low (Pseudo $R^2=32.2\%$). It is likely that there are other factors, not included here, that influence the detection of reactors at subsequent check tests in slaughterhouse cases.

The probability of detecting reactors at the herd test increased with herd size, with the odds of detecting a reactor 6.4 times greater in herds with >300 cattle than in herds containing no more than 50 cattle (95% CI: 3.86-10.57, p<0.0001).

There was a higher probability of detecting test reactors in herds in the Edge Area (95% CI: 1.09-2.58, p=0.019) and LRA (95% CI: 3.29-27.18, p<0.0001) than in herds in the HRA. There was also a higher probability of detecting reactors in Scotland compared to the HRA, though this was not statistically significant.

The probability of detecting reactors at the skin or interferon-gamma tests of TB herd incidents initiated by slaughterhouse cases was lower for the HTBE, HTBW, and ITBN compared to the HRA, however this was only statistically significant for the HTBE and ITBN. Caution should be used when interpreting the higher probabilities of detecting reactors due to the wide confidence intervals surrounding the odds ratios.

There was evidence that the year in which a TB incident was detected by slaughterhouse surveillance was significantly associated with the disclosure of reactors at subsequent skin or gamma tests. In 2020, there was a 34% increase in odds of finding a TB reactor at the next check test after detecting an incident in the slaughterhouse compared to 2019 (95% CI 1.05-1.71, p=0.019). In 2022, there was a 45% decrease in odds of finding a TB reactor at the next check test after detecting an incident in the slaughterhouse compared to 2019 (95% CI 0.42 -0.73, p<0.0001).

An increased number of movements onto the farm in the 12 months prior to the start of the TB incident was significantly associated with a decrease in the probability of detecting

reactors at the check test. The duration of the incident was also significantly associated with the probability of detecting reactors at the check test.

Herd type was excluded from the model as it was correlated with herd size and when included in the model, it increased the estimation of prediction error (AIC) and the amount of variation explained by the model decreased from 32.2% to 29.8%.

However, these results should be interpreted with caution, given the low amount of variation explained by the model and the probable interdependence of some variables. It is likely the reason for the detection of reactors following TB incidents triggered at the slaughterhouse is complex. The previous report highlighted that further work was necessary to better understand the complex reasons why subsequent TB reactors are detected in some TB incidents which originate in the slaughterhouse and not in others. The data presenting in this report further confirms the requirement for this work.

Table 4.3: Results of multivariable logistic regression analysis to identify factors associated with the odds of TB incidents initiated by slaughterhouse cases having skin or interferon-gamma test reactors, using data from 2019 to 2022. (Std. Err. Adjusted for 73 clusters in SLH ID; OR: Odds Ratio; aOR: adjusted OR). Risk factors with a significant aOR are highlighted in bold.

		N	crude OR	P-value	95% CI	aOR	P-value	95% CI
Herd size								
	1 to 50	2,295	1.0 (ref)			1.0 (ref)		
	51 to 100	**2,546**	**2.95**	**<0.0001**	**1.88 to 4.64**	**3.12**	**<0.0001**	**1.67 to 5.82**
	101 to 200	**3,561**	**3.90**	**<0.0001**	**2.43 to 6.25**	**5.07**	**<0.0001**	**2.78 to 9.23**
	201 to 300	**2,133**	**5.00**	**<0.0001**	**3.23 to 7.74**	**4.39**	**<0.0001**	**2.41 to 7.98**
	>300	**3,884**	**7.51**	**<0.0001**	**4.95 to 11.39**	**6.39**	**<0.0001**	**3.86 to 10.57**
	0 or no data	15	0.44	0.45	0.05 to 3.75	0.38	0.184	0.09 to 1.59
Region								
	England							
	HRA	9,059	1.0 (ref)			1.0 (ref)		
	Edge	**2,320**	**1.11**	**0.597**	**0.76 to 1.61**	**1.68**	**0.019**	**1.09 to 2.58**
	LRA	**539**	**1.79**	**0.219**	**0.71 to 4.54**	**9.45**	**<0.0001**	**3.29 to 27.18**
	Scotland	129	1.71	0.316	0.6 to 4.88	2.13	0.481	0.26 to 17.4
	Wales							
	HTBE	**749**	**0.38**	**0.001**	**0.21 to 0.67**	**0.41**	**0.001**	**0.24 to 0.69**
	HTBW	923	0.58	0.003	0.41 to 0.83	0.72	0.214	0.43 to 1.21
	ITBM	370	3.14	0.237	0.47 to 20.83	1.86	0.488	0.32 to 10.83
	ITBN	**238**	**0.88**	**0.79**	**0.35 to 2.24**	**0.31**	**0.021**	**0.11 to 0.83**
	LTB	107	0.95	0.952	0.18 to 4.96	2.87	0.088	0.86 to 9.64
Year								
	2019	3,948	1.0 (ref)			1.0 (ref)		
	2020	**3,761**	**1.21**	**0.106**	**0.96 to 1.53**	**1.34**	**0.019**	**1.05 to 1.71**
	2021	3,467	0.89	0.345	0.71 to 1.13	0.95	0.721	0.71 to 1.26
	2022	**3,258**	**0.56**	**<0.0001**	**0.43 to 0.74**	**0.55**	**<0.0001**	**0.42 to 0.73**
Duration		**14,434**	**1.02**	**<0.0001**	**1.01 to 1.03**	**1.02**	**<0.0001**	**1.01 to 1.03**
Movements on per 100 animals		**14,434**	**0.92**	**<0.0001**	**0.88 to 0.96**	**0.86**	**<0.0001**	**0.81 to 0.92**

Section 5: Impact of PCR testing on slaughterhouse case detection between 2019 and 2022

AIM: This section aims to provide some context and additional analysis on the use of PCR, which was introduced at the end of March 2022.

Polymerase Chain Reaction (PCR) testing was introduced as the default confirmatory method for TB slaughterhouse case samples submitted to the laboratory from 30 March 2022. As such, this was only applicable to suspected lesions of TB detected at routine slaughter in the last nine months of the report period. The method of sampling from slaughterhouse cases is described in Figure 5.1, and highlights that this change would not affect the detection of slaughterhouse cases (which relies on the detection of visible or atypical lesions) but may impact on the proportion of confirmed (*M. bovis*-positive) slaughterhouse cases.

As PCR testing only took place in the last eight months covered by this report, it was not appropriate to conduct statistical analyses of this data. A summary of the data are presented below.

The sensitivity of PCR for detecting *M. bovis* from slaughterhouse case lesions is comparable to that of culture (Morris and 2023).

Between April and December 2022, a total of 640 carcasses were eligible for PCR testing, and 642 samples underwent PCR testing (2 carcasses submitted 2 samples for testing). The PCR and culture results are shown in Table 5.1. Of these 642 samples, 61% were positive by PCR, thus triggering OTF-W herd incidents. The remaining samples were either negative (38%, n=247), pending results (n=1), or did not have a PCR test despite being eligible (n=2).

PCR is the primary diagnostic technique for *M. bovis* detection in tissue samples, and slaughterhouse case submissions with a negative PCR test result are reported by the laboratory as such without further testing. However, PCR-positive slaughterhouse case samples are processed for culture to enable WGS and phylogenetic analysis of *M. bovis* isolates.
PCR was found to have a relative sensitivity and specificity of 96% and 97% in bovines compared to culture in trials (Morris and ., 2023). In this current study, agreement between PCR and culture was 99.84% (kappa statistic=0.9967).

PCR testing for identification of *M. bovis* DNA in post-mortem tissue samples is a relatively novel diagnostic procedure in the APHA TB laboratories. The test is constantly under review to monitor its performance as part of APHA's robust quality standards systems. Following evidence to indicate that the PCR test might not be performing as well

as expected for the detection of *M. bovis* in some samples in late 2023, APHA moved to subject all visible lesion submissions with a negative PCR result to bacteriological culture prior to confirming the negative status of the sample to customers. This did not affect the results discussed in this report (up to the end of 2022), as this additional procedure was in place from mid-2024 onwards. There is no indication that the PCR test for *M. bovis* was not performing as expected during 2022, following its initial rollout at the end of March of that year.

Figure 5.1a: Flow chart illustrating the process of laboratory testing of slaughterhouse case samples during the report period, before the adoption of PCR testing at APHA.

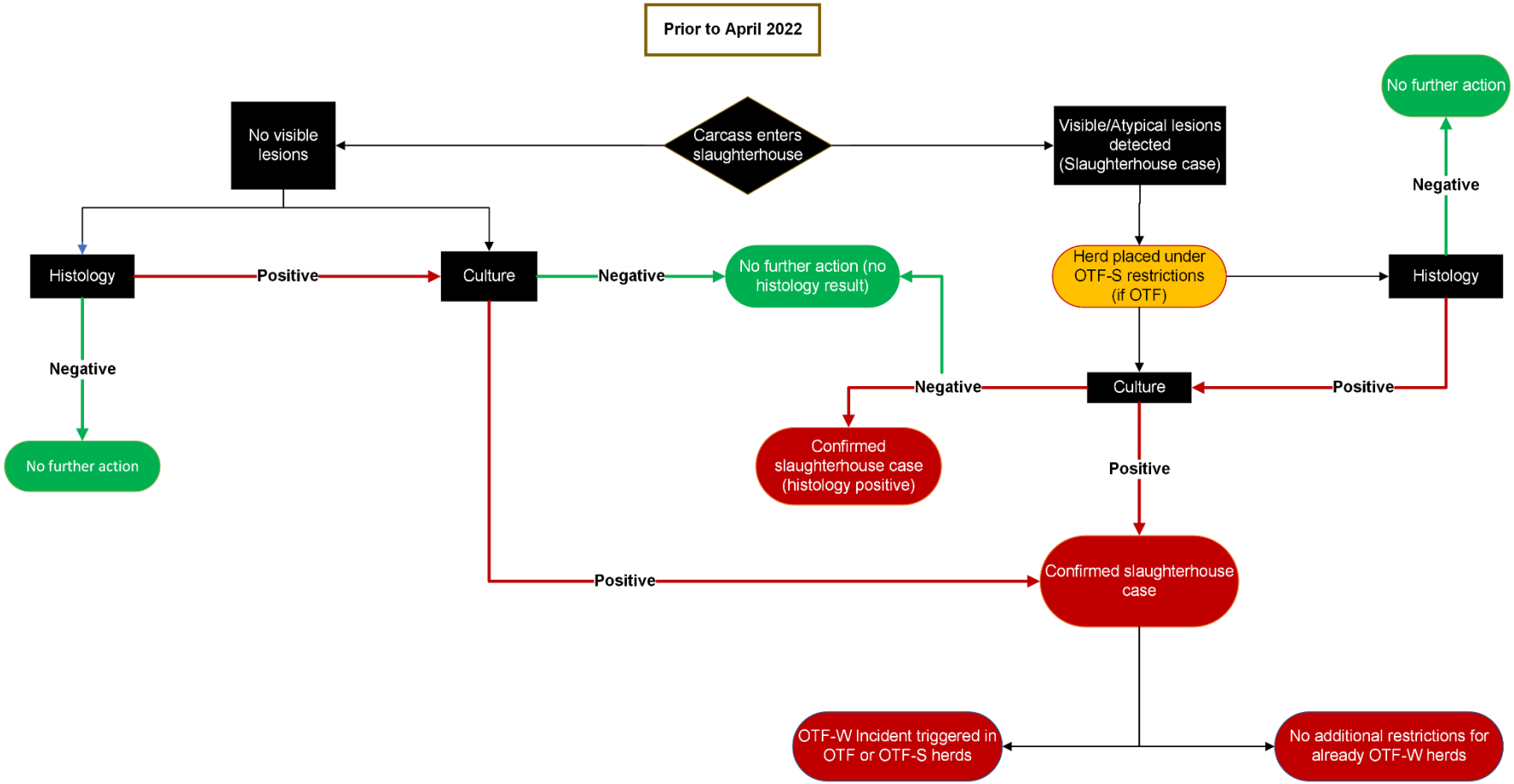


Figure 5.1a description: Flow chart diagram showing the process of testing carcasses in the slaughterhouse prior to the introduction of PCR at APHA. A carcass enters the slaughterhouse. If visible lesions are found, the herd is placed under OTF-S restrictions. Culture and/or histology are performed. Positive results from either test result in the carcass becoming a confirmed slaughterhouse case and the herd of origin is placed on OTF-W restrictions if not already under them. A negative culture result, with no positive histology test, results in OTF-S restrictions being lifted. If no visible lesions are found, the herd still undergoes histology and/or culture. Positive results from either test result in the carcass becoming a confirmed slaughterhouse case and the herd of origin is placed on OTF-W restrictions if not already under them. A negative culture result, with no positive histology test, results in OTF-S restrictions being lifted.

Figure 5.1b: Flow chart illustrating the process of laboratory testing of slaughterhouse case samples during the report period, after the adoption of PCR testing at APHA.

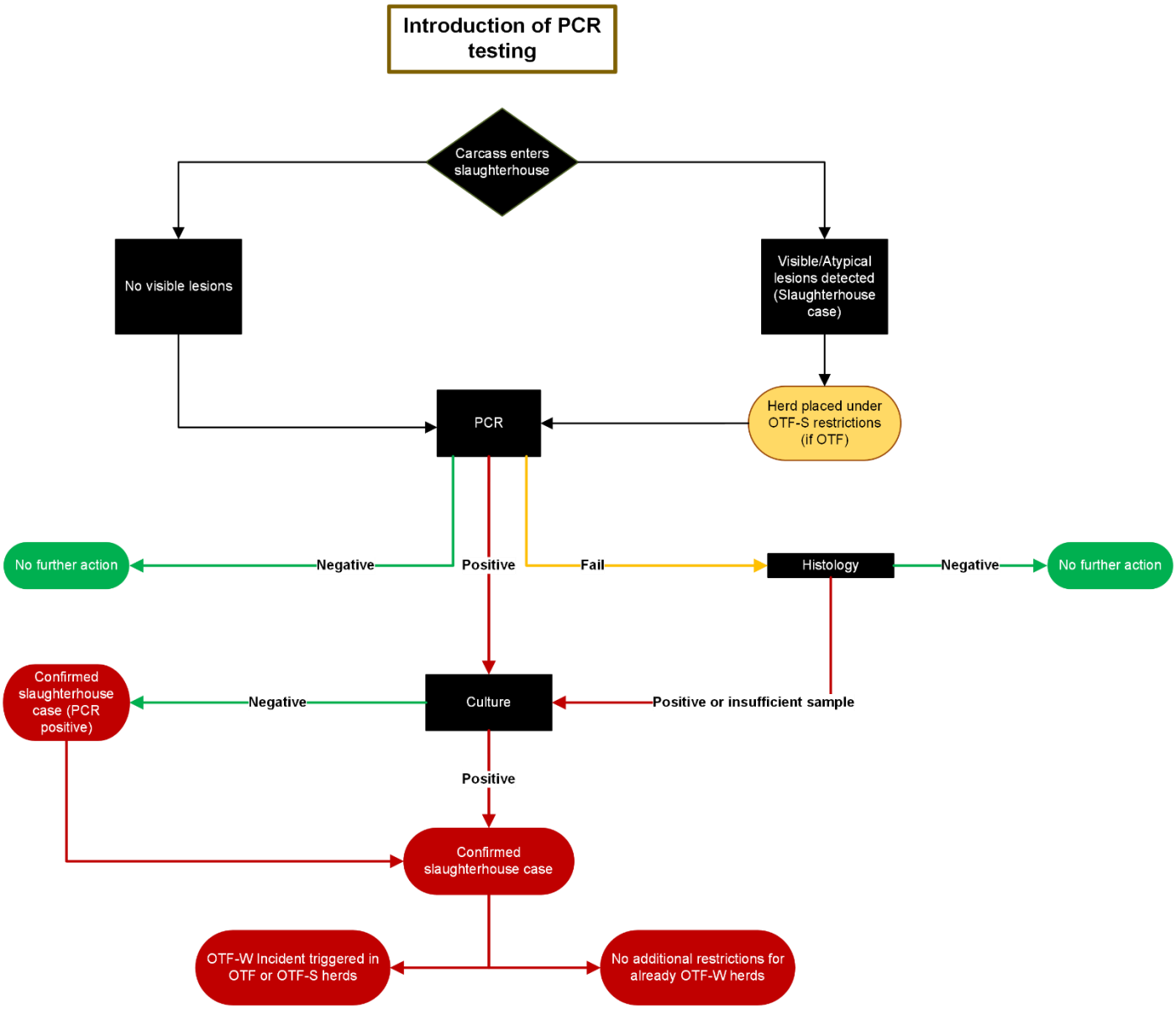


Figure 5.1b description: Flow chart diagram showing the process of testing carcasses in the slaughterhouse after the introduction of PCR at APHA. A carcass enters the slaughterhouse. Carcases with either visible and non-visible lesions are tested by PCR (visible lesions place the herd from which the carcass came from under OTF-S restrictions). A negative PCR test lifts all restrictions. A positive PCR test results in the carcass undergoing culture to generate the WGS clade and means the carcass becomes a confirmed slaughterhouse case. A failed PCR test means the sample is submitted for histology (if there is enough sample) or sent direct to culture. A negative histology result is final and any restrictions placed are lifted. A positive histology result results in the carcass

undergoing culture to generate the WGS clade and means the carcass becomes a confirmed slaughterhouse case.

Table 5.1: PCR and bacteriological culture results from slaughterhouse case samples from OTF herds in GB submitted to APHA between April and December and 2022, where both diagnostic methods were performed.

	Culture Result			
	Positive	**Negative**	**Pending**	**Total**
PCR Result				
Missing	**0**	**1**	**0**	**1**
Negative	**1**	**244**	**2**	**247**
Not done	**1**	**1**	**0**	**2**
Pending	**0**	**1**	**0**	**1**
Positive	**392**	**0**	**0**	**392**
Total	**394**	**247**	**2**	**643**

Section 6: model to explore residual variation in detection rates of TB slaughterhouse cases across cattle abattoirs in GB

This section presents the output of the model created at Cambridge University (now curated by APHA) to analyse TB slaughterhouse case detection rates in GB cattle abattoirs. The model is regularly updated by APHA with more recent data. The aim of this analysis was to identify establishments that detected a lower than expected number of TB slaughterhouse cases at private, commercial slaughter of cattle according to their throughput and the characteristics of the animals they processed (McKinley and 2018).

The model is set to explore patterns in residual variation in TB lesion detection rates between slaughterhouses, after accounting for individual animal-level risk factors. These include:

- sex
- age
- breed
- days in high or low risk herds
- contact with high or low risk herds
- skin testing status
- year
- quarter
- risk area

Taking all these factors into account, the ability of a slaughterhouse in detecting and reporting a case of TB at routine PMMI can be compared to what might be expected according to the type of animals processed. These patterns can be summarised by the posterior mean odds ratio (OR); with slaughterhouses scoring positive posterior ORs detecting more tuberculous carcasses at commercial slaughter of non-reactor cattle (slaughterhouse cases) than the average expected. Conversely, a negative posterior ORs would indicate fewer than the average expected number of slaughterhouse cases are being detected. However, by design we would expect the ORs for the different slaughterhouses to be distributed above-and-below the average and, due to the large heterogeneity in throughputs, the ORs for some slaughterhouses will be better estimated than others.

The perceived reliability of this estimation is measured by the posterior variance, and those with a lower variance have a better estimation of the posterior mean. Therefore, although it makes sense to focus attention on slaughterhouses with large negative odds ratios, it is also sensible to account for how precisely each OR is estimated. This can be achieved by considering the 95% credible interval around the posterior mean using the

variance, which allows for the ORs to be compared against some predefined baseline level (such as the average), or alternatively to each other.

Appendix 3 presents these figures for each slaughterhouse in GB that processed cattle in 2019 to 2022. If the credible interval includes zero, then the model does not provide sufficient statistical evidence that the slaughterhouse is reporting any more or fewer cases than predicted by the model, given the other factors accounted for in the model. The size of the interval is mainly down to the throughput of the slaughterhouse; the higher the throughput the smaller the interval and hence the greater the precision of the estimate (that is to say the smaller the dot, the better the precision of the estimated OR.)

There were 12 slaughterhouses with an upper credible interval below zero for the period 2019 to 2022. This provides evidence that these premises were not disclosing as many slaughterhouse cases as the number predicted by the model. These have been highlighted in Appendix 3. For others with a low posterior mean, but with upper intervals above zero, they may appear to be detecting fewer TB slaughterhouse cases than predicted by the model, but with low precision of estimate. This is likely to be caused by large model variance due to a relatively low throughput.

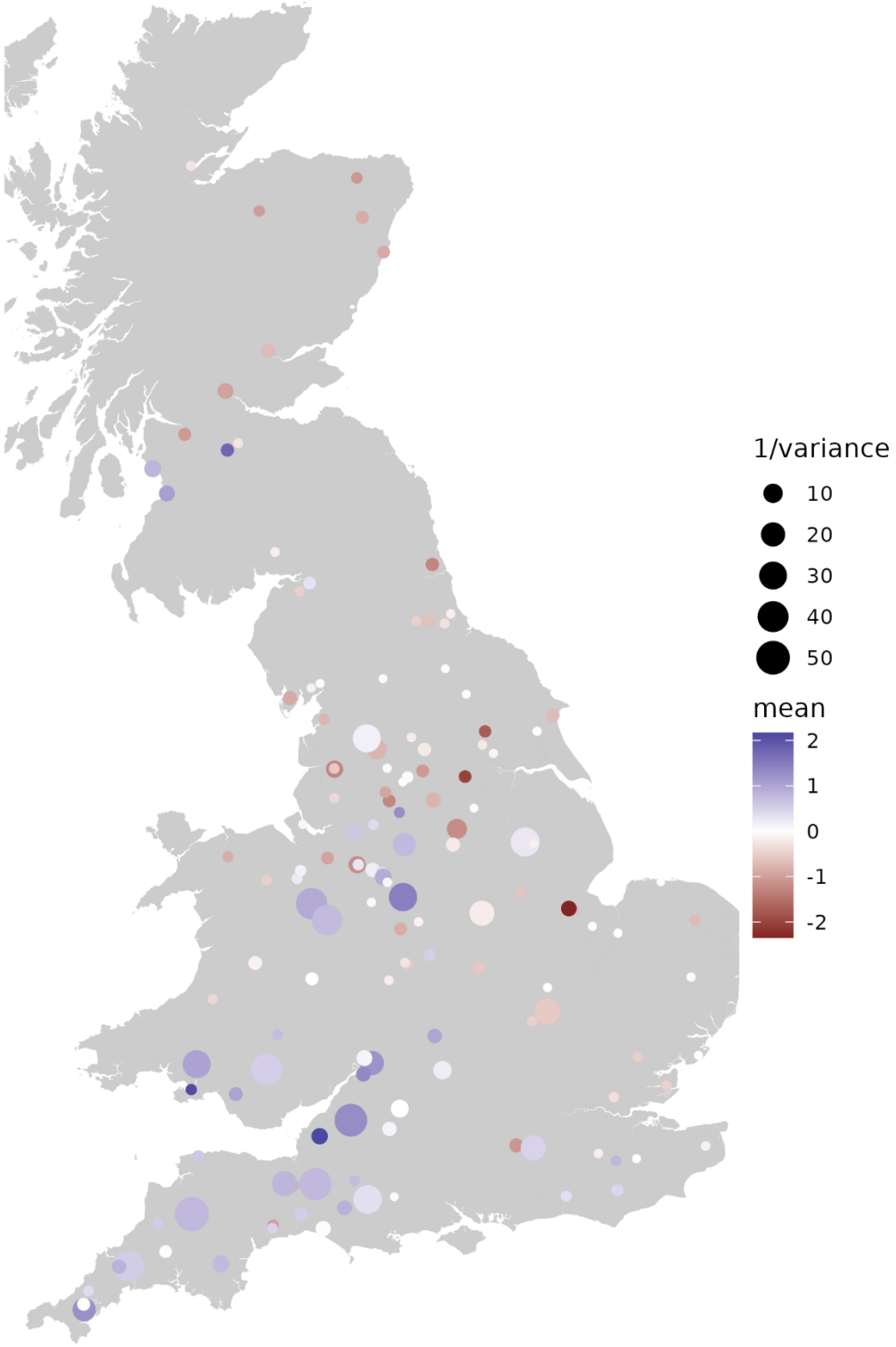
Caution should still be observed in interpreting the biological rationale behind these values. A consistently low detection rate in a slaughterhouse could be due to a failure to identify as many carcases with TB lesions as the model would expect. However, this could also be due to fewer than predicted TB-infected animals passing through that slaughterhouse due to multiple factors not accounted for by this model. The model outputs should be used as a guide for further investigation, not as a definitive ranking of performance. Interestingly, there appears to be some spatial clustering in the ORs of slaughterhouses within a region, suggesting interregional comparisons could be possible (Appendix 3).

Furthermore, in many systems, performance does oscillate from year-to-year. To account for this, performance should be measured across four-yearly periods. As a result of the above discussion, slaughterhouses may be recommended for further investigation on the basis of: (i) large negative OR, (ii) that OR being well estimated (by consideration of the posterior variance and/or 95% credible intervals, for which the 12 slaughterhouses previously referred to applies), (iii) comparison to slaughterhouses within the same region. The exact classification and selection of slaughterhouses for further investigation will depend on the relative importance assigned to each of the criteria above.

Figure 6.1 shows the posterior mean and variance from the model for each slaughterhouse in GB that processed cattle for the period 2019 to 22. The same data plotted against mean vs variance is shown in Figure 6.2. Figure 6.3 presents the posterior mean and 95% credible interval for 2019 to 2022 for the 12 slaughterhouses detecting significantly fewer cases than expected in 2019 to 22 (that is to say having a negative posterior mean and a 95% upper interval below zero).

There are certain differences between the data input into the model, and that presented in the main body of this report. In the report all suspect slaughterhouse case submissions to APHA are considered, whether subsequently positive by culture or negative. In the model slaughterhouse cases are identified either as disclosers of a TB incident or within a TB incident, regardless of whether the lesions were submitted to APHA for laboratory testing, hence *M. bovis*-negative submissions (which do not generate TB incidents) do not contribute. This is partly because the model determines detection of positive cases; and current policy dictates that (in general) suspect slaughterhouse cases included within a TB incident are not always submitted for culture. Therefore, their true status remains unconfirmed (assumed to be *M. bovis* positive). The parameters of the model result in output data which are not directly comparable to the remainder of the report. Also, the model does not account for the herd type of origin but uses measures that average risk over the lifetime of individual animals, based on time spent in high- or low-risk herds.

Figure 6.1: Map of GB with posterior mean and variance from the model for each slaughterhouse that processed cattle from 2019 to 2022.

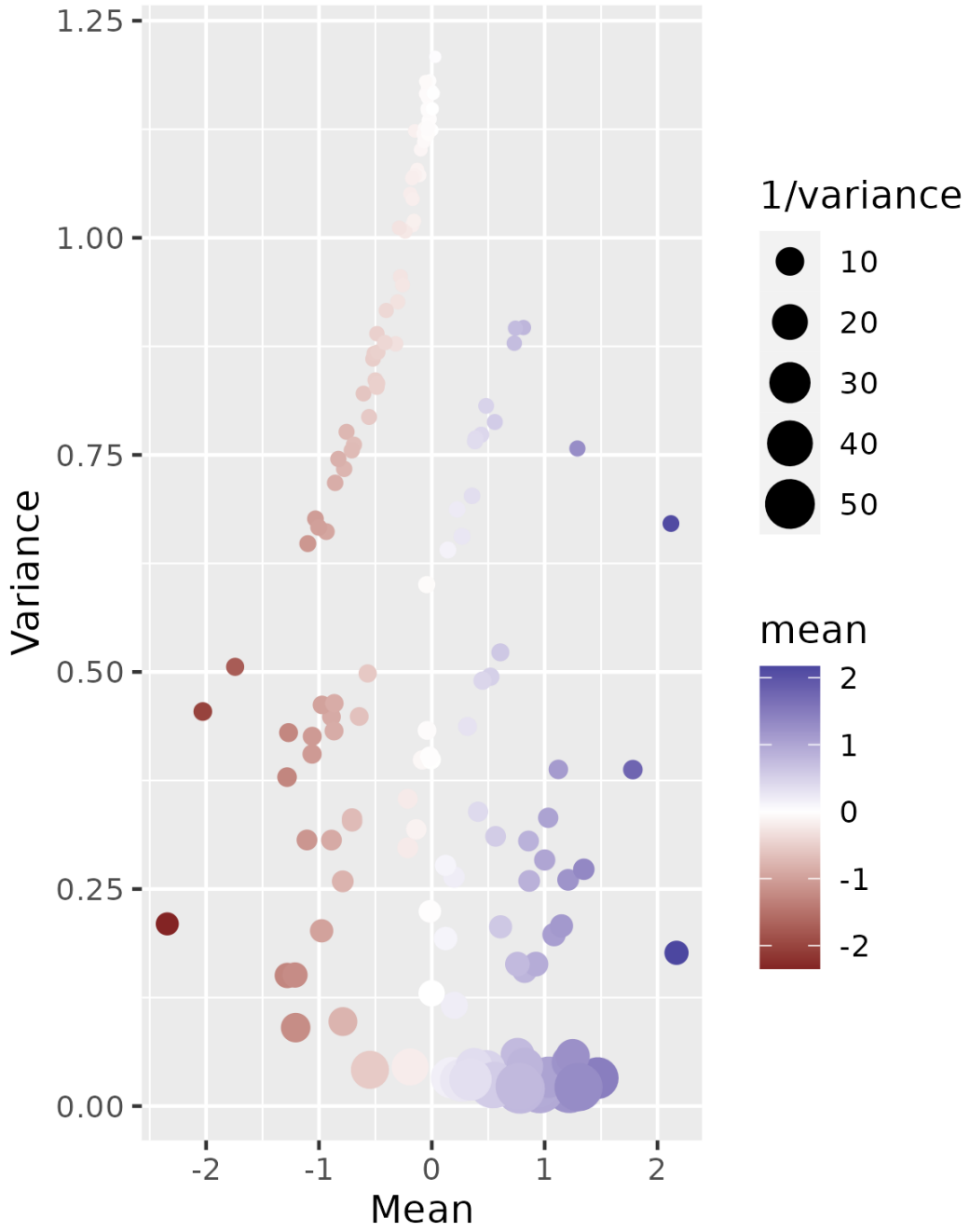


Note: (i) Smaller dot = higher variance = lower throughput and higher uncertainty about ability; (ii) Colour coded by posterior mean (red = detecting lesions at a lower rate than the

model would expect, blue = detecting lesions at a higher rate than the model would expect, white = detecting lesions at the rate the model would expect).

Figure 6.1 description: This shows a map of GB in grey with dots of various sizes and colours on it. Each dot represents a slaughterhouse – red colours represent the slaughterhouse is detecting less TB than expected by the model, and blue represents a slaughterhouse detecting more TB than expected by the model. The size is related to the variance of the calculation, with smaller dots indicating a higher variance, which comes from a lower throughput of carcasses in the slaughterhouse and therefore higher uncertainty and their ability to detect TB. In GB, the west of England is mostly covered in large blue dots, indicating they are detecting less TB than expected. Conversely, the east of England is covered in smaller red dots, indicated those slaughterhouses are detecting TB at a lower rate than expected and with more uncertainty about their true ability.

Figure 6.2: Posterior mean and variance from the model, plotted for every slaughterhouse in the 2019-2022 dataset.



Note: These are the same data as Figure 6.1 but plotted against mean versus variance.

Figure 6.2 description: This shows a dot plot representing the same data as in Figure 6.1 but as a dot plot instead of geographical location. There is a relatively even number of red and blue dots, and blue dots are on average larger than the red dots.

Figure 6.3: Posterior mean and 95% credible interval for the 12 cattle slaughterhouses identifying significantly less cases than expected during 2019 to 22 (model output).

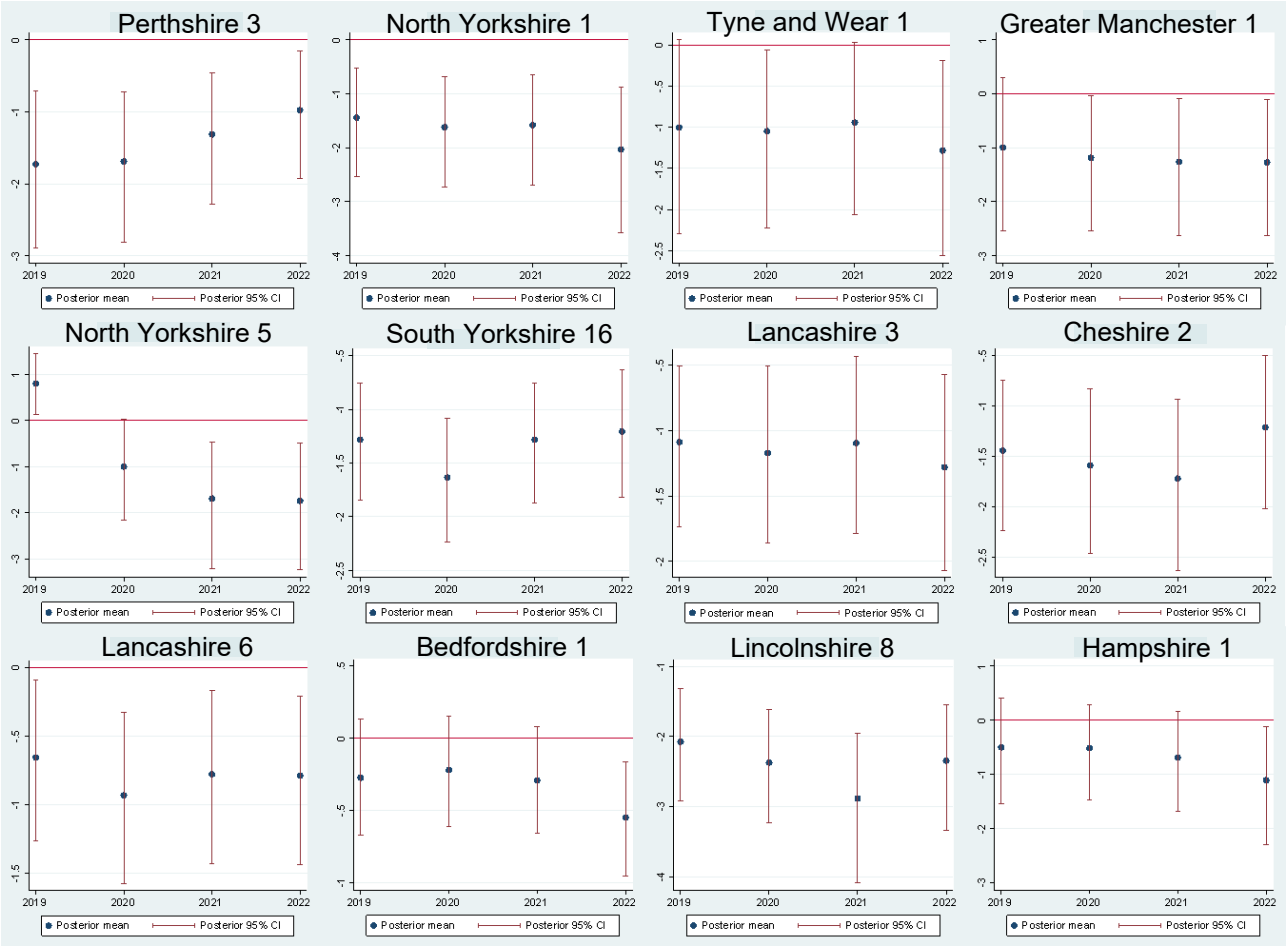


Figure 6.3 description: This shows the posterior mean and 95% credible interval for 12 slaughterhouses in GB that were detecting significantly less TB than expected by the model. These were located in Perthshire, North Yorkshire, Tyne and Wear, Greater Manchester, South Yorkshire, Lancashire, Cheshire, Bedfordshire, Lincolnshire and Hampshire.

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Appendices

Appendix 1: throughput and submission data for each slaughterhouse in GB

Individual slaughterhouses have been anonymised by replacing their official ID number with a slaughterhouse code in the table below.

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
Edge Area	CHESHIRE 1a	23,667	14,957	6,990	5,405	51,019	12,754.75	2	1	0.50	0.02	0.04
Edge Area	CHESHIRE 2	17,165	14,648	13,432	13,078	58,323	14,580.75	7	3	0.43	0.05	0.12
Edge Area	CHESHIRE 3	2,484	2,692	2,597	2,304	10,077	2,519.25	5	5	1.00	0.50	0.50
Edge Area	CHESHIRE 4	506	563	471	498	2038	509.5	2	-	-	-	0.98
Edge Area	DERBYSHIRE 1a	5,282	5,026	4,434	4,448	19,190	4,797.5	7	3	0.43	0.16	0.36
Edge Area	DERBYSHIRE 1b	9	13	11	8	41	10.25	-	-	-	-	-
Edge Area	DERBYSHIRE 2a	437	485	416	251	1,589	397.25	2	2	1.00	1.26	1.26
Edge Area	DERBYSHIRE 2b	22,103	14,307	11,747	12,521	60,678	15,169.5	46	28	0.61	0.46	0.76
Edge Area	DERBYSHIRE 3	13	-	-	-	13	3.25	-	-	-	-	-

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
Edge Area	DERBYSHIRE 4	141	-	-	-	141	35.25	-	-	-	-	-
Edge Area	EAST SUSSEX 1	1,370	1,809	1,649	1,580	6,408	1,602	2	1	0.50	0.16	0.31
Edge Area	HAMPSHIRE 1	8,084	9,089	7,507	8,300	32,980	8,245	3	2	0.67	0.06	0.09
Edge Area	LEICESTERSHIRE 1	49,366	50,461	49,857	49,990	19,9674	49,918.5	47	29	0.62	0.15	0.24
Edge Area	LEICESTERSHIRE 2	2299	2348	2311	2340	9298	2,324.5	1	1	1.00	0.11	0.11
Edge Area	LEICESTERSHIRE 4	54	53	32	21	160	40	-	-	-	-	-
Edge Area	LEICESTERSHIRE 5	1	-	-	-	1	0.25	-	-	-	-	-
Edge Area	NOTTINGHAMSHIRE 1		-	-	3	3	0.75	-	-	-	-	-
Edge Area	NOTTINGHAMSHIRE 2	1	-	-	-	1	0.25	-	-	-	-	-
Edge Area	OXFORDSHIRE 1	6,764	8,905	8,781	7,530	31,980	7,995	13	10	0.77	0.31	0.41
Edge Area	WARWICKSHIRE 1b	1,028	999	1,094	1,209	4,330	1,082.5	6	3	0.50	0.69	1.39
Edge Area	WARWICKSHIRE 2	657	895	820	731	3,103	775.75	1				0.32
HTBE	POWYS 1	200	243	250	232	925	231.25	1	1	1.00	1.08	1.08
HTBE	POWYS 2	7,319	-	-	-	7,319	1,829.75	3	2	0.67	0.27	0.41
HTBW	PEMBROKESHIRE 1	3,223	32,440	31,736	33,059	100458	25,114.5	59	28	0.47	0.28	0.59
HTBW	WEST GLAMORGAN 1	164	165	153	142	624	156	3	3	1.00	4.81	4.81
HRA	AVON 1	961	940	896	847	3644	911	21	7	0.33	1.92	5.76
HRA	AVON 2	50,046	44,218	42,313	46,937	18,3514	45,878.5	236	198	0.84	1.08	1.29

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
HRA	AVON 4	45	54	34		133	33.25	-	-	-	-	-
HRA	CORNWALL 1	4,655	-	-	-	4,655	1,163.75	4	-	-	-	0.86
HRA	CORNWALL 2	71,741	74,758	66,234	65,043	277,776	69,444	130	107	0.82	0.39	0.47
HRA	CORNWALL 3	10,064	8,983	7,865	7,209	34,121	8,530.25	37	33	0.89	0.97	1.08
HRA	CORNWALL 4	44	42	31	30	147	36.75	-	-	-	-	-
HRA	CORNWALL 5	328	362	-	-	690	172.5	1	-	-	-	1.45
HRA	CORNWALL 6	1,092	1,291	1,331	1,237	4,951	1,237.75	3	3	1.00	0.61	0.61
HRA	CORNWALL 7	1,171	3,544	3,465	4,809	12,989	3,247.25	5	1	0.20	0.08	0.38
HRA	CORNWALL 8	277	231	196	175	879	219.75	1	-	-	-	1.14
HRA	CORNWALL 9	94	-	-	-	94	23.5	-	-	-	-	-
HRA	DEVON 1		-	-	6	6	1.5	-	-	-	-	-
HRA	DEVON 2	683	545	568	603	2399	599.75	5	2	0.40	0.83	2.08
HRA	DEVON 3	1,095	1,351	1,694	1,356	5,496	1374	-	-	-	-	-
HRA	DEVON 4	75,280	88,845	85,933	86,304	33,6362	84,090.5	224	184	0.82	0.55	0.67
HRA	DEVON 5	194	250	140	173	757	189.25	1	1	1.00	1.32	1.32
HRA	DEVON 6	2,507	2,693	2,547	2,429	10,176	2,544	7	7	1.00	0.69	0.69
HRA	DORSET 1	40,020	38,363	35,449	35,793	14,9625	37,406.25	90	63	0.70	0.42	0.60
HRA	DORSET 2	7,555	2,082	-	-	9,637	2,409.25	5	3	0.60	0.31	0.52
HRA	DORSET 3	140	158	149	214	661	165.25	-	-	-	-	-
HRA	DORSET 4	1,025	1,423	1,754	1,725	5,927	1,481.75	5	2	0.40	0.34	0.84
HRA	DORSET 5	-	-	23	37	60	15	-	-	-	-	-
HRA	GLOUCESTERSHIRE 1	66,780	68,221	58,491	61,049	25,4541	63,635.25	415	253	0.61	0.99	1.63
HRA	GLOUCESTERSHIRE 3	7,957	7,053	7,938	6,899	29,847	7,461.75	36	27	0.75	0.90	1.21
HRA	GLOUCESTERSHIRE 4	717	944	829	786	3,276	819	8	3	0.38	0.92	2.44

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
HRA	GLOUCESTERSHIRE 5	5,247	5,495	5,964	6,031	22,737	5,684.25	3	3	1.00	0.13	0.13
HRA	GLOUCHESTERSHIRE 2	-	-	-	3	3	0.75	-	-	-	-	-
HRA	HEREFORD and WORCESTER 1	1,886	1,972	1,833	1,598	7,289	1,822.25	3	2	0.67	0.27	0.41
HRA	HEREFORD and WORCESTER 2	186	169	183	187	725	181.25	-	-	-	-	-
HRA	HEREFORD and WORCESTER 3	444	695	1321	1236	3696	924	7	6	0.86	1.62	1.89
HRA	SHROPSHIRE 1	102,133	93,699	93,412	103,264	39,2508	98127	403	299	0.74	0.76	1.03
HRA	SHROPSHIRE 2	62,703	70,687	73,493	78,890	28,5773	71,443.25	189	114	0.60	0.40	0.66
HRA	SHROPSHIRE 3	68,436	74,437	71,337	64,071	27,8281	69,570.25	133	102	0.77	0.37	0.48
HRA	SOMERSET 3	9,752	4,740	2,406	3,017	19,915	4,978.75	-	-	-	-	-
HRA	SOMERSET 5	150	-	-	-	150	37.5	-	-	-	-	-
HRA	SOMERSET 6	1,486	1,793	1,439	1,323	6,041	1,510.25	3	1	0.33	0.17	0.50
HRA	SOMERSET 7	146	157	97	79	479	119.75	1	1	1.00	2.09	2.09
HRA	SOMERSET 8	11,641	13,468	12,517	12,649	50,275	12,568.75	73	32	0.44	0.64	1.45
HRA	SOMERSET 9	69,426	70,467	71,188	76,964	28,8045	72,011.25	178	97	0.54	0.34	0.62
HRA	STAFFORDSHIRE 11	101	119	88	80	388	97	-	-	-	-	-
HRA	STAFFORDSHIRE 12	21,214	18,005	14,745	19,158	73,122	18,280.5	157	66	0.42	0.90	2.15
HRA	STAFFORDSHIRE 13	4,886	3,900	2,819	2,109	13,714	3,428.5	15	8	0.53	0.58	1.09
HRA	STAFFORDSHIRE 15	347	-	-	-	347	86.75	-	-	-	-	-
HRA	STAFFORDSHIRE 16	547	632	726	705	2610	652.5	6	1	0.17	0.38	2.30
HRA	STAFFORDSHIRE 17	543	4,803	4,461	7,801	17,608	4,402	7	3	0.43	0.17	0.40
HRA	STAFFORDSHIRE 18	3,372	2,321	1,406	789	7,888	1,972	-	-	-	-	-
HRA	STAFFORDSHIRE 20	18	36	31	34	119	29.75	-	-	-	-	-
HRA	STAFFORDSHIRE 4	178	140	136	148	602	150.5	-	-	-	-	-

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
HRA	STAFFORDSHIRE 5	4,779	4,711	3,891	3,650	17,031	4,257.75	2	1	0.50	0.06	0.12
HRA	STAFFORDSHIRE 6	5,146	5,072	4,200	3,060	17,478	4,369.5	7	3	0.43	0.17	0.40
HRA	STAFFORDSHIRE 7	19	2	-	1	22	5.5	-	-	-	-	-
HRA	STAFFORDSHIRE 8	208	242	248	263	961	240.25	2	1	0.50	1.04	2.08
HRA	WEST MIDLANDS 1	823	1,261	1,631	482	4,197	1,049.25	-	-	-	-	-
HRA	WEST MIDLANDS 2	898	412	510	1410	3230	807.5	-	-	-	-	-
HRA	WILTSHIRE 1	29,906	22,003	25,221	40,508	11,7638	29,409.5	14	8	0.57	0.07	0.12
HRA	WILTSHIRE 2	2,925	2,791	2,894	2,754	11,364	2,841	7	4	0.57	0.35	0.62
ITBM	CARMARTHENSHIRE 1	-	-	-	8,379	8,379	2,094.75	7	6	0.86	0.72	0.84
ITBM	DYFED 1	470	550	542	463	2,025	506.25	1				0.49
ITBM	DYFED 3	40,254	27,036	23,332	18,575	109,197	27,299.25	102	64	0.63	0.59	0.93
ITBM	GLAMORGAN 1	-	-	-	2	2	0.5	-	-	-	-	-
ITBM	MID GLAMORGAN 1	1,494	1,246	1,076	984	4,800	1,200	2	-	-	-	0.42
ITBM	MID GLAMORGAN 2	9,4131	100,366	86,548	88,131	369,176	92,294	130	106	0.82	0.29	0.35
ITBM	MID GLAMORGAN 3	92	38	25	16	171	42.75	-	-	-	-	-
ITBM	NORTH POWYS 1	46	49	18		113	28.25	-	-	-	-	-
ITBN	CLWYD 1	839	770	812	650	3,071	767.75	5	1	0.20	0.33	1.63
ITBN	CLWYD 2	1,315	1,095	1,029	902	4,341	1,085.25	1	1	1.00	0.23	0.23
ITBN	CLWYD 4	1	-	-	-	1	0.25	-	-	-	-	-
ITBN	CLWYD 5	1,217	1,325	1,172	920	4,634	1,158.5	1	-	-	-	0.22
ITBN	GWYNEDD 3	2,223	2,497	2,331	2,030	9,081	2,270.25	3	-	-	-	0.33
LTB	ANGLESEY 1	34	8	-	-	42	10.5		-	-	-	-
LTB	GWYNEDD 5	41	133	137	158	469	117.25	1	-	-	-	2.13
LRA	BEDFORDSHIRE 1	69,561	69,201	66,784	69,911	275,457	68,864.25	43	25	0.58	0.09	0.16
LRA	BEDFORDSHIRE 2	658	879	827	797	3,161	790.25	-	-	-	-	-

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
LRA	CAMBRIDGESHIRE 1	263	117	-	-	380	95	-	-	-	-	-
LRA	CAMBRIDGESHIRE 2	80	77	56	54	267	66.75	-	-	-	-	-
LRA	CAMBRIDGESHIRE 3	117	188	150	74	529	132.25	-	-	-	-	-
LRA	CUMBRIA 1	5,881	3,510	3,379	3,358	16,128	4,032	1	-	-	-	0.06
LRA	CUMBRIA 2	6,473	5,374	7,609	8,161	27,617	6,904.25	15	2	0.13	0.07	0.54
LRA	CUMBRIA 3	969	773	710	810	3,262	815.5	1	-	-	-	0.31
LRA	CUMBRIA 4	255	313	240	334	1,142	285.5	-	-	-	-	-
LRA	CUMBRIA 5	-	-	5	-	5	1.25	-	-	-	-	-
LRA	CUMBRIA 6	23,498	24,359	23,747	25,464	97,068	24,267	13	2	0.15	0.02	0.13
LRA	DURHAM 1	220	48	-	-	268	67	-	-	-	-	-
LRA	DURHAM 2	5,934	5,594	5,454	5,779	22,761	5,690.25	2				0.09
LRA	DURHAM 3	15,906	15,778	15,493	15,362	62,539	15,634.75	3	1	0.33	0.02	0.05
LRA	DURHAM 4	106	106	113	93	418	104.5	-	-	-	-	-
LRA	DURHAM 5	2,448	2,159	1,921	1,892	8,420	2,105	-	-	-	-	-
LRA	ESSEX 1	3,795	4,409	4,010	3,373	15,587	3,896.75	-	-	-	-	-
LRA	ESSEX 2	1,824	2,379	2,005	1,957	8,165	2,041.25	2	-	-	-	0.24
LRA	ESSEX 3	272	325	300	260	1,157	289.25	-	-	-	-	-
LRA	GREATER LONDON 1	820	1,077	862	902	3,661	915.25	1	-	-	-	0.27
LRA	GREATER MANCHESTER 1	12,204	14,868	17,435	18,617	63,124	15,781	2	1	0.50	0.02	0.03
LRA	GREATER MANCHESTER 2	2,430	2,490	2,240	1,953	9,113	2,278.25	3	-	-	-	0.33
LRA	GREATER MANCHESTER 3	29	26	27	23	105	26.25	-	-	-	-	-
LRA	GREATER MANCHESTER 4	-	-	-	1	1	0.25	-	-	-	-	-

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
LRA	GREATER MANCHESTER 5	13,845	13,994	5,934	-	33,773	8,443.25	-	-	-	-	-
LRA	GREATER MANCHESTER 6	268	347	287	275	1177	294.25	2	-	-	-	1.70
LRA	HUMBERSIDE 1	22,097	25,041	24,355	25,922	97,415	24,353.75	5	2	0.40	0.02	0.05
LRA	HUMBERSIDE 2	448	523	482	562	2015	503.75	-	-	-	-	-
LRA	HUMBERSIDE 4	80	79	79	98	336	84	-	-	-	-	-
LRA	HUMBERSIDE 5	12	-	-	-	12	3	-	-	-	-	-
LRA	KENT 1	580	-	-	-	580	145	-	-	-	-	-
LRA	KENT 2	1	-	-	-	1	0.25	-	-	-	-	-
LRA	KENT 3	99	146	146	109	500	125	-	-	-	-	-
LRA	KENT 4	254	159	82	101	596	149	-	-	-	-	-
LRA	KENT 5	338	469	458	411	1676	419	-	-	-	-	-
LRA	KENT 6	49	55	63	59	226	56.5	-	-	-	-	-
LRA	KENT 7	-	-	1413	10	1423	355.75	1	-	-	-	0.70
LRA	KENT 8	-	4	-	-	4	1	-	-	-	-	-
LRA	LANCASHIRE 2	14,534	14,018	5,089	5,818	39,459	9,864.75	4	2	0.50	0.05	0.10
LRA	LANCASHIRE 3	60,194	59,228	49,365	39,388	20,8175	52,043.75	7	6	0.86	0.03	0.03
LRA	LANCASHIRE 4	3	-	-	-	3	0.75	-	-	-	-	-
LRA	LANCASHIRE 5	3,324	3,053	2,612	2,301	11,290	2,822.5	-	-	-	-	-
LRA	LANCASHIRE 6	71,708	73,641	79,617	86,921	311,887	77,971.75	14	9	0.64	0.03	0.04
LRA	LANCASHIRE 7	104,784	96,750	85,021	87,174	373,729	93,432.25	63	42	0.67	0.11	0.17
LRA	LANCASHIRE 8	3,790	3,317	2,478	845	10,430	2,607.5	-	-	-	-	-
LRA	LINCOLNSHIRE 2	53	45	69	52	219	54.75	-	-	-	-	-
LRA	LINCOLNSHIRE 3	57,492	70,817	69,227	70,124	267,660	66915	83	69	0.83	0.26	0.31
LRA	LINCOLNSHIRE 4	1,359	1,547	1,939	1,490	6,335	1,583.75	-	-	-	-	-
LRA	LINCOLNSHIRE 5	3,505	3,807	3,978	4,820	16,110	4,027.5	1	-	-	-	0.06

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
LRA	LINCOLNSHIRE 6	99	68	55	32	254	63.5	-	-	-	-	-
LRA	LINCOLNSHIRE 7	772	855	795	733	3155	788.75	-	-	-	-	-
LRA	LINCOLNSHIRE 8	92,095	91,298	82,708	73,213	339,314	84,828.5	3	3	1.00	0.01	0.01
LRA	MERSEYSIDE 2	90	122	82	102	396	99	-	-	-	-	-
LRA	NORFOLK 1	9,598	11,251	10,987	10,054	41,890	10,472.5	-	-	-	-	-
LRA	NORFOLK 3	318	2	-	-	320	80	-	-	-	-	-
LRA	NORFOLK 4	247	233	219	220	919	229.75	-	-	-	-	-
LRA	NORFOLK 5	122	152	153	186	613	153.25	-	-	-	-	-
LRA	NORFOLK 7	20	-	-	-	20	5	-	-	-	-	-
LRA	NORTH YORKSHIRE 1	27,685	27,197	26,794	23,033	104,709	26,177.25	-	-	-	-	-
LRA	NORTH YORKSHIRE 12	377	368	294	270	1,309	327.25	-	-	-	-	-
LRA	NORTH YORKSHIRE 13	278	310	297	248	1,133	283.25	-	-	-	-	-
LRA	NORTH YORKSHIRE 3	102	3	-	-	105	26.25	-	-	-	-	-
LRA	NORTH YORKSHIRE 5	29929	33102	35,824	36,020	134,875	33,718.75	3	-	-	-	0.02
LRA	NORTH YORKSHIRE 6	551	578	154	-	1,283	320.75	1	-	-	-	0.78
LRA	NORTH YORKSHIRE 7	1,362	1,147	1,011	121	3,641	910.25	-	-	-	-	-
LRA	SOUTH YORKSHIRE 14	14,482	13,143	13,447	18,347	59,419	14,854.75	6	2	0.33	0.03	0.10
LRA	SOUTH YORKSHIRE 15	186	189	212	220	807	201.75	-	-	-	-	-
LRA	SOUTH YORKSHIRE 16	61,545	57,009	52,489	57,202	228,245	57,061.25	15	9	0.60	0.04	0.07

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
LRA	SOUTH YORKSHIRE 17	134	8	-	-	142	35.5	-	-	-	-	-
LRA	SUFFOLK 2	1,205	-	-	-	1,205	301.25	-	-	-	-	-
LRA	SURREY 1	36338	35,516	34,210	34,785	140,849	35,212.25	71	23	0.32	0.16	0.50
LRA	TYNE and WEAR 1	31,266	33,992	30,002	23,190	11,8450	29,612.5	6	1	0.17	0.01	0.05
LRA	WEST SUSSEX 1	923	1019	976	919	3,837	959.25	1	-	-	-	0.26
LRA	WEST YORKSHIRE 1	18,672	18,431	18,133	25,732	80,968	20,242	4	1	0.25	0.01	0.05
LRA	WEST YORKSHIRE 3	536	325	2	-	863	215.75	-	-	-	-	-
LRA	WEST YORKSHIRE 4	13,281	13,396	20,899	21,974	69,550	17,387.5	3	2	0.67	0.03	0.04
LRA	WEST YORKSHIRE 5	429	513	346	287	1575	393.75	1	-	-	-	0.63
LRA	WEST YORKSHIRE 6	4,231	4,858	4,672	5,313	19,074	4,768.5	7	1	0.14	0.05	0.37
LRA	WEST YORKSHIRE 7	2,466	558	-	-	3,024	756	-	-	-	-	-
Scotland	ABERDEENSHIRE 1	33,140	35,308	38,991	38,497	14,5936	36,484	-	-	-	-	-
Scotland	ABERDEENSHIRE 3	37,853	40,390	38,799	37,982	15,5024	38,756	2	1	0.50	0.01	0.01
Scotland	ARGYLL 1	135	177	152	108	572	143	-	-	-	-	-
Scotland	ARGYLL 2	10	13	10	11	44	11	-	-	-	-	-
Scotland	AYRSHIRE 1	42,412	35,848	31,753	31,113	14,1126	35,281.5	5	3	0.60	0.02	0.04
Scotland	AYRSHIRE 2	59,219	61,942	59,305	60,193	24,0659	60,164.75	26	9	0.35	0.04	0.11
Scotland	BERWICKSHIRE 1	8	-	-	-	8	2	-	-	-	-	-
Scotland	DUMFRIESHIRE 1	2,197	2,195	2,302	2,524	9,218	2,304.5	-	-	-	-	-
Scotland	INVERNESS-SHIRE 1	1	4	6	1	12	3	-	-	-	-	-
Scotland	INVERNESS-SHIRE 2	1	-	-	-	1	0.25	-	-	-	-	-
Scotland	KINCARDINE 1	69,881	66,804	73,624	79,603	28,9912	72,478	1	1	1.00	0.00	0.00
Scotland	LANARKSHIRE 1	3,694	3,986	3,677	3,144	14,501	3,625.25	-	-	-	-	-
Scotland	LANARKSHIRE 2	7,957	8,936	8,093	7,433	32,419	8,104.75	6	3	0.50	0.09	0.19
Scotland	LANARKSHIRE 3	1	-	-	-	1	0.25	-	-	-	-	-

Region	SLH code	Through put 2019	Through put 2020	Through put 2021	Through put 2022	Through put 19 to 22	Through put per year	Subs 19 to 22	Positive subs 2019 to 22	Proportion confirmed	Positive subs rate /1000	Subs rate /1000
Scotland	MORAY 2	11,467	9,020	8,006	8,315	36,808	9,202	-	-	-	-	-
Scotland	PERTHSHIRE 1	68,184	71,852	71,114	68,553	27,9703	69,925.75	2	2	1.00	0.01	0.01
Scotland	PERTHSHIRE 2	6	13	2	-	21	5.25	-	-	-	-	-
Scotland	PERTHSHIRE 3	92,653	94,947	92,599	91,300	37,1499	92,874.75	5	3	0.60	0.01	0.01
Scotland	RENFREW 1	17,317	16,687	16,367	14,903	65,274	16,318.5	-	-	-	-	-
Scotland	ROSS and CROMARTY 1	164	171	164	146	645	161.25	-	-	-	-	-
Scotland	ROSS and CROMARTY 2	5,211	5,914	5,789	5,677	22,591	5,647.75	4	-	-	-	0.18
Scotland	SHETLAND 1	309	339	330	360	1338	334.5	-	-	-	-	-

Appendix 2: TB test types

Code	Type Code	Description	When and Why	Group	Surveillance Stream
PBT	WH	Yorkshire only, from early 80s. Appear to be RHTs			
UNKNOWN	IA	Test used for Breakdowns of unknown origin. Not necessarily IA but likely to be missing SLH Cases.		Other	Area and Herd Risk
VE-12M	WH	12 months post-6M test	Carried out 12 months after 6M if that test was clear. Or six-12 months after the last SI of a breakdown with unconfirmed disease in four yearly testing areas. Scotland: Carried out between six and 12 months following lifting of restrictions in an OTF-W herd	Herd Risk	Area and Herd Risk
VE-6M	WH	6 Month test	Carried out six months from the date of the clear short interval test which led to the lifting of restrictions. Not required in OTF-S herds in four yr testing areas.	Herd Risk	Area and Herd Risk
VE-90D	WH	90 day test for AFU herd		Control	Area and Herd Risk
VE-AI	IA	AI animal test	Carried out on bulls, teasers and embryo donors prior to admission to an Artificial Insemination Centre.	Movement Risk 1	Proactive
VE-ANTIBODY	IA	Ancillary IDEXX ELISA is an antibody detection assay/blood test			
VE-ANTIBODYPOSTM	IA	IDEXX test for animals showing a positive bovine SIT response in cattle not homebred in herds in the ITBAN Wales area, plus any others once a homebred is IDEXX positive at the test			
VE-ANTIBODYSEVIR	IA	IDEXX test on animals IR at severe interpretation			
VE-ANTIBODYSEVIREXIT	IA	IDEXX test on animals IR at severe interpretation in an otherwise clear test that would lift restrictions on the herd; Wales only.			
VE-ASG	WH	Testing of restricted isolated groups of cattle within a breakdown or non-breakdown herd at RVL discretion	To be used for the testing of restricted isolated groups of cattle within a breakdown or non-breakdown herd at RVL, SVL or VLW discretion. It should only be used to identify these groups from other ongoing testing on the premises, such as	Other	Area and Herd Risk

Code	Type Code	Description	When and Why	Group	Surveillance Stream
			SIs (breakdown herds) or other (non-breakdown herds)		
VE-BHH	IA	For TB Bull Hirers test (carried out on hire bulls requiring annual testing).	Carried out on hire bulls requiring annual testing.	Movement Risk 1	Proactive
VE-CLINICAL	IA	Ancillary blood test			
VE-CON	WH	Contiguous test	Carried out on herds contiguous to OTF-W herds outside their regular test frequency. Scotland :Risk based - limited to an epidemiological link	Area Risk	Area and Herd Risk
VE-CON12	WH	12 months post CON6-Contiguous test	Carried out 12 months after a CON Wales :or CON6 (if the latter has been carried out)	Area Risk	Area and Herd Risk
VE-CON6	WH	6 months post Contiguous test	Carried out at the VLW's discretion six months after a CON	Area Risk	Area and Herd Risk
VE-CT	WH	Check test		Control	Area and Herd Risk
VE-CT(EM)	WH	Carried out outside the normal testing frequency for the herd, to determine its disease status when there is a suspicion of infection.	Carried out outside the normal testing frequency for the herd, to determine its disease status when there is a suspicion of infection. This will come after, for instance: Back tracing of OTF-W reactors found in another herd	Control	Area and Herd Risk
VE-CT(I-I)	WH	As VE-CT(EM) except it will be for voluntary slaughter of an IR identified in an IR-only herd, id of a clinical case of TB, Disclosure of lesions suggestive of TB at SLH, knackers yard etc. ID of reactors at routine herd test that included adults only etc	Carried out outside the normal testing frequency for the herd, to determine its disease status when there is a suspicion of infection. This will come after, for instance: Voluntary slaughter of an IR identified in an IR-only herd, Identification of a clinical case of TB, Disclosure of lesions suggestive of TB at a slaughterhouse, knackers yard, hunt kennel, VLA regional lab, etc. Identification of reactors at a routine herd test that included adults only, For any other reason at the RVL's, SVL's or VLW's discretion	Control	Area and Herd Risk
VE-CT(RTA)	WH	Check test following an RTA incident - only up to 2007		Area Risk	Area and Herd Risk
VE-CT-HS1	WH	1st hotspot check test	Test carried out if a holding is within a 3km radius of an incident, which triggers a potential hotspot area.	Area Risk	Area and Herd Risk
VE-CT-HS2	WH	2nd hotspot check test	Test carried out 12 months after the CT-HS1 test.	Area Risk	Area and Herd Risk
VE-CT-LRA-SA	WH	Voluntary herd tests carried out in four yearly testing herds meeting certain criteria at the owner's request		Movement Risk 1	Proactive

Code	Type Code	Description	When and Why	Group	Surveillance Stream
VE-CT-NH1	WH	1st new herd check test	Test carried out when a new or reformed herd has been identified, (Scotland that includes any cattle born or kept in a high incidence area (one or two yearly testing parishes). Following completion, herds will revert to the four yearly parish testing interval) within 12 months of arrival of the first animal. Reformed herds following depopulation for TB reasons will require a second check test (CT-NH2) after 12 months, all other herds will revert to routine testing in line with the area testing interval for that holding.	New Herds	Routine
VE-CT-NH2	WH	2nd new herd check test	Test carried out 12 months after a VE-CT-NH1 test on reformed herds following depopulation for TB reasons.	New Herds	Routine
VE-CT-NH3	WH	3rd new herd check test		New Herds	Routine
VE-CT-RH1	WH	1st reformed herd check test - only up to 2011		New Herds	Area and Herd Risk
VE-CT-RH2	WH	2nd reformed herd check test - only up to 2011		New Herds	Area and Herd Risk
VE-CT-RH3	WH	3rd reformed herd check test - only up to 2011		New Herds	Area and Herd Risk
VE-CTW1	WH	For Welsh herds not due a test 1/10/08-31/12/09	Whole Herd Test equivalent allocated to herds in Wales that would not normally be subject to annual testing had a PTI review taken place. Previously used as part of the TB Health Check Wales which ended in December 2009. No longer available as of 01/04/12	Routine	
VE-CTW2	WH	WHT for Welsh herds prev. due RHT 1/10/08-31/12/09	Whole herd test equivalent allocated to herds in Wales than would normally be subject to a Routine Herd Test (RHT) had a PTI review taken place. Previously used as part of the TB Health Check Wales which ended in December 2009	Routine	
VE-DTG	IA	Delayed Testing Group; testing for the detached animals, in connection with a VE-PSI group.	To be used for a group of low risk cattle away at grass keep, following a VRA and authorisation. It must be used in conjunction with Partial Short Interval Test (PSI).	Control	Area and Herd Risk
VE-EX	IA	Export Test	Test on cattle exported from Great Britain	Movement Risk 1	Proactive
VE-EXEMPT(S)	WH	Herds scheduled for a routine test but exempt under Scottish policy as low risk			Routine

Code	Type Code	Description	When and Why	Group	Surveillance Stream
VE-IA12	WH	Routine 12M test within the Welsh IAA area only	Tests carried out on all herds within the IAA every 6 months. Test codes are alternated such as IA6 is used at six months, IA12 at twelve months, IA6 at 18 months.	Routine	Routine
VE-IA6	WH	Routine 6M test within the Welsh IAA area only	Tests carried out on all herds within the IAA every 6 months. Test codes are alternated such as IA6 is used at six months, IA12 at twelve months, IA6 at 18 months.	Routine	Routine
VE-IASI	WH	2nd SI test for OTF-S herds within the Welsh IAA area only.	Test code used for the second SI test on herds within the IAA that remain OTF-S. From 1 May 2013 this test code will no longer be required.	Control	Area and Herd Risk
VE-IFN	WH	Gamma-Interferon trial blood test		Control	Area and Herd Risk
VE-IFN_2x_IR	IA	IFN TB Test 2xIR - Investigation andand Intervention		IR	Area and Herd Risk
VE-IFN_ANOM	IA	IFN Anomalous Reactions Procedure	In-vitro blood test for bovine TB, used to supplement the intradermal tuberculin test in a range of situations. The test is carried out on RVL, SVL or VLW instruction on eligible TB incidents where certain criteria are met.	Control	Area and Herd Risk
VE-IFN_BOV_OTH	IA	Ad hoc use of the gamma test; not one of the established scenarios			
VE-IFN_CHRONIC	IA	IFN test on breakdown herds with persistent infection			
VE-IFN_FLEX	WH	IFN test of unknown purpose at present (new test)			
VE-IFN_LOW_IN	WH	IFN OTF-W TB Breakdown in Lower TB Incidence Area - Investigation and Interpretation	In-vitro blood test for bovine TB, used to supplement the intradermal tuberculin test in a range of situations. The test is carried out on RVL, SVL or VLW instruction on eligible TB incidents where certain criteria are met	Control	Area and Herd Risk
VE-IFN_NBCP	WH	Gamma testing in breakdown herds in badger culling areas	Carried out 60 days after removal (or effective isolation) of the last reactor, or following confirmation of disease whilst the herd is under TB movement restriction. In OTF-S (2) or OTF-W breakdowns, if there are no reactors or IRs at the first SI test carried out, the subsequent SI test should be carried out a minimum of 60 days from the previous TT1 date of the previous test.	Movement Risk 1	
VE-IFN_NSR	WH	IFN Non-Specific Reactor Herd - Investigation and Intervention	In-vitro blood test for bovine TB, used to supplement the intradermal tuberculin test in a	Control	Area and Herd Risk

Code	Type Code	Description	When and Why	Group	Surveillance Stream
			range of situations. The test is carried out on RVL, SVL or VLW instruction on eligible TB incidents where certain criteria are met		
VE-IFN_OTH_SP	WH	IFN test performed due to disease in other species		Control	Area and Herd Risk
VE-IFN_PBCP	WH	IFN testing at persistent OTF-W breakdowns in badger culling areas			
VE-IFN_PERSI	WH	IFN OTF-W Herd with Persistent Infection - Investigation and Intervention	In-vitro blood test for bovine TB, used to supplement the intradermal tuberculin test in a range of situations. The test is carried out on RVL, SVL or VLW instruction on eligible TB incidents where certain criteria are met	Control	Area and Herd Risk
VE-IFN_POSTM	IA	IFN test for animals showing a positive bovine SIT response in cattle not homebred in herds in the ITBAN Wales area, plus any others once a homebred is IFN positive at the test			
VE-IFN_PRI	WH	Private IFN Test	In-vitro blood test for bovine TB, used to supplement the intradermal tuberculin test in a range of situations. The test is carried out on RVL, SVL or VLW instruction on eligible TB incidents where certain criteria	Control	Area and Herd Risk
VE-IFN_RECUR	WH	In Wales this test will be required in only those recurrent TB breakdowns which are disclosed at or before the 6M test. In England (provisional code) in HRA and 6 monthly tested parts of Edge OTFW breakdowns within 18 months of previous OTFW breakdown.			
VE-IFN_SEVEREIR	IA	IFN test on animals IR at severe interpretation; Wales only.			
VE-IFN_SEVEREIREXIT	IA	IFN test on animals IR at severe interpretation in an otherwise clear test that would lift restrictions on the herd; Wales only.			
VE-IFN_SLHERD	WH	IFN Whole or Partial Slaughter of Reactor Herds - Investigation and Intervention	In-vitro blood test for bovine TB, used to supplement the intradermal tuberculin test in a range of situations. The test is carried out on RVL, SVL or VLW instruction on eligible TB incidents where certain criteria are met	Control	Area and Herd Risk
VE-IR	IA	Inconclusive Reactor Retest	Carried out on inconclusive reactors identified at an earlier test. To be conducted at least 60 days	IR	Area and Herd Risk

Code	Type Code	Description	When and Why	Group	Surveillance Stream
			later. Currently, one retest of the same IR animal is permitted.		
VE-MOAR		Letter sent as WHT overdue			
VE-MOAR	IA	Movement of Animal Recording			
VE-NES		No Eligible Stock			
VE-OT	WH	Other test		Routine	Routine
VE-PII	IA	Post Irish Import	Test on cattle imported from Northern Ireland and the Republic of Ireland 60 days after arrival. Scotland :(Cattle from Northern Ireland should be tested as POSTMTS 60-120 days after arrival to Scotland)	Movement Risk 1	Proactive
VE-PIO	IA	Post Other Import	Carried out post-import as prescribed by the conditions of the import license.	Movement Risk 1	Proactive
VE-PIU	IA	Presumably a post-import test-old, one-off error?			
VE-POSTLRANC	IA	To be used for post-movement testing in the LRA by OVs as instructed by APHA when a breach has been disclosed.		Movement Risk 2	Proactive
VE-POSTLRAOV	IA	To be used for post-movement testing in the lRA by OVs. Not to be used when a required pre-movement test has not taken place – POSTMT should be used then.		Movement Risk 2	Proactive
VE-POSTMOVNC	IA	Post Movement TB Test LRA (Eng) and LTBA (Wales) - Non-Compliance			
VE-POSTMOVOV	IA	Post Movement TB Test LRA (Eng) and LTBA (Wales)			
VE-POSTMT	IA	Post movement testing	This code is to be used for a post-movement test to be carried out in circumstances where cattle have been moved into a holding without a required pre-movement test.	Movement Risk 2	Proactive
VE-POSTMTS	IA	Post movement testing Scotland	This is a post-movement test carried out 60-120 days after arrival to Scotland from England or Wales (exceptions apply).	Movement Risk 2	Proactive
VE-POSTMTS(NI)	IA	Post-movement tests carried out 60-120 days after arrival in Scotland from Northern Ireland	Post-movement tests carried out 60-120 days after arrival in Scotland from Northern Ireland	Movement Risk 2	Proactive
VE-PR	IA	Private test		Movement Risk 1	Proactive

Code	Type Code	Description	When and Why	Group	Surveillance Stream
VE-PRI	IA	Private test	A test commissioned and paid for by the owner and carried out by an OV with the RVLs, SVLs or VLWs agreement.	Movement Risk 2	Proactive
VE-PRMT	IA	Pre-movement testing	This code is to be used for a pre-movement test to be carried out 60 days or less prior to movement of an animal(s) from an annually tested herd.	Movement Risk 2	Proactive
VE-PRMTS	IA	Pre-movement testing Scotland	This test should be carried out on cattle that have arrived into Scotland that should have had a pre-movement test before departure.	Movement Risk 2	Proactive
VE-PSI	WH	Partial Short Interval test; some animals are detached and cannot be tested. New 2012	Carried out 60 days after removal (or effective isolation) of the last reactor, or following confirmation of disease whilst the herd is under TB movement restriction. In OTF-S (2) or OTF-W breakdowns, if there are no reactors or IRs at the first SI test carried out, the subsequent SI test should be carried out a minimum of 60 days from the TT1 date of the previous test. To be used for the main herd when delayed testing has been authorised for a group of low risk cattle away at grass keep. It must be used in conjunction with Delayed Test Group (DTG)	Control	Area and Herd Risk
VE_QSLH	IA	TB Slaughterhouse suspicion, prior to export			
VE-RAD	WH	Radial Herd Test. Stock eligibility will be as with CON tests - all bovines except calves under 6 weeks old	Carried out on herds within a 3km radius of a herd with its Officially TB Free status withdrawn in the Low Incidence Area or in the Cheshire and Derbyshire Edge Area	Area Risk	Area and Herd Risk
VE-RAD12	WH	12 months post Radial Herd Test. Stock eligibility will be as with CON tests - all bovines except calves under 6 weeks old	Carried out 12 months after a RAD6 in the Low Incidence Area. Not required in Cheshire and Derbyshire Edge Area as revert to routine annual testing	Area Risk	Area and Herd Risk
VE-RAD6	WH	6 months post Radial Herd Test. Stock eligibility will be as with CON tests - all bovines except calves under 6 weeks old	Carried out six months after a RAD/Clear Herd Test in the Low Incidence Area or in the Cheshire and Derbyshire Edge Area	Area Risk	Area and Herd Risk
VE-REST		No testing so restrictions have been imposed.			
VE-RHT	WH	Routine Whole herd test		Routine	Routine
VE-RHT12 (S)	WH	For herds that are on 12 monthly testing intervals. Eligibility is as per 48-month Routine Herd Tests	A routine surveillance test carried out every 12 months. Herds sustained by a regular intake of imported cattle from Northern Ireland, Republic of	Routine	Routine

Code	Type Code	Description	When and Why	Group	Surveillance Stream
			Ireland, Isle of Man and non-Officially Tuberculosis Free (OTF). Member States must be tested on an annual basis.		
VE-RHT24/36	WH	Carried out in parishes with a 24, 36-month testing interval		Routine	Routine
VE-RHT24/36/48	WH	Carried out in parishes with a 24, 36, 48-month testing interval		Routine	Routine
VE-RHT48	WH	Routine surveillance test carried out every 48 months	Carried out in parishes with a 48-month testing interval. Scotland: New and reformed herds must commence routine testing no earlier than six months, and no later than 12 months, after the arrival of the first animal onto the holding.	Routine	Routine
VE-SI	WH	Short Interval test	Carried out 60 days after removal (or effective isolation) of the last reactor, or following confirmation of disease whilst the herd is under TB movement restriction. In OTF-S (2) or OTF-W breakdowns, if there are no reactors or IRs at the first SI test carried out, the subsequent SI test should be carried out a minimum of 60 days from the previous TT1 date of the previous test.	Control	Area and Herd Risk
VE-SLH	IA	Slaughterhouse case		SLH	Slaughterhouse
VE_SV	IA	Special Visit			
VE-TBU	WH	Carried out every 90 days on Approved Finishing Units (AFU's) with grazing or every 6 months on AFU's without grazing (This is the former VE-90D)	Test carried out every 90 days on Approved Finishing Units (AFU's) with grazing. (This is the former VE-90D)	Control	Area and Herd Risk
VE-TR	IA	Traced Bovine Test	Test of bovines that have moved from OTF-W herds prior to service of restrictions	Movement Risk 1	Area and Herd Risk
VE-UNK	IA	Unknown type; added at DSG as appears to be missing from Sam			
VE-V		No test numbers recorded, from Cheshire			
VE-WHT	WH	Whole herd test	Carried out routinely every 12 months in annual testing areas and in individual herds requiring annual testing, e.g. producer-retailer dairy herds, bull hirers, heifer rearers, city/open farms, AI centres, etc. Can also be carried out via RVL discretion in 48 month testing areas. Scotland: Can also be carried out via SVL discretion in 48 month parishes. In CHESHIRE EDGE AREA every 6 months (Jan16).	Routine	Routine

Code	Type Code	Description	When and Why	Group	Surveillance Stream
VE-WHT2	WH	Yearly test in 2 yearly testing parishes	Can be carried out via SVL discretion in 48 month parishes.	Routine	Routine

Appendix 3: performance posterior Mean, Standard Deviation and lower-upper 95% credible interval bounds for all slaughterhouses.

Slaughterhouses with a significantly lower number of positive slaughterhouse case submissions between 2019 and 2022 than the number predicted by the statistical model have been highlighted in amber. Individual slaughterhouses have been anonymised by replacing their official ID number with a slaughterhouse code.

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
Edge Area	CHESHIRE 1a	-0.87	0.6	-2.16	0.2	-0.37	0.53	-1.46	0.56	-0.83	0.59	-2.05	0.2	-0.97	0.68	-2.42	0.22
Edge Area	CHESHIRE 2	-1.44	0.39	-2.23	-0.75	-1.59	0.41	-2.47	-0.83	-1.72	0.43	-2.63	-0.93	-1.21	0.39	-2.02	-0.5
Edge Area	CHESHIRE 3	1.21	0.39	0.44	1.97	0.83	0.45	-0.09	1.68	0.68	0.45	-0.25	1.53	0.61	0.45	-0.29	1.45
Edge Area	CHESHIRE 4	0.29	0.91	-1.55	1.94	0.1	0.85	-1.64	1.66	0.17	0.81	-1.46	1.66	0.27	0.81	-1.33	1.81
Edge Area	DERBYSHIRE 1a	-0.09	0.5	-1.13	0.86	-0.45	0.53	-1.55	0.5	-0.66	0.59	-1.92	0.42	-0.21	0.55	-1.37	0.76
Edge Area	DERBYSHIRE 2a	-0.22	1.17	-2.69	1.94	-0.23	1.01	-2.26	1.71	1.08	0.8	-0.57	2.62	1.29	0.87	-0.43	2.94
Edge Area	DERBYSHIRE 2b	0.49	0.26	-0.05	1	0.47	0.25	-0.03	0.96	0.45	0.25	-0.03	0.92	0.76	0.24	0.27	1.23
Edge Area	DERBYSHIRE 4	-0.23	1.16	-2.59	1.94	-0.23	1.04	-2.3	1.74	-	-	-	-	-	-	-	-
Edge Area	EAST SUSSEX 1	-0.76	0.98	-2.83	1.03	-0.14	0.77	-1.75	1.29	0.26	0.68	-1.17	1.5	0.45	0.7	-0.98	1.76
Edge Area	HAMPSHIRE 1	-0.5	0.51	-1.54	0.41	-0.52	0.45	-1.47	0.3	-0.69	0.48	-1.69	0.16	-1.11	0.55	-2.3	-0.11
Edge Area	LEICESTERSHIRE 1	-0.1	0.2	-0.5	0.29	-0.34	0.21	-0.75	0.05	-0.53	0.22	-0.97	-0.1	-0.19	0.21	-0.61	0.23

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
Edge Area	LEICESTERSHIRE 2	-0.21	0.66	-1.62	0.94	-0.28	0.61	-1.55	0.84	-0.55	0.73	-2.07	0.77	-0.57	0.71	-2.05	0.71
Edge Area	OXFORDSHIRE 1	1.34	0.25	0.85	1.82	0.96	0.26	0.45	1.46	0.48	0.31	-0.15	1.08	0.2	0.34	-0.49	0.83
Edge Area	WARWICKSHIRE 1b	-0.32	0.8	-1.98	1.12	-0.41	0.73	-1.93	0.95	0.52	0.63	-0.82	1.7	1	0.53	-0.07	2
Edge Area	WARWICKSHIRE 2	0.1	0.88	-1.72	1.69	-0.03	0.78	-1.67	1.39	0.42	0.71	-1	1.74	0.52	0.7	-0.91	1.84
HRA	STAFFORDSHIRE 18	-0.92	0.94	-2.98	0.73	-0.82	0.85	-2.59	0.68	-1.05	0.8	-2.77	0.38	-0.76	0.88	-2.65	0.81
HRA	AVON 4	1.16	1.14	-1.06	3.37	0.97	1.09	-1.23	3.12	-	-	-	-	-	-	-	-
HRA	STAFFORDSHIRE 17	0.94	1.03	-1.13	2.95	0.82	0.74	-0.71	2.18	0.42	0.69	-1.03	1.67	0.41	0.58	-0.82	1.48
HRA	HEREFORD and WORCHESTER 3	1.04	0.7	-0.39	2.42	1.38	0.6	0.2	2.53	1.51	0.53	0.47	2.54	1.21	0.51	0.18	2.19
HRA	AVON 1	1.59	0.6	0.4	2.74	1.33	0.54	0.23	2.37	2.07	0.44	1.24	2.95	2.17	0.42	1.34	2.99
HRA	AVON 2	1.21	0.16	0.89	1.53	1.04	0.15	0.75	1.34	1.16	0.15	0.87	1.45	1.3	0.15	1.02	1.59
HRA	AVON 3	2.16	0.42	1.35	2.96	1.32	0.58	0.17	2.42	0.67	0.94	-1.25	2.54	-	-	-	-
HRA	CORNWALL 1	1.15	0.18	0.81	1.5	0.89	0.19	0.52	1.27	0.87	0.23	0.43	1.31	-0.04	0.66	-1.43	1.21
HRA	CORNWALL 2	0.83	0.16	0.53	1.15	0.58	0.15	0.28	0.87	0.48	0.16	0.18	0.78	0.56	0.16	0.25	0.87
HRA	CORNWALL 3	1.17	0.24	0.71	1.64	0.6	0.24	0.12	1.07	0.96	0.24	0.49	1.43	1.25	0.24	0.76	1.72
HRA	CORNWALL 5	0.4	0.93	-1.47	2.12	0.4	0.88	-1.35	2.08	0.23	0.86	-1.54	1.86	0.38	0.87	-1.4	2.09
HRA	CORNWALL 6	0.93	0.58	-0.27	2.02	0.55	0.56	-0.61	1.57	0.53	0.62	-0.72	1.68	0.86	0.55	-0.26	1.91
HRA	CORNWALL 7	1.53	0.41	0.7	2.34	1.25	0.46	0.3	2.13	0.69	0.52	-0.37	1.65	-0.02	0.63	-1.4	1.11
HRA	CORNWALL 8	1.37	0.74	-0.13	2.78	1.25	0.71	-0.19	2.65	0.46	0.91	-1.39	2.22	0.56	0.89	-1.25	2.23
HRA	CORNWALL 9	0.15	0.9	-1.76	1.79	-0.45	1	-2.5	1.41	-0.22	1.04	-2.32	1.76	-	-	-	-
HRA	DEVON 2	1.64	0.62	0.37	2.87	0.94	0.67	-0.44	2.19	0.7	0.75	-0.86	2.08	0.61	0.72	-0.93	1.94
HRA	DEVON 3	0.37	0.67	-1.02	1.6	-0.96	0.83	-2.69	0.55	-1.09	0.86	-2.89	0.47	-1	0.82	-2.74	0.47

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
HRA	DEVON 4	1.29	0.16	0.99	1.6	0.9	0.15	0.61	1.19	0.9	0.15	0.62	1.19	0.78	0.14	0.51	1.06
HRA	DEVON 5	1.41	0.82	-0.18	2.99	-0.17	1.07	-2.29	1.89	0.41	0.9	-1.38	2.11	0.48	0.9	-1.3	2.2
HRA	DEVON 6	1.82	0.32	1.18	2.46	1.43	0.32	0.78	2.06	0.71	0.43	-0.17	1.53	0.76	0.4	-0.06	1.52
HRA	DORSET 1	0.23	0.18	-0.13	0.6	0.12	0.18	-0.22	0.47	0.22	0.17	-0.12	0.55	0.34	0.18	0	0.71
HRA	DORSET 2	0.25	0.31	-0.36	0.83	0.26	0.32	-0.37	0.86	0.16	0.37	-0.59	0.82	-0.02	0.47	-0.97	0.9
HRA	DORSET 3	1.36	0.92	-0.43	3.11	1.17	0.89	-0.62	2.98	1.16	0.84	-0.51	2.78	-0.06	1.09	-2.23	2.09
HRA	DORSET 4	-0.3	0.79	-1.97	1.15	0.37	0.61	-0.92	1.51	0.94	0.52	-0.1	1.93	0.86	0.51	-0.13	1.8
HRA	GLOUCESTERSHIRE 1	0.47	0.16	0.16	0.79	0.78	0.15	0.47	1.07	1.07	0.15	0.8	1.36	1.22	0.14	0.94	1.51
HRA	GLOUCESTERSHIRE 3	1.13	0.22	0.71	1.56	1.15	0.22	0.73	1.6	1.21	0.21	0.8	1.62	1.22	0.22	0.78	1.67
HRA	GLOUCESTERSHIRE 4	1.04	0.63	-0.2	2.23	0.62	0.63	-0.68	1.82	1.51	0.52	0.46	2.51	1.35	0.52	0.31	2.36
HRA	GLOUCESTERSHIRE 5	-0.49	0.55	-1.65	0.49	0.12	0.43	-0.76	0.94	0.48	0.4	-0.32	1.23	0.12	0.44	-0.8	0.93
HRA	HEREFORD and WORCESTER 1	0.64	0.56	-0.52	1.7	0.71	0.51	-0.37	1.64	0.48	0.54	-0.63	1.48	0	0.63	-1.33	1.11
HRA	HEREFORD and WORCESTER 2	1.68	0.76	0.16	3.13	1.16	0.85	-0.55	2.85	0.97	0.81	-0.63	2.54	-0.17	1.02	-2.25	1.76
HRA	SHROPSHIRE 1	0.86	0.15	0.56	1.17	0.83	0.15	0.55	1.12	0.9	0.14	0.63	1.19	0.96	0.14	0.68	1.24
HRA	SHROPSHIRE 2	0.87	0.17	0.54	1.21	0.88	0.16	0.57	1.2	0.91	0.16	0.62	1.22	0.94	0.16	0.64	1.24
HRA	SHROPSHIRE 3	0.32	0.18	-0.03	0.68	0.47	0.17	0.15	0.8	0.73	0.16	0.42	1.06	0.75	0.16	0.43	1.07
HRA	SOMERSET 3	-1.43	0.86	-3.33	0.08	-1.01	0.82	-2.72	0.48	-0.9	0.85	-2.7	0.66	-0.83	0.86	-2.64	0.72
HRA	SOMERSET 5	0.74	1.03	-1.41	2.67	0.72	0.97	-1.25	2.56	0.62	0.92	-1.24	2.48	-	-	-	-
HRA	SOMERSET 6	1.49	0.42	0.67	2.27	1.14	0.44	0.29	1.99	0.95	0.45	0.03	1.81	0.57	0.56	-0.61	1.58
HRA	SOMERSET 7	-0.02	1.22	-2.46	2.4	0.61	0.96	-1.34	2.43	0.69	0.96	-1.24	2.51	0.74	0.95	-1.19	2.54
HRA	SOMERSET 8	1.02	0.2	0.63	1.41	0.73	0.21	0.32	1.13	0.67	0.21	0.26	1.06	0.82	0.21	0.4	1.24
HRA	SOMERSET 9	1.53	0.15	1.25	1.84	1.23	0.15	0.94	1.52	0.98	0.15	0.7	1.28	0.78	0.15	0.48	1.08

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
HRA	STAFFORDSHIRE 1	-0.32	1.1	-2.55	1.78	-	-	-	-	-	-	-	-	-	-	-	-
HRA	STAFFORDSHIRE 11	-0.09	1.23	-2.58	2.29	-0.13	1.08	-2.34	1.91	-0.18	1.08	-2.34	1.87	-0.07	1.05	-2.12	1.94
HRA	STAFFORDSHIRE 12	1.58	0.2	1.21	1.97	1.6	0.18	1.26	1.95	1.58	0.18	1.25	1.94	1.47	0.18	1.12	1.83
HRA	STAFFORDSHIRE 13	1.64	0.27	1.11	2.17	1.43	0.28	0.86	1.98	1.09	0.35	0.36	1.75	0.92	0.4	0.1	1.67
HRA	STAFFORDSHIRE 15	-0.33	1.13	-2.69	1.74	-0.22	1.06	-2.34	1.86	-0.13	1.04	-2.17	1.89	-0.11	1.04	-2.13	1.9
HRA	STAFFORDSHIRE 16	1.58	0.55	0.48	2.66	1.33	0.61	0.15	2.54	0.96	0.61	-0.25	2.11	1.12	0.62	-0.11	2.31
HRA	STAFFORDSHIRE 2	0.31	0.94	-1.64	2.12	0.6	0.95	-1.34	2.38	-0.03	1.12	-2.24	2.25	-	-	-	-
HRA	STAFFORDSHIRE 4	-0.27	1.1	-2.49	1.86	-0.19	1.04	-2.31	1.8	-0.04	1.12	-2.35	2.08	-0.13	1.04	-2.16	1.89
HRA	STAFFORDSHIRE 5	0.79	0.33	0.12	1.43	0.45	0.33	-0.19	1.1	-0.23	0.5	-1.28	0.68	-0.86	0.68	-2.32	0.31
HRA	STAFFORDSHIRE 6	0.47	0.41	-0.38	1.25	0.7	0.38	-0.09	1.42	0.78	0.41	-0.06	1.53	0.2	0.51	-0.88	1.14
HRA	STAFFORDSHIRE 8	1.44	0.89	-0.34	3.11	1.19	0.83	-0.44	2.76	0.67	0.93	-1.24	2.42	0.44	0.88	-1.29	2.07
HRA	WEST MIDLANDS 1	-0.6	1.05	-2.74	1.38	-0.55	0.91	-2.46	1.12	-0.65	0.9	-2.54	0.92	-0.52	0.93	-2.44	1.2
HRA	WEST MIDLANDS 2	-0.42	1.06	-2.68	1.48	-0.31	1.01	-2.48	1.55	-0.22	1.04	-2.32	1.73	-0.29	1.01	-2.35	1.5
HRA	WILTSHIRE 1	-0.06	0.31	-0.68	0.53	-0.12	0.32	-0.78	0.46	0.02	0.35	-0.67	0.65	0	0.36	-0.73	0.69
HRA	WILTSHIRE 2	-0.16	0.53	-1.28	0.79	-0.04	0.49	-1.06	0.85	-0.28	0.55	-1.49	0.71	0.12	0.53	-1	1.04
HTBE	POWYS 1	-0.26	1.14	-2.54	1.89	-0.2	1.07	-2.38	1.81	-0.09	1.06	-2.22	1.97	0.73	0.94	-1.17	2.53

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
HTBE	POWYS 2	0.09	0.31	-0.55	0.68	-0.21	0.39	-1.01	0.5	-0.16	0.43	-1.08	0.65	-0.14	0.56	-1.34	0.88
HTBW	PEMBROKESHIRE 1	-0.56	1.02	-2.78	1.3	0.04	0.37	-0.69	0.73	0.19	0.28	-0.38	0.72	0.37	0.21	-0.06	0.79
HTBW	WEST GLAMORGAN 1	0.98	1.02	-1.06	2.93	1.56	0.86	-0.19	3.2	1.6	0.88	-0.21	3.26	2.12	0.82	0.52	3.73
ITBM	CARMERTHENSHIRE 1	-	-	-	-	-	-	-	-	-	-	-	-	1.15	0.46	0.23	2.01
ITBM	NORTH POWYS 1	1.29	1.19	-1.04	3.68	1.06	1.06	-1.02	3.15	0.95	1.06	-1.18	3.03	-	-	-	-
ITBM	DYFED 1	0.61	0.93	-1.31	2.22	0.49	0.91	-1.31	2.23	-0.37	1.01	-2.43	1.52	-0.42	0.94	-2.4	1.3
ITBM	DYFED 3	0.55	0.2	0.16	0.95	0.8	0.18	0.43	1.16	0.89	0.18	0.54	1.26	1.03	0.18	0.68	1.41
ITBM	MID GLAMORGAN 1	0.95	0.51	-0.08	1.89	0.91	0.51	-0.15	1.87	1.07	0.51	0.01	2	1.03	0.58	-0.14	2.15
ITBM	MID GLAMORGAN 2	0.77	0.16	0.46	1.08	0.62	0.16	0.31	0.93	0.62	0.16	0.32	0.92	0.54	0.16	0.23	0.84
ITBM	MID GLAMORGAN 3	-0.09	1.19	-2.54	2.31	-	-	-	-	-	-	-	-	-	-	-	-
ITBN	CLWYD 1	0.31	0.89	-1.53	1.91	0.69	0.74	-0.88	2.06	0.87	0.76	-0.68	2.27	0.22	0.83	-1.59	1.73
ITBN	CLWYD 2	-0.02	0.83	-1.79	1.44	0.43	0.72	-1.08	1.75	0.03	0.78	-1.59	1.47	0.14	0.8	-1.54	1.58
ITBN	CLWYD 3	0.82	1.01	-1.24	2.75	-0.15	1.05	-2.24	1.9	-	-	-	-	-	-	-	-
ITBN	CLWYD 4	-0.2	1.18	-2.58	2.05	-	-	-	-	-	-	-	-	-	-	-	-
ITBN	CLWYD 5	-0.01	0.82	-1.76	1.44	-0.07	0.79	-1.77	1.34	-0.54	0.95	-2.51	1.22	-0.49	0.91	-2.44	1.19
ITBN	GWYNEDD 3	-0.9	0.96	-2.94	0.79	-0.79	0.87	-2.66	0.76	-0.85	0.86	-2.69	0.69	-0.86	0.85	-2.7	0.65
LRA	KENT 7	-	-	-	-	-	-	-	-	0.83	0.98	-1.11	2.76	0.81	0.95	-1.11	2.62
LRA	BEDFORDSHIRE 1	-0.27	0.21	-0.67	0.13	-0.22	0.19	-0.61	0.15	-0.29	0.19	-0.66	0.08	-0.55	0.2	-0.95	-0.16
LRA	BEDFORDSHIRE 2	-0.55	1.04	-2.66	1.39	-0.61	0.91	-2.52	1.03	-0.56	0.95	-2.53	1.18	-0.48	0.91	-2.41	1.19

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
LRA	CAMBRIDGESHIRE 1	-0.09	1.18	-2.44	2.09	-0.04	1.11	-2.25	2.16	-0.03	1.11	-2.19	2.19	-0.04	1.07	-2.11	2.12
LRA	CAMBRIDGESHIRE 2	-0.01	1.26	-2.59	2.4	0	1.11	-2.2	2.14	-	-	-	-	-	-	-	-
LRA	CAMBRIDGESHIRE 3	-0.2	1.15	-2.5	1.98	-0.01	1.13	-2.28	2.25	-0.09	1.09	-2.31	2.01	0	1.06	-2.15	2.13
LRA	CLEVELAND 1	-0.9	0.94	-2.93	0.71	-0.45	0.96	-2.4	1.33	-	-	-	-	-	-	-	-
LRA	CUMBRIA 1	0.84	0.61	-0.45	1.95	0.98	0.61	-0.27	2.1	-0.58	0.92	-2.51	1.1	-0.5	0.91	-2.39	1.24
LRA	CUMBRIA 2	1.13	0.47	0.16	2.02	1.46	0.49	0.45	2.36	0.63	0.6	-0.65	1.73	0.32	0.66	-1.08	1.52
LRA	CUMBRIA 3	-0.25	1.16	-2.6	1.96	-0.16	1.08	-2.32	1.96	-0.2	1.03	-2.33	1.83	-0.15	1.06	-2.39	1.81
LRA	CUMBRIA 4	-0.05	1.23	-2.54	2.27	-0.04	1.08	-2.22	2.04	0.01	1.07	-2.14	2.07	-0.04	1.07	-2.18	2.06
LRA	CUMBRIA 6	-1.38	0.68	-2.86	-0.2	-1.8	0.73	-3.39	-0.54	-1.75	0.72	-3.33	-0.47	-0.89	0.55	-2.02	0.12
LRA	DURHAM 1	-0.07	1.22	-2.52	2.29	-0.02	1.14	-2.27	2.17	-0.02	1.11	-2.18	2.18	-	-	-	-
LRA	DURHAM 2	-0.78	0.97	-2.88	0.96	-0.57	0.94	-2.48	1.17	-0.55	0.92	-2.44	1.13	-0.49	0.94	-2.43	1.24
LRA	DURHAM 3	-1.78	0.85	-3.58	-0.33	-1.12	0.67	-2.59	0.06	-0.71	0.7	-2.21	0.54	-0.64	0.67	-2.04	0.57
LRA	DURHAM 4	0.02	1.23	-2.36	2.45	-0.04	1.14	-2.22	2.26	-0.05	1.14	-2.32	2.19	-0.17	1.03	-2.2	1.9
LRA	DURHAM 5	0.88	0.77	-0.72	2.29	0.98	0.77	-0.62	2.48	-0.25	1.04	-2.4	1.74	-0.3	0.96	-2.27	1.53
LRA	ESSEX 1	-0.86	0.99	-3.05	0.86	-0.45	0.96	-2.41	1.29	-0.37	0.98	-2.43	1.47	-0.51	0.93	-2.45	1.2
LRA	ESSEX 2	-0.48	1.04	-2.57	1.48	-0.4	0.96	-2.34	1.4	-0.41	0.94	-2.36	1.32	-0.48	0.93	-2.42	1.21
LRA	ESSEX 3	-0.06	1.22	-2.58	2.21	-0.02	1.13	-2.23	2.12	-0.03	1.1	-2.25	2.14	-0.03	1.06	-2.1	2.02
LRA	GREATER LONDON 1	-0.43	1.06	-2.75	1.54	-0.55	0.95	-2.5	1.2	-0.58	0.94	-2.49	1.15	-0.32	0.94	-2.19	1.45
LRA	GREATER MANCHESTER 1	-0.99	0.72	-2.54	0.29	-1.19	0.65	-2.55	-0.04	-1.26	0.64	-2.63	-0.09	-1.27	0.66	-2.63	-0.11
LRA	GREATER MANCHESTER 2	-0.6	1.06	-2.88	1.24	-0.4	0.97	-2.4	1.35	-0.36	1	-2.36	1.55	-0.4	0.96	-2.39	1.4
LRA	GREATER MANCHESTER 4	-0.19	1.15	-2.51	2.04	-	-	-	-	-	-	-	-	-	-	-	-

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
LRA	GREATER MANCHESTER 5	-1.63	0.83	-3.41	-0.16	-1.4	0.76	-2.98	-0.03	-1.26	0.78	-2.93	0.16	-0.94	0.81	-2.64	0.49
LRA	GREATER MANCHESTER 6	0.33	0.95	-1.6	2.12	-0.31	1.02	-2.37	1.59	0.39	0.89	-1.45	2.1	0.39	0.88	-1.4	2.02
LRA	GREATER MANCHESTER 7	0.77	1.1	-1.33	3.01	-	-	-	-	-	-	-	-	-	-	-	-
LRA	HUMBERSIDE 1	-1.16	0.67	-2.59	0.01	-0.46	0.52	-1.53	0.48	-0.5	0.52	-1.57	0.44	-0.71	0.58	-1.92	0.29
LRA	HUMBERSIDE 2	-0.07	1.2	-2.47	2.25	-0.03	1.12	-2.29	2.12	-0.03	1.1	-2.19	2.15	-0.1	1.05	-2.16	1.92
LRA	HUMBERSIDE 4	-0.02	1.23	-2.46	2.39	-	-	-	-	-	-	-	-	-0.03	1.07	-2.09	2.09
LRA	KENT 1	-0.39	1.08	-2.71	1.55	-0.39	1	-2.4	1.51	-0.47	0.97	-2.4	1.4	-0.05	1.08	-2.15	2.07
LRA	KENT 3	-0.02	1.27	-2.51	2.47	-0.11	1.09	-2.33	2.04	-0.02	1.12	-2.13	2.16	-0.17	1.03	-2.22	1.83
LRA	KENT 4	-0.12	1.14	-2.39	2.17	-0.05	1.11	-2.25	2.15	-0.05	1.12	-2.31	2.08	0.01	1.08	-2.09	2.12
LRA	KENT 5	-0.08	1.25	-2.6	2.37	-0.08	1.11	-2.3	2.06	-0.12	1.07	-2.24	1.91	-0.16	1.01	-2.16	1.79
LRA	LANCASHIRE 2	-0.48	0.79	-2.18	0.91	-0.29	0.65	-1.68	0.86	-0.34	0.6	-1.6	0.72	-0.08	0.63	-1.41	1.04
LRA	LANCASHIRE 3	-1.09	0.31	-1.73	-0.51	-1.17	0.34	-1.86	-0.51	-1.1	0.34	-1.79	-0.43	-1.28	0.39	-2.07	-0.58
LRA	LANCASHIRE 5	-0.67	0.99	-2.74	1.15	-0.44	0.96	-2.41	1.31	-0.51	0.95	-2.43	1.2	-0.56	0.89	-2.43	1.12
LRA	LANCASHIRE 6	-0.65	0.31	-1.27	-0.09	-0.93	0.32	-1.57	-0.32	-0.78	0.32	-1.43	-0.17	-0.79	0.31	-1.44	-0.21
LRA	LANCASHIRE 7	0.22	0.17	-0.12	0.56	0.3	0.17	-0.02	0.62	0.17	0.17	-0.17	0.5	0.18	0.18	-0.19	0.52
LRA	LANCASHIRE 8	-0.57	0.64	-1.94	0.54	-0.33	0.62	-1.62	0.78	-0.08	0.78	-1.71	1.34	-0.78	0.86	-2.53	0.79
LRA	LINCOLNSHIRE 3	0.17	0.19	-0.21	0.55	0.01	0.18	-0.34	0.37	0.13	0.17	-0.2	0.48	0.26	0.17	-0.08	0.6
LRA	LINCOLNSHIRE 4	-0.57	1.04	-2.72	1.36	-0.56	0.93	-2.46	1.1	-0.76	0.88	-2.55	0.79	-0.61	0.91	-2.5	1.03
LRA	LINCOLNSHIRE 5	-0.88	0.94	-2.89	0.77	-0.71	0.9	-2.61	0.91	-0.69	0.9	-2.58	0.94	-0.69	0.87	-2.5	0.93
LRA	LINCOLNSHIRE 6	-0.19	1.16	-2.58	2.03	-0.17	1.07	-2.31	1.9	-0.15	1.1	-2.33	1.95	-	-	-	-
LRA	LINCOLNSHIRE 7	-0.23	1.1	-2.59	1.83	-0.15	1.07	-2.28	1.91	-0.08	1.07	-2.28	1.99	-0.15	1.04	-2.29	1.86
LRA	LINCOLNSHIRE 8	-2.08	0.41	-2.92	-1.32	-2.37	0.41	-3.23	-1.62	-2.88	0.54	-4.09	-1.96	-2.34	0.46	-3.34	-1.55
LRA	MERSEYSIDE 2	-0.02	1.24	-2.53	2.34	-0.14	1.1	-2.34	1.97	-0.15	1.09	-2.35	1.92	-0.08	1.06	-2.16	2
LRA	NORFOLK 1	-1.21	0.92	-3.15	0.41	-0.95	0.83	-2.71	0.59	-0.71	0.89	-2.58	0.91	-0.71	0.87	-2.54	0.87

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
LRA	NORFOLK 3	-0.2	1.13	-2.43	1.98	-0.11	1.06	-2.2	1.92	-0.03	1.12	-2.26	2.12	-	-	-	-
LRA	NORFOLK 4	-0.12	1.22	-2.54	2.16	-0.02	1.12	-2.19	2.2	-0.02	1.11	-2.23	2.18	0	1.07	-2.06	2.07
LRA	NORFOLK 5	-0.02	1.25	-2.48	2.49	-0.23	1.05	-2.34	1.8	-0.02	1.13	-2.25	2.19	0.03	1.1	-2.1	2.24
LRA	NORTH YORKSHIRE 1	-1.44	0.51	-2.53	-0.53	-1.62	0.52	-2.72	-0.68	-1.58	0.52	-2.7	-0.64	-2.03	0.67	-3.57	-0.88
LRA	NORTH YORKSHIRE 10	-0.05	1.23	-2.52	2.35	-	-	-	-	-	-	-	-	-	-	-	-
LRA	NORTH YORKSHIRE 12	-0.15	1.2	-2.54	2.19	-0.32	1.05	-2.38	1.67	-0.18	1.04	-2.25	1.8	-0.06	1.08	-2.2	2.05
LRA	NORTH YORKSHIRE 13	-0.04	1.19	-2.41	2.22	-0.04	1.12	-2.27	2.08	-0.2	1.06	-2.31	1.83	-0.02	1.09	-2.16	2.13
LRA	NORTH YORKSHIRE 2	-0.1	1.17	-2.41	2.16	-0.02	1.09	-2.2	2.14	-0.03	1.12	-2.3	2.12	-	-	-	-
LRA	NORTH YORKSHIRE 3	-0.05	1.24	-2.48	2.44	-0.07	1.14	-2.41	2.09	-	-	-	-	-	-	-	-
LRA	NORTH YORKSHIRE 5	0.8	0.34	0.13	1.44	-1	0.56	-2.16	0.02	-1.69	0.71	-3.21	-0.47	-1.74	0.71	-3.24	-0.49
LRA	NORTH YORKSHIRE 6	-0.17	1.17	-2.55	2.02	-0.12	1.1	-2.34	2	-0.05	1.08	-2.14	2.01	-0.04	1.08	-2.09	2.12
LRA	NORTH YORKSHIRE 7	-0.43	1.07	-2.72	1.52	-0.28	1	-2.37	1.59	-0.21	1.03	-2.27	1.74	-0.24	1	-2.26	1.66
LRA	SOUTH YORKSHIRE 14	-1.6	0.68	-3.08	-0.38	-1.66	0.6	-2.95	-0.59	-1.88	0.7	-3.41	-0.64	-0.79	0.51	-1.84	0.14
LRA	SOUTH YORKSHIRE 15	-0.03	1.24	-2.54	2.33	-0.05	1.14	-2.3	2.24	-0.01	1.11	-2.22	2.18	-0.04	1.08	-2.15	2.09
LRA	SOUTH YORKSHIRE 16	-1.28	0.28	-1.85	-0.75	-1.64	0.29	-2.24	-1.08	-1.28	0.28	-1.88	-0.75	-1.21	0.3	-1.82	-0.63
LRA	SOUTH YORKSHIRE 17	-0.03	1.25	-2.48	2.36	0	1.12	-2.17	2.26	-	-	-	-	-	-	-	-

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
LRA	SUFFOLK 2	-0.54	1.07	-2.76	1.4	-0.2	1.01	-2.34	1.68	-0.12	1.1	-2.3	1.93	-0.03	1.06	-2.13	2.05
LRA	SURREY 1	0.38	0.21	-0.05	0.8	0.59	0.21	0.18	0.99	0.44	0.22	0.01	0.84	0.49	0.21	0.08	0.9
LRA	TYNE andandand WEAR 1	-1	0.59	-2.29	0.06	-1.05	0.55	-2.23	-0.06	-0.94	0.55	-2.07	0.04	-1.28	0.62	-2.56	-0.19
LRA	WEST SUSSEX 1	-0.52	1.07	-2.73	1.42	0.28	0.85	-1.46	1.84	0.41	0.87	-1.4	2.02	0.36	0.84	-1.33	1.92
LRA	WEST YORKSHIRE 1	-0.54	0.62	-1.83	0.58	-0.49	0.59	-1.77	0.58	-0.66	0.59	-1.9	0.4	-1.06	0.65	-2.45	0.11
LRA	WEST YORKSHIRE 3	-0.06	1.18	-2.45	2.26	-0.1	1.09	-2.31	1.99	-0.12	1.08	-2.38	1.94	-0.06	1.06	-2.19	2.08
LRA	WEST YORKSHIRE 4	-0.07	0.66	-1.5	1.12	-0.28	0.62	-1.58	0.83	-0.24	0.61	-1.54	0.83	-0.21	0.59	-1.47	0.89
LRA	WEST YORKSHIRE 5	-0.11	1.19	-2.51	2.18	-0.1	1.11	-2.32	2.01	-0.05	1.08	-2.18	1.99	0	1.08	-2.14	2.16
LRA	WEST YORKSHIRE 6	-0.9	0.95	-2.91	0.78	0.06	0.78	-1.54	1.53	0.19	0.82	-1.51	1.68	-0.05	0.77	-1.67	1.38
LRA	WEST YORKSHIRE 7	-0.6	0.99	-2.68	1.17	-0.35	1	-2.35	1.47	-0.16	1.04	-2.23	1.78	-0.19	1.03	-2.29	1.69
LTB	GWYNEDD 5	-	-	-	-	-	-	-	-	-	-	-	-	-0.04	1.06	-2.13	2.1
LTB	GWYNEDD 1	-0.54	1.04	-2.74	1.4	-	-	-	-	-	-	-	-	-	-	-	-
Scotland	ABERDEENSHIRE 1	-1.35	0.85	-3.18	0.2	-1.04	0.85	-2.84	0.49	-0.91	0.84	-2.71	0.61	-1.1	0.8	-2.74	0.35
Scotland	ABERDEENSHIRE 3	-1.19	0.7	-2.69	0.01	-1.03	0.67	-2.44	0.18	-0.91	0.67	-2.34	0.26	-0.87	0.66	-2.24	0.32
Scotland	ARGYLL 1	-0.05	1.21	-2.41	2.36	-0.03	1.14	-2.23	2.22	-0.02	1.11	-2.31	2.13	-0.04	1.08	-2.15	2.02
Scotland	AYRSHIRE 1	-1.04	0.72	-2.61	0.18	-0.83	0.68	-2.23	0.42	-0.65	0.73	-2.2	0.64	1.08	0.44	0.2	1.91

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
Scotland	AYRSHIRE 2	0.07	0.42	-0.77	0.87	0.35	0.4	-0.43	1.13	0.94	0.37	0.21	1.66	0.82	0.4	0.04	1.56
Scotland	DUMFRIESHIRE 1	-0.32	1.13	-2.71	1.72	-0.24	1	-2.24	1.59	-0.12	1.03	-2.13	1.94	-0.17	1.01	-2.17	1.76
Scotland	KINCARDINE 1	-1.72	0.79	-3.41	-0.32	-1.4	0.77	-3.05	-0.04	-0.7	0.7	-2.22	0.52	-0.89	0.67	-2.33	0.32
Scotland	LANARKSHIRE 1	-0.47	1.05	-2.71	1.42	-0.37	1	-2.41	1.42	-0.19	1.01	-2.22	1.71	-0.26	0.97	-2.25	1.52
Scotland	LANARKSHIRE 2	1.45	0.59	0.25	2.49	1.64	0.6	0.4	2.75	1.94	0.64	0.56	3.14	1.78	0.62	0.51	2.94
Scotland	MORAY 1	-0.78	0.94	-2.71	0.91	-0.56	0.93	-2.5	1.09	-0.23	1.02	-2.28	1.7	-	-	-	-
Scotland	MORAY 2	-1.4	0.88	-3.3	0.11	-1.19	0.83	-2.93	0.29	-1.1	0.79	-2.77	0.38	-1.03	0.82	-2.76	0.48
Scotland	ORKNEY 1	-0.09	1.18	-2.36	2.25	-0.08	1.11	-2.31	2.02	-	-	-	-	-	-	-	-
Scotland	PERTHSHIRE 1	-1.92	0.8	-3.61	-0.5	-0.84	0.58	-2.08	0.2	-0.61	0.6	-1.89	0.49	-0.71	0.57	-1.89	0.31
Scotland	PERTHSHIRE 2	-0.22	1.14	-2.58	1.9	-0.03	1.08	-2.15	2.04	-	-	-	-	-	-	-	-
Scotland	PERTHSHIRE 3	-1.73	0.55	-2.89	-0.71	-1.69	0.53	-2.81	-0.72	-1.31	0.47	-2.29	-0.46	-0.98	0.45	-1.93	-0.16
Scotland	RENFREW 1	-2.11	0.79	-3.87	-0.75	-1.93	0.73	-3.58	-0.69	-1.66	0.77	-3.32	-0.3	-1.06	0.64	-2.47	0.08
Scotland	ROSS and CROMARTY 1	0.01	1.23	-2.41	2.34	-0.07	1.09	-2.23	2.03	0.01	1.13	-2.22	2.24	-0.02	1.07	-2.12	2.14
Scotland	ROSS and CROMARTY 2	-0.47	1.01	-2.61	1.41	-0.34	0.99	-2.42	1.49	-0.25	1.01	-2.31	1.68	-0.28	0.98	-2.33	1.58

Region	SLH Code	Mean 16 - 19	SD 16-19	LCI 16 - 19	UCI 16 - 19	Mean 17 - 20	SD 17 - 20	LCI 17 - 20	UCI 17 - 20	Mean 18 - 21	SD 18 - 21	LCI 18 - 21	UCI 18 - 21	Mean 19 - 22	SD 19 - 22	LCI 19 - 22	UCI 19 - 22
Scotland	SHETLAND 1	-0.13	1.2	-2.45	2.18	-0.03	1.1	-2.22	2.1	-0.04	1.11	-2.19	2.11	-0.03	1.08	-2.18	2.08