Animal & Plant Health Agency

Asiantaeth Iechyd Anifeiliaid a Phlanhigion

Epidemiology of bovine tuberculosis in Wales

Annual surveillance report

For the period: January to December 2020

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Background

This report is presented in eight sections in which the cattle population and testing regime are summarised, and various measures of disease are used to describe the epidemiology of bovine TB in Wales in 2020. It reports both the frequency and geographic distribution of the disease in Wales in 2020, as well as changes over time. It also explores the different surveillance and control measures used to control TB in cattle herds and the impact of the disease.

The intended audience for this report is those involved in the eradication of TB in cattle, both nationally and locally. This includes, but is not limited to farmers, veterinarians, policy makers and the scientific community.

Data presented in these reports are derived from the same source as Defra's 'National Statistics' on the incidence and prevalence of TB in Great Britain, which include monthly statistical reports and other quarterly statistics on specific aspects of TB surveillance. Whilst the data source is the same, additional time has been spent by APHA removing duplicates and correcting other transactional data errors before compiling the Wales TB report. As such, there may be some differences between the data presented in this report and the national statistics.

Bovine TB in Wales is subject to a statutory eradication programme based on the devolved administrations strategy published first in 2008 and updated again in 2017. All cattle herds within Wales are subjected to annual routine skin testing (and have been since 2010), plus six-monthly testing within the 'Intensive Action Area' or 'IAA', within Pembrokeshire. Wales is divided into five TB risk areas which have been determined by the level of disease. The High TB Areas in the West and East (HTBAW, HTBAE) lie along the West and East of Wales, where most TB infection is disclosed. The Intermediate TB Areas in the mid and north of Wales (ITBAM, ITBAN) denote areas with a lower risk of TB infection, but where pockets of infection have been disclosed, particularly in recent years in the ITBAN. The Low TB Area (LTBA) is in the north west of Wales and includes Anglesey. The level of infection in this area is extremely low, however clusters of infection have been identified. These TB Risk Areas help to identify the different patterns of disease across the country, where TB incidence and prevalence is not uniformly distributed across Wales.

The following summary highlights the main findings described in each section and the data suggests that progress continues to be made in Wales to tackle bovine tuberculosis (TB) through the comprehensive TB eradication programme introduced in 2008. A refreshed eradication strategy was published in 2017[1] to check progress towards a TB-free Wales and focus on a regionalised approach to TB control.

The implementation of annual testing across all cattle herds in Wales since 2010 has continued to be effective in identifying infection early, with the number of new TB incidents at a ten-year low. Six per cent of cattle herds had a new TB incident in 2020.

[1] https://gov.wales/sites/default/files/publications/2017-11/wales-bovine-tb-eradication-programme.pdf

1. Executive summary

Welsh cattle population characteristics

Herd density has remained consistent with previous years and was highest in the High TB Area West (HTBAW). Beef herds accounted for nearly 80% of all herds in Wales, however the majority of large herds (of greater than 300 animals) are dairy (74%).

There is wide variation in cattle movements by TB Area. Movements are heavily influenced by location, for example, there are more movements from England risk areas to the High TB Area East (HTBAE) and Intermediate TB Area North (ITBAN) where they border English counties. Other notable changes include a 10% decrease in the percentage of movements within the Low TB Area (LTBA) in 2020 compared to 2019, but increased movements from the HTBAE into the LTBA.

Cattle and herd tests

In 2020, just over 2.1 million skin tests were conducted in Wales which was a 7% decrease compared to 2019. The decrease in the number of skin tests carried out in all TB Areas apart from the LTBA is attributed to a reduction in the number of new TB incidents in Wales since 2010, as well as a reduction in field testing in 2020 due to Covid-19.

Most TB incidents were disclosed through routine skin testing, area risk tests (contiguous herd) and herd-risk (post-incident) tests. The percentage of TB incidents disclosed by other surveillance testing (new herd, control, movement risk and slaughterhouse surveillance) methods remain similar in 2020 to previous years.

Thirty-five per cent of TB incidents were disclosed through area risk tests in Wales in 2020. This was a 21% decrease compared to 2019, likely due to fewer TB incidents being disclosed in 2020. The number of TB incidents disclosed by private, pre- and post-movement testing also decreased by 25% in 2020, compared to 2019. In contrast, TB incidents disclosed by routine (whole herd) testing increased by 15% in 2020 compared to 2019.

The number of reactors disclosed following standard interpretation of the tuberculin skin test increased in the HTBAE, ITBAN and LTBA in 2020. The percentage of skin tests disclosing reactors through severe interpretation has been increasing in the ITBAN since 2016, likely due to the increase in persistent TB herds. There was also an increase in the number of reactors disclosed through severe interpretation in the LTBA in 2020, above that recorded over the previous ten years.

Interferon gamma (IFN-γ) tests are used in less heavily infected areas of Wales to help prevent TB from becoming established in low incidence areas, and in areas where TB is more prevalent, the use of IFN-γ helps to clear infection from herds more quickly. The percentage of IFN-γ tests that disclosed reactors in 2020 increased in all TB Areas apart from the LTBA, following a decline since 2016.

Use of antibody blood tests increased by 85% in 2020 compared to 2019, with 11-13% of tests disclosing reactors in the HTBAW, HTBAE and ITBAM. The percentage of reactors disclosed in the ITBAN and LTBA was lower (9% and 7% respectively).

Incidence

The number of new TB incidents declined by 7% in 2020 compared to 2019 and was the lowest observed for over ten years. A total of 614 new TB incidents were disclosed, 90% of which were classified as Officially Tuberculosis Free-Withdrawn, or OTF-W. Like previous years, most TB infection was disclosed in the HTBAE and HTBAW in 2020.

The incidence rate per 100 herd years at risk (HYR) in Wales decreased slightly in 2020 compared to 2019 (6.6 vs. 6.7 respectively), however this varies by TB Area. In the HTBAE and HTBAW where most TB infected cattle are located, the incidence rate has shown a decreasing trend since annual testing was implemented. The incidence rate in the ITBAM also decreased in 2020, however the ITBAN and LTBA experienced an increase.

The incidence rate in the ITBAN has been increasing since 2016 (from 4.7 in 2016 to 8.5 in 2020). Additional control measures were introduced to curb and reverse the emerging epidemic in this area. From November 2018, enhanced TB surveillance has been carried out in herds contiguous to a TB incident in the ITBAN. Visits from vets were also offered to farmers as part of the 'Keep it out' campaign. The LTBA disclosed very few TB incidents in 2020, however a cluster of new TB incidents have been disclosed around Denbigh/ Conwy. Sixty-five per cent of TB incidents disclosed in the LTBA were fully confirmed by the presence of test reactors with typical TB lesions and/or one or more animals with positive bacteriological results (OTF-W).

The risk of a herd becoming infected with TB is associated with factors such as herd density, herd size, production type, TB history and location. These factors contribute to the spatial pattern of TB in cattle herds across Wales. Dairy herds had a significantly higher TB incidence rate compared to beef herds, with this effect remaining after adjusting for herd size and location. Similarly, herds with more than 300 animals have the highest incidence rates, with this effect remaining after adjusting for herd type and TB Area.

The increase in recurrent infection (a TB incident occurring within the last two years) in cattle suggests this remains an important driver of infection in Wales. Half of herds with new TB incidents in the HTBAW and ITBAN in 2020 had a previous TB incident in the preceding two years with lower percentages in other TB Areas (40% in the HTBAE, 30% in the ITBAM and 8% in the LTBA).

Herds with a history of TB were more likely to have a TB incident in 2020 compared to herds with no TB history, irrespective of herd size or herd type. Beef and dairy herds with TB history were twice as likely to have a TB incident in 2020 compared to herds with no TB history. Where there is no difference with herd type, this suggests that management differences are not affecting recurrent TB infection in Wales.

The percentage of new TB incidents in 2020 where reactors had previously been inconclusive reactors (IRs) was highest in the ITBAM and HTBAW (10.4 and 8.3% respectively) and closer to 2% in the ITBAN and HTBAE (1.7 and 1.5% respectively) having decreased in 2020. None were identified in the LTBA in 2020.

Prevalence

Application of movement restrictions helps to prevent infection from spreading, and to reduce the risk of TB persisting in cattle herds. Six per cent of Welsh herds incurred a new TB incident in 2020. A total of 5.3% of herds were under movement restrictions in mid-December 2020 (excluding herds under restriction due to an overdue test). Prevalence has remained relatively stable at around 5% since annual testing was implemented in 2013, however there was a 5% decrease observed in in 2020 compared to 2019. This decrease is driven by the decrease observed in the HTBAE and HTBAW which still make up most TB incidents in any given year.

Prevalence was highest in the HTBAW where over half of all TB incidents are located. Prevalence increased in the ITBAN in 2020 and surpassed that observed in the HTBAE, as well as the average for Wales overall.

The median duration of OTF-W incidents that are resolved each year has been increasing in Wales since 2015, up to 256 days in 2020, driven by an increase in persistent herd infections. Longer lasting TB incidents result in herds requiring additional short interval testing (SIT) to clear the herd.

There has been a 21% increase in the number of TB incidents closing in 2020 that were classed as persistent (under restriction for >550 days), most of which were in the HTBAW (28), followed by the HTBAE (10) and ITBAN (6). Where the number of new persistent incidents has increased, this suggests that infection may not be being removed effectively in persistent TB herds and may also be related to farm management factors. This may also be due to a change in test requirements prior to lifting movement restrictions.

PME outcomes, WGS clades and/or genotypes

The number of cattle slaughtered for TB control in 2020 decreased by 15% compared with 2019, in contrast to the previous five years during which an increasing trend had been observed. An initial increase in reactors was primarily attributable to increases in IFN-γ testing, which is more sensitive than the SICCT test. This decrease observed in 2020 is attributable to the reduction in infected cattle disclosed in Wales, as well as a reduction in the number of IRs and direct contacts (DCs) slaughtered, due to changes in policy regarding IRs as described below.

Of the 10,680 cattle slaughtered in 2020 for TB control; 83.6% were reactors to either the skin test, IFN-γ or antibody test, 11.6% were IRs and 4.8% were DCs. In 2020, the 646 disclosed by antibody tests was more than double compared to 2019 (272). Lesions were detected in 12% of slaughtered animals in Wales although this varied depending on the reason for disclosure; reactors (13%), IRs (3%) or DCs (6%).

Of the 2,740 samples from animals with non-detected lesions (NDLs) and for which culture results were available, 1.5% (40) were M. bovis positive.

The percentage of skin and blood test reactors with detected lesions (DLs) decreased from 16% in 2018, 12% in 2019, to around 13% in 2020. This is considered to be in part because of increased IFN-y testing, detecting infection earlier.

In 2020, around 93% of cultured samples from DLs were M. bovis positive, however this varies by TB Area. Up to 2017, the percentage was stable at around 95-97% but has since decreased to nearer 90%.

In 2020, a total of 397 bovine and 37 non-bovine isolates were genotyped, which is like the last five years. The most predominant and frequently found genotypes in Wales were 9:b located mostly in the HTBAW and 17:a in the HTBAE in particular, although this genotype showed further spread across TB Areas. A notable change in 2020 was a cluster of genotype 17:a emerging in the LTBA compared to 2019. This genotype also increased in frequency in the ITBAN in 2020.

Fate of inconclusive reactors (IRs)

A review of the IR policy in Wales in 2019 has led to revisions implemented in early 2020. All cattle disclosed as IRs at standard interpretation in persistent herd incidents are removed as reactors. Cattle recorded as 2x standard IRs and 3x IRs are removed. Cattle disclosed as IRs at severe interpretation of the skin test are subject to both IFN-y and antibody blood testing (using IDEXX). In hotspot areas of the LTBA and the ITBAN, severe IRs are tested using IFN-y.

Of 856 IR-only herds in 2020, 12% went on to have an OTF-W incident at the IR retest. The remaining 730 were negative at the IR-retest.

Significantly more IR-only herds (15.3%, n=109) went on to have a TB incident at the next whole herd test, compared to non-IR only herds in 2020 (4.6%; 397/8,592; $p<0.001$).

In 2020, the percentage of IR-only herds disclosing a new TB incident at the test after an IR retest that was negative (within 15 months) ranged from 5% (LTBA, ITBAM) to 22% (ITBAN).

In 2020, most IR-only herds that had a new TB incident [at either the IR retest or at the test subsequent to a previously negative IR test] were located in the HTBAW and HTBAE, with the majority being OTF-W rather than OTF-S. OTF-S incidents were mostly distributed around the ITBAM and HTBAE.

The percentage of IR-only herds with any subsequent incident continued to decrease in 2020, which may be due to the use of IFN-y and IDEXX antibody testing in managing IR herds resulting in *M. bovis* infected animals being identified sooner.

Slaughterhouse cases

As well as routine surveillance skin testing [active], slaughterhouse surveillance [passive] also contributes to identification and removal of infected animals. In 2020, 63 (11.4%) of all new OTF-W incidents were disclosed through slaughterhouse surveillance (SHC). This was an increase over 2019 when fewer than 10% were disclosed through SHC detection. The geographic distribution of OTF-W incidents disclosed by SHC is similar to the distribution of all new TB incidents disclosed in 2020. Most are in the HTBAE and HTBAW where the burden of disease is highest (16 and 28 incidents disclosed by SHC in 2020, respectively).

Compared to herd sizes of 300 or more animals (reference category), only herds with between 51 and 100 animals had significantly reduced odds ($P<0.05$) of an OTF-W incident being disclosed in the slaughterhouse, an effect which remained after adjusting for herd type and TB Area. There was no significant difference in the odds of dairy herds incurring an OTF-W incident through SHC detection, compared to beef herds. However, there is a disparity in the risk of detection of TB in the field where dairy herds appear to have more than three times the risk of detection. Therefore, slaughterhouse surveillance may not be as effective for dairy herds (or likewise, active surveillance via routine testing may not be as effective in beef as it is in dairy herds).

After adjusting for herd size and type, herds in the ITBAM were three times more likely to have an OTF-W incident disclosed by SHC compared to the HTBAW. There was no significant difference for all other TB Areas.

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

- April 2020 – calves under 180 days could be temporarily excluded from a surveillance test for Covid-19 reasons [continued throughout 2020].
- May 2020 – calves under 180 days could be temporarily excluded from breakdown testing for Covid-19 reasons, but not from breakdown clearing tests [continued throughout 2020].
- March 2020 – overdue referrals temporarily suspended, but herds were restricted – [continued throughout 2020 and led to more herds being under restrictions as overdue].

Table S1: Summary of key bovine TB parameters, by TB Area, 2020

Key parameter	HTBAW	HTBAE	ITBAM	ITBAN	LTBA	Wales total
Number of herds	2,760	3,128	2,005	904	2,792	11,589
Number of new TB incidents	201	253	48	60	52	614
Number of new OTF-W incidents	189	239	35	55	34	552
New TB incidents per 100 herd years at risk	9.0	10.7	2.9	8.5	2.2	6.6
New TB incidents per 100 unrestricted herds tested	8.3	9.5	2.7	7.8	2.2	6.1
Herds under restriction per 100 live herds (mid-December)	5.9	10.2	2.0	7.0	1.1	5.3
New TB incidents per 100 live herds (mid-December)	7.3	8.1	2.4	6.6	1.9	5.3
Median duration total TB (days)	203	270	246.5	269.5	144	241
Median duration OTF-W (days)	213	277	286.5	300	232	256
Number of open persistent incidents	29	101	4	13	1	148
Persistent TB incidents (closing in 2019)	10	28	2	6	1	47
Number of non-bovine TB isolates genotyped	20	11	1	3	0	36*

* The total number of isolates includes one badger that is not included in the subtotals by TB Area, as its location was unknown.

2. Welsh cattle demographic and movements

Key Points:

- Herd density by area has remained consistent, with the highest density observed in the High TB Area West (HTBAW).
- The High TB Area East (HTBAE) and Low TB Area (LTBA) have a similar number of herds in Wales. Both have heterogeneity in the distribution of herds due to geographical landscape with mountainous regions unable to accommodate many cattle herds.
- Herds in the LTBA are concentrated in the West around Anglesey and the Llyn peninsula and Conwy on the East towards the border of the Intermediate TB Area North (ITBAN). Herd density in the HTBAE is highest in north Powys & Gwent.
- Beef herds account for nearly 80% of all herds in Wales however most large herds (with more than 300 animals) are dairy (74%). This is consistent with previous reporting years.
- The number of animal tests conducted in a reporting year had been increasing since 2016, with a large increase in 2018. However, there was a 7% drop in 2020, in part because of reduced field testing due toCovid-19, as well as a reduction in incidence which reduces the number of tests carried out (e.g., short-interval and contiguous herd tests).
- The ratio of animal-level tests to cattle (2:1) reflects the stability in the routine testing frequency as well as in the size of a herd, although there was a slight drop in 2020 because of a reduction in the number of tests carried out (Covid-19).
- Overall, movements from GB areas into each TB Area between 2018 and 2020 has been similar. More noticeable exceptions include, for example, a 10% decrease in the percentage of movements within the LTBA from the same TB Area in 2020 compared to 2019, with increased movements from the HTBAE into the LTBA.
- In the HTBAE, there has also been a decrease in the percentage of movements from within the same TB Area and in comparison, an increase in the percentage of movements from the HRA in England.
- There is wide variation between the movements when looking at each TB Area. This will be heavily influenced by the location, for example, there are more movements from England risk areas to the HTBAE and ITBAN where they border English counties.

2.1 Welsh cattle population characteristics

Cattle herd density in Wales is highest in the High TB Area West (HTBAW), Anglesey and the north east and north west of the Low TB Area (LTBA) as well as in the High TB Area East (HTBAE) and Intermediate TB Area North (ITBAN) (Figure 2.1.1). Herd density is not always reflective of areas of increased TB infection levels. For example, Anglesey has low levels of TB infection.

Large areas of low cattle density exist across the central mountainous region of Wales, from mainland Gwynedd in the north, to the Glamorgans in the south, resulting in heterogeneity in the distribution of cattle in certain TB Areas, for example in the LTBA, ITBAM (Intermediate TB Area Mid) and HTBAE.

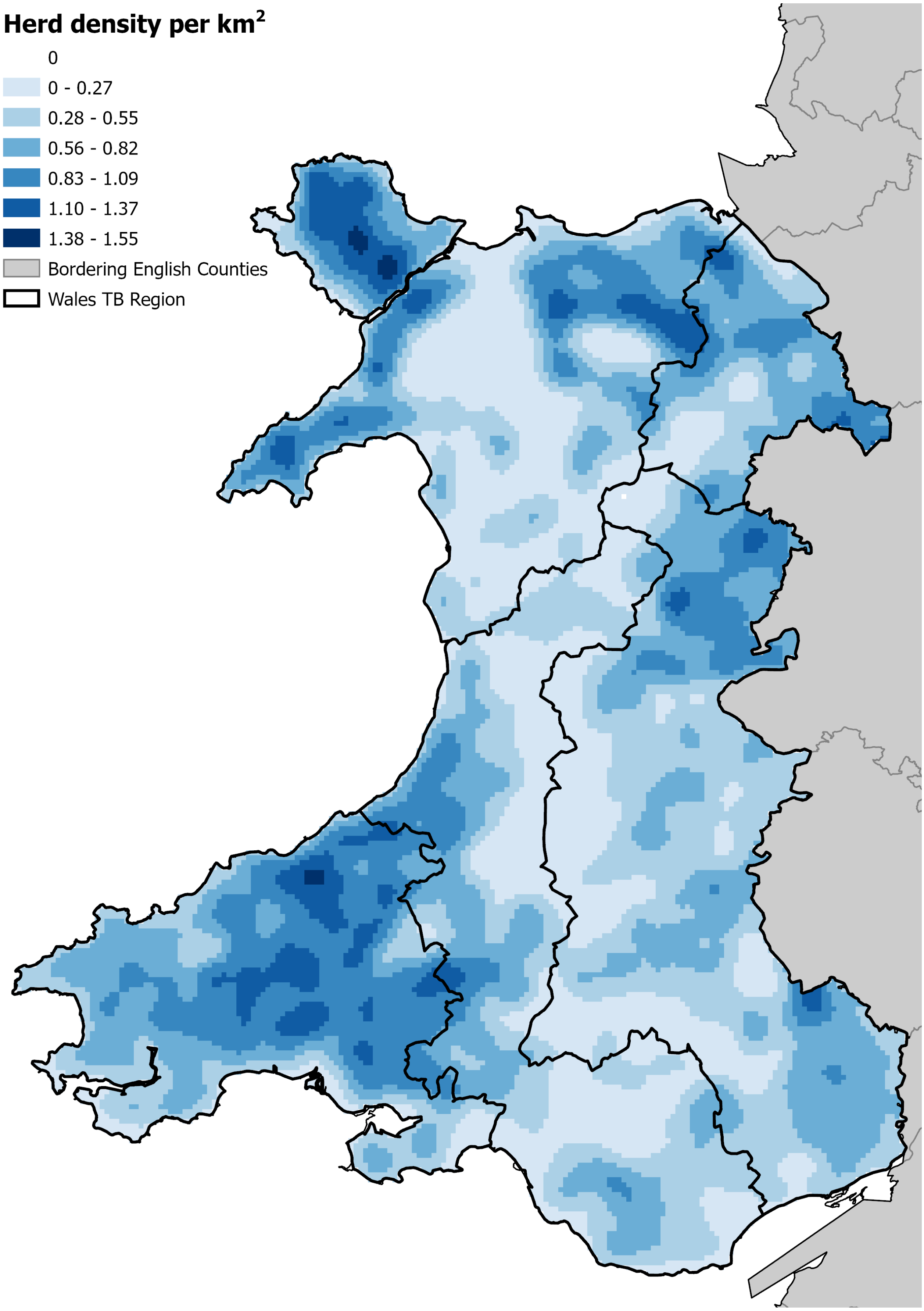

Figure 2.1.1: Density of cattle herds in Wales and English border counties, 2020

The number of cattle herds in existence on the 31st December 2020 has shown a 2% decrease in 2020 compared to 2019, observed across all TB Areas in Wales except in the LTBA (1%). In terms of the distribution of cattle herds across Wales, the percentage in each TB Area remains the same in 2020 to 2019, as does the distribution by herd type (Tables 2.1.1a, 2.1.2b). There has been a decreasing trend in the number of herds over the past three years, although the number of cattle increased slightly in 2020.

Cattle herds in Wales remain predominantly beef herds (77%) with some variation in the percentage, by TB Area (Table 2.1.1a). The percentage of dairy herds is at least twice as high in the ITBAN and HTBAW compared to other TB Areas.

Despite the disparity in the percentage of herds by production type due to dairy herds inherently being larger in size, the total number of cattle for dairy and beef herds in Wales is very similar. The total number of cattle is close to 600,000 cattle for each production type, and less than 14,000 for mixed/ other herds[2] (Tables 2.1.1b and c).

Table 2.1.1a: Herds in Wales (active on SAM) by herd type and TB area, end-2020

TB Area	Herds	Percentage of total herds in Wales	Beef [no. herds (%)]	Dairy [no. herds (%)]	Mixed / Other [no. herds (%)]
HTBAE	2,760	24	2,364 (86)	311 (11)	85 (3)
HTBAW	3,128	27	1,985 (63)	1,047 (33)	96 (3)
ITBAM	2,005	17	1,660 (83)	287 (14)	58 (3)
ITBAN	904	8	614 (68)	260 (29)	30 (3)
LTBA	2,792	24	2,333 (84)	341 (12)	118 (4)
Total	**11,589**	**100**	**8,956 (77)**	**2,246 (20)**	**387 (3)**

Table 2.1.1b: Number of cattle in Wales (active on SAM) by herd type and TB Area, end-2020

TB Area	Total cattle	Number of cattle from beef herds	Number of cattle from dairy herds	Number of cattle from mixed/ other herds
HTBAE	233,611	164,391 (70.4)	65,864 (28.2)	3,356 (1.4)
HTBAW	436,859	130,366 (29.8)	303,962 (69.6)	2,531 (0.6)
ITBAM	154,532	87,793 (56.8)	65,617 (42.5)	1,122 (0.7)
ITBAN	101,025	39,732 (39.3)	59,461 (58.9)	1,832 (1.8)
LTBA	253,950	169,743 (66.8)	79,432 (31.3)	4,775 (1.9)
Total	1,179,977	592,025 (50.2)	574,336 (48.7)	13,616 (1.2)

[2] N.B. Mixed/ other herds are those herds categorised as such on Sam, and includes calf rearers, unspecified dealer herds, AI, buffalo herds and herds bred or reared for products other than beef and dairy. It could also include temporary premises and quarantine facilities.

Table 2.1.1c: Number of herds in Wales (active on SAM) by herd size category, geographic location and herd type, end-2020

TB Area	Undeter-mined [1]	1-10	11-50	51-100	101-200	201-300	>300	Total
HTBAE	17	433	998	635	400	152	125	2,760
HTBAW	11	517	896	579	535	225	365	3,128
ITBAM	4	441	746	398	263	82	71	2,005
ITBAN	1	162	260	170	158	70	83	904
LTBA	16	511	981	525	424	159	176	2,792

Herd type	Undeter-mined [1]	1-10	11-50	51-100	101-200	201-300	>300	Total
Beef	12	1,792	3,468	1,923	1,218	334	209	8,956
Dairy	2	112	288	351	538	348	607	2,246
Other	35	160	125	33	24	6	4	387
Total in each herd size category	**49**	**2,064**	**3,881**	**2,307**	**1,780**	**688**	**820**	**11,589**

[1] Undetermined herd sizes arise due to no testing taking place or no cattle showing on the Cattle Tracing System (CTS). These are mainly herds that do not have cattle shown on CTS or no link on the CPH, hence are not tested. Many of these are listed as ‘temporary gatherings’ on SAM and are therefore not typical cattle farms.

The number of animal tests conducted in the reporting year had been increasing since 2016, with a 3% increase in 2018 (Table 2.1.2). The larger increase in 2018 may be because of the refreshed eradication strategy which was announced at the end of 2017. This included regionalisation of TB Areas and policy changes affecting testing e.g., post-movement testing in the LTBA and withdrawing the use of short-interval tests in chronic (or persistent) TB incidents as pre-movement tests.

The number of persistent TB incidents increased where severe interpretation at short-interval tests is used as an exit strategy. The number of short-interval tests are likely to have increased because of increased use of interferon gamma (IFN-y) testing on severe IRs, thus delaying the removal of TB restrictions in a breakdown. The use of check tests increased in 2018 and were used rather than short interval tests to ensure that there wasn’t a significant delay between herd breakdown tests. The number of check tests used as surveillance tests in Wales increased in 2020 compared to 2019, however the number used for disease control had decreased.

In 2020, the number of animal-level tests carried out (including SICCT, IFN-y and IDEXX tests, as well as post-mortem examination of slaughterhouse cases) dropped by 7%. This large decrease in 2020 compared to increases observed in previous years can in part be attributed to a decrease in incidence (which in turn will result in fewer short interval and contiguous herd tests being carried out), as well as a reduction in the number of field tests carried out due to Covid-19.

Table 2.1.2: Herds (active on SAM), cattle and animal-level tests, 2016-2020

Year	Total herds	% change in herds[1]	Total cattle[2]	% change in cattle[1]	Total tests (animal level)[3]	% change in tests[1]	Total tests (excluding SLH surveillance)	% change in tests[1]
2016	11,651	↓ 0.2	1,134,341	↑ 1.4	2,267,154	↑ 1.0	2,035,588	↑ 1.0
2017	11,978	↑ 2.8	1,137,399	↑ 0.3	2,275,632	↑ 0.4	2,049,445	↑ 0.4
2018	11,955	↓ 0.2	1,134,137	↓ 0.3	2,344,785	↑ 3.0	2,109,398	↑ 3.0
2019	11,775	↓ 1.5	1,119,844	↓ 1.3	2,347,762	↑ 0.1	2,109,531	↑ 0.1
2020	11,589	↓ 1.6	1,122,369	↑ 0.2	2,182,724	↓ 7.0	1,944,523	↓ 7.0

[1] Arrows indicate the direction of the percentage change from the previous reporting year: ↓ = reduction in number, ↑ = increase in number.

[2] Sourced from official Defra statistics.

[3] Tests for both surveillance and for disease control purposes are included (SICCT, IFN-y, IDEXX). Numbers of routinely slaughtered cattle (derived from CTS) are included because every carcase undergoes inspection for macroscopic lesions that could indicate TB.

2.2 Welsh cattle movements

Cattle movements within and between TB risk areas across GB can increase the risk of herds becoming infected with TB, particularly where movements into a herd are from herds at higher risk of infection.

Tables 2.2.1 a-e show the total (and percentage) of movements from each GB area (also by risk trading score) into each TB Area in Wales in 2020. These scores rank cattle herds based on their risk of being or becoming infected with TB (determined by the number of years the herd remains TB-free, combined with information on high-risk movements [see definitions and abbreviations in the supplementary document for further information]). There are several holdings where the risk score was unknown (as recorded in each table). Risk scores have been grouped into low (1 or 2), medium (3) or high (4 or 5) risk.

Most movements occurred in the LTBA (nearly 100,000 movements) compared to other TB Areas in Wales, with 65% of all movements occurring from within the LTBA (from low-risk herds). The HTBAW had the next highest number of movements of just over 94,000 movements, followed by the HTBAE (62,000) and the ITBAN and ITBAM (around 40,000 and 43,000 respectively).

In the HTBAE, a third of cattle movements were within the same TB Area, followed by 26% from the HRA in England, which is unsurprising considering the geographical location bordering English HRA counties (Table 2.2.1a). Nearly half (46%) of all movements had a risk score of 1 or 2, however nearly 40% also had the highest risk score of 4 or 5, most of which were from the HRA in England and from within the HTBAE. Although pre- and post-movement testing is used to mitigate the risk of moving cattle, having a large percentage of higher risk moves in the HTBAE increases the risk of disease transmission.

In the HTBAW, nearly 76% of all movements occurred within the same TB Area, followed by the ITBAM (11%) and the HRA in England (7%, Table 2.2.1b). Thirty-eight per cent of cattle movements across GB into the HTBAW have a risk score of 1 or 2, and 43% a high-risk score of 4 or 5.

In the ITBAM, 44% of cattle movements occurred within the same TB Area, and a further 30% from the HTBAW (Table 2.2.1c). Over half of all cattle movements were from holdings with a risk score of 1 or 2, 30% with a risk score of 4 or 5 and 16% with a medium risk score of 3.

In the ITBAN, 29% of cattle movements occurred within the same TB Area, and a further 30% from the Edge Area of England (Table 2.2.1d). A further 17% were from the LTBA and 15% from the HRA in England. Over half of all cattle movements were from holdings with a risk score of 1 or 2, and 34% with a risk score of 4 or 5.

In the LTBA, 77% of all cattle movements occurred within the same TB Area, and of these, over 65% were from holdings with a low-risk score of 1 or 2 (Table 2.2.1e). The LTBA had the lowest percentage of high-risk movements across all TB Areas, from holdings with a risk score of 4 or 5 (11%).

Table 2.2.1a-e: Number and percentage of animal movements from GB areas to each Welsh TB Area, 2020

(a) HTBAE

GB TB Area moved from	No risk score	Risk score 1/ 2	Risk score 3	Risk Score 4/5
Scotland	0 (0%)	272 (0.96%)	0 (0%)	3 (0.01%)
England: Edge	8 (0.7%)	1,290 (4.55%)	512 (5.55%)	1,983 (8.51%)
England: HRA	261 (22.68%)	5,072 (17.87%)	2,206 (23.92%)	8,709 (37.36%)
England: LRA	617 (53.61%)	1,698 (5.98%)	98 (1.06%)	13 (0.06%)
Wales: HTBAE	225 (19.55%)	8,998 (31.7%)	3,652 (39.6%)	7,796 (33.44%)
Wales: HTBAW	28 (2.43%)	2,318 (8.17%)	1,394 (15.11%)	3,054 (13.1%)
Wales: ITBAN	1 (0.09%)	2,654 (9.35%)	200 (2.17%)	483 (2.07%)
Wales: ITBAM	6 (0.52%)	4,493 (15.83%)	1,055 (11.44%)	1,169 (5.01%)
Wales: LTBA	5 (0.43%)	1,586 (5.59%)	106 (1.15%)	102 (0.44%)
Total	**1,151**	**28,381**	**9,223**	**23,312**

(b) HTBAW

GB TB Area moved from	No risk score	Risk score 1/ 2	Risk score 3	Risk Score 4/5
Scotland	0 (0%)	138 (0.38%)	0 (0%)	122 (0.3%)
England: Edge	0 (0%)	194 (0.54%)	219 (1.31%)	441 (1.08%)
England: HRA	22 (2.77%)	2,160 (6.02%)	713 (4.28%)	3,236 (7.92%)
England: LRA	2 (0.25%)	223 (0.62%)	39 (0.23%)	32 (0.08%)
Wales: HTBAE	0 (0%)	886 (2.47%)	327 (1.96%)	937 (2.29%)
Wales: HTBAW	657 (82.64%)	24,666 (68.79%)	14,007 (84.03%)	33,740 (82.58%)
Wales: ITBAN	0 (0%)	136 (0.38%)	31 (0.19%)	5 (0.01%)
Wales: ITBAM	114 (14.34%)	7,103 (19.81%)	1,326 (7.95%)	2,234 (5.47%)
Wales: LTBA	0 (0%)	351 (0.98%)	7 (0.04%)	110 (0.27%)
Total	**795**	**35,857**	**16,669**	**40,857**

(c) ITBAM

GB TB Area moved from	No risk score	Risk score 1/ 2	Risk score 3	Risk Score 4/5
Scotland	0 (0%)	56 (0.24%)	6 (0.09%)	0 (0%)
England: Edge	0 (0%)	268 (1.17%)	97 (1.38%)	493 (3.88%)
England: HRA	14 (4.36%)	1,360 (5.92%)	556 (7.93%)	1,778 (13.99%)
England: LRA	0 (0%)	469 (2.04%)	1 (0.01%)	1 (0.01%)
Wales: HTBAE	14 (4.36%)	1,398 (6.09%)	883 (12.59%)	993 (7.82%)
Wales: HTBAW	67 (20.87%)	3,880 (16.9%)	2,689 (38.34%)	6,146 (48.37%)
Wales: ITBAN	0 (0%)	437 (1.9%)	19 (0.27%)	50 (0.39%)

Wales: ITBAM	225 (70.09%)	13,197 (57.49%)	2,599 (37.05%)	2,985 (23.49%)
Wales: LTBA	1 (0.31%)	1,892 (8.24%)	164 (2.34%)	259 (2.04%)
Total	**321**	**22,957**	**7,014**	**12,705**

(d) ITBAN

GB TB Area moved from	No risk score	Risk score 1/ 2	Risk score 3	Risk Score 4/5
Scotland	0 (0%)	28 (0.13%)	0 (0%)	0 (0%)
England: Edge	5 (4.63%)	3,999 (18.99%)	1,483 (28.09%)	6,427 (46.83%)
England: HRA	6 (5.56%)	1488 (7.06%)	901 (17.06%)	3,731 (27.18%)
England: LRA	0 (0%)	815 (3.87%)	188 (3.56%)	43 (0.31%)
Wales: HTBAE	1 (0.93%)	509 (2.42%)	264 (5%)	861 (6.27%)
Wales: HTBAW	0 (0%)	109 (0.52%)	69 (1.31%)	57 (0.42%)
Wales: ITBAN	62 (57.41%)	7,820 (37.13%)	1,569 (29.72%)	2,213 (16.12%)
Wales: ITBAM	0 (0%)	434 (2.06%)	122 (2.31%)	47 (0.34%)
Wales: LTBA	34 (31.48%)	5,861 (27.83%)	684 (12.95%)	346 (2.52%)
Total	**108**	**21,063**	**5,280**	**13,725**

(e) LTBA

GB TB Area moved from	No risk score	Risk score 1/ 2	Risk score 3	Risk Score 4/5
Scotland	0 (0%)	690 (0.86%)	2 (0.03%)	0 (0%)
England: Edge	0 (0%)	1,805 (2.25%)	851 (12.14%)	1,862 (16.77%)
England: HRA	77 (6.03%)	967 (1.2%)	407 (5.81%)	2,221 (20.01%)
England: LRA	121 (9.48%)	3,185 (3.96%)	106 (1.51%)	70 (0.63%)
Wales: HTBAE	1 (0.08%)	674 (0.84%)	160 (2.28%)	221 (1.99%)
Wales: HTBAW	0 (0%)	248 (0.31%)	93 (1.33%)	227 (2.04%)
Wales: ITBAN	3 (0.23%)	6,803 (8.47%)	612 (8.73%)	927 (8.35%)
Wales: ITBAM	5 (0.39%)	1,032 (1.28%)	71 (1.01%)	63 (0.57%)
Wales: LTBA	1,070 (83.79%)	64,949 (80.83%)	4,707 (67.16%)	5,510 (49.64%)
Total	**1,277**	**80,353**	**7,009**	**11,101**

When comparing the previous three years for each TB Area, there has mostly been little variation in the percentage of movements from GB areas into each TB Area (Figure 2.2.1). However, there have been some changes, for example, the percentage of movements within the LTBA from the same TB Area has reduced by around 10% compared to 2019, with the difference being accounted for with increased movements from the HTBAE into the LTBA. In the HTBAE, there has also been a decrease in the percentage of movements from within the same TB Area and in comparison, an increase in the percentage of movements from the HRA in England.

However, there is wide variation between the movements when looking at each TB Area. This is heavily influenced by the location, for example, there are more movements from England risk areas to the HTBAE and ITBAN where they border English counties.

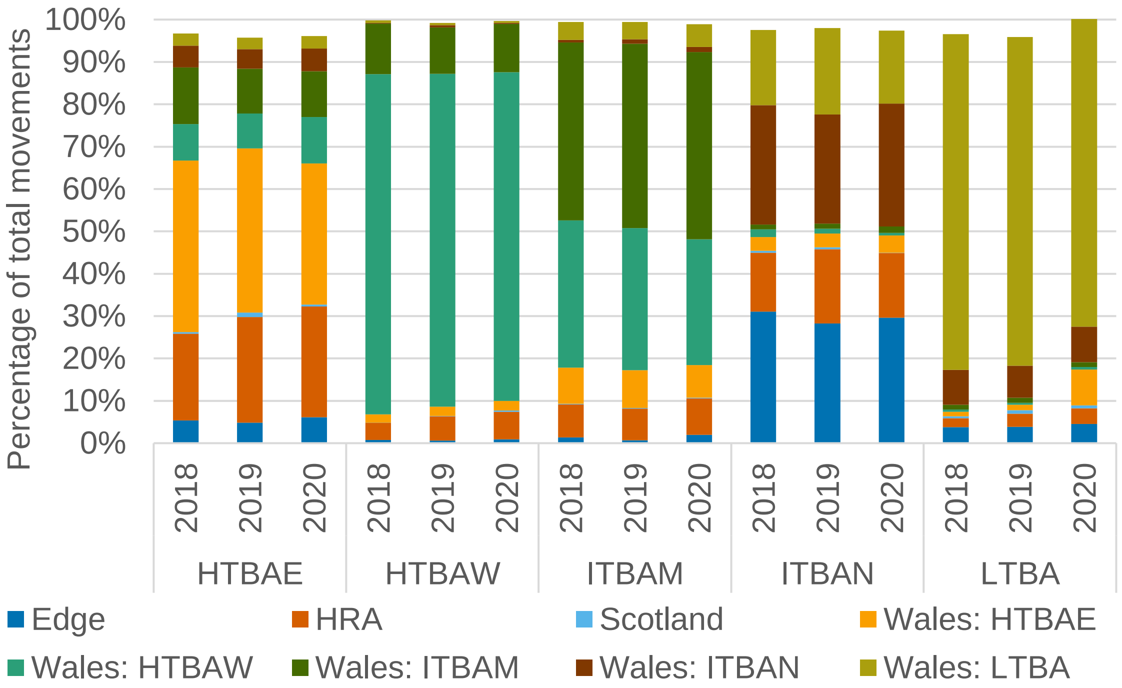

Figure 2.2.1: Percentage of animal movements into Welsh TB Areas from each GB area, 2018-2020

3. Cattle and herd tests

Key Points:

- In 2020, a total of 1.1 million TB tests (field and post-mortem examination) were carried out in Wales. A total of 614 new TB incidents were disclosed in Wales in 2020, 90% of which were classified as OTF-W.
- Apart from the LTBA, all other TB Areas of Wales saw a decrease in the number of skin tests carried out in 2020, attributed in part to a reduction in the number of new TB incidents in Wales since 2010, as well as a reduction in field testing in 2020 due to Covid-19.
- The number of reactors disclosed following standard interpretation of the tuberculin skin test increased in the HTBAE, ITBAN and LTBA.
- The percentage of skin tests disclosing reactors through severe interpretation has been increasing in the ITBAN since 2016, likely because of the increase in persistent TB herds. There was also an increase in the number of reactors disclosed through severe interpretation in the LTBA in 2020, above what has been recorded over the previous ten years.
- The percentage of IFN-γ tests that disclosed reactors in 2020 increased in all TB Areas apart from the LTBA, following a decline since 2016.
- Use of antibody blood tests increased by 85% in 2020 compared to 2019, with 11-13% of tests disclosing reactors in the HTBAW, HTBAE and ITBAM. The percentage of reactors disclosed in the ITBAN and LTBA was lower (9% and 7% respectively).
- Most TB incidents were disclosed through routine skin testing, area risk tests (contiguous herd) and herd-risk (post-incident) tests. The percentage of TB incidents disclosed by other surveillance testing (new herd, control, movement risk and slaughterhouse surveillance) methods has not changed much in 2020 compared to previous years.
- Thirty-five per cent of TB incidents were disclosed through area risk tests in Wales in 2020, showing a decline since 2019, likely because of fewer new TB incidents being disclosed overall. The number of TB incidents disclosed by area risk tests declined by 21% in 2020 compared to 2019 (215 vs. 271, respectively).
- The number of TB incidents disclosed by private, pre- and post-movement testing also decreased in 2020, by 25% compared to 2019.
- In contrast, TB incidents disclosed by routine (whole herd) testing increased by 15% in 2020 compared to 2019.
- There has been no change for three years in the median or mean number of reactors disclosed at the first whole herd test (short interval or check test) following disclosure of an incident through skin testing, or as SHC.
- The mean number of reactors disclosed at the first whole herd test following disclosure in the slaughterhouse increased sharply in 2020 (8 reactors). This may

be a result of some check tests (following a SHC) disclosing many reactors (102 reactors in Clwyd and 158 in Gwent), thus inflating the mean.

3.1 Numbers of tests (skin, interferon gamma and antibody) and reactors over time

Apart from the LTBA, all other TB Areas of Wales saw a decrease in the number of skin tests carried out in 2020. The number of herds has continued to decline since 2017 although the number of cattle increased slightly in 2020. Overall, the number of skin tests carried out decreased by 8% in 2020 compared to 2019. There was a 14% decline in the number of IFN-y tests carried out, and an 85% increase in the number of antibody tests carried out.

Since the implementation of annual testing in 2010, the number of new TB incidents has been decreasing, presumably because of greater detection and removal of infection. The reduction in field testing due to Covid-19 could have led to a reduction in the apparent incidence of TB in 2020

The percentage of skin tests disclosing reactors at standard interpretation increased in 2020 in all TB Areas apart from the ITBAM (Figure 3.1.1). There was a particularly sharp increase in the HTBAE from 0.15% in 2019 to 0.25% in 2020. In Wales, the number of new TB incidents has been falling since 2017 with the lowest number in 2020, however the number of reactors has increased between 2019 and 2020. The increase observed may be because of control testing increasing relative to routine surveillance tests, due to Covid-19.

Across most TB Areas of Wales, the percentage of skin tests at severe interpretation disclosing reactors has remained relatively stable since 2013, with small fluctuations.

In the ITBAN, there has been a steady increase in the percentage of skin tests (animal level) disclosing reactors since 2016, and in the HTBAW since 2017 (Figure 3.1.2). Although still extremely low, the LTBA saw an increase in 2020 above what has been recorded over the past ten years and beyond, at both standard and severe interpretation of the skin test. Increases in the ITBAN and LTBA can be linked to an increase in incidence in hotspot areas where otherwise the numbers of new TB incidents and reactors disclosed is low in comparison to the High TB Areas.

In 2020, all TB Areas except the LTBA showed an increase in the percentage of reactors disclosed by IFN-γ testing (Figure 3.1.3). There has mostly been a downward trend in the percentage of IFN-γ tests disclosing reactors in both High TB Areas and the LTBA since 2011, although all TB Areas experienced an increase in 2016. In the ITBAN, the percentage of reactors disclosed by IFN-γ has remained relatively stable since 2011, between two and five reactors. Despite greater variation in the ITBAM in each reporting year, there was an increasing trend in the percentage of reactors disclosed via IFN-γ tests from 2013 to 2016 and again in 2020.

Antibody tests supplement routine skin testing and are typically used in persistent TB herds. Apart from an incident in 2013 in the HTBAW where a total of seven reactors were disclosed from 10 antibody tests, antibody tests were not used in Wales until 2018. Since then, the number of tests carried out has been increasing, as has the percentage of test positives, particularly in the HTBAE and HTBAW (Figure 3.1.4).

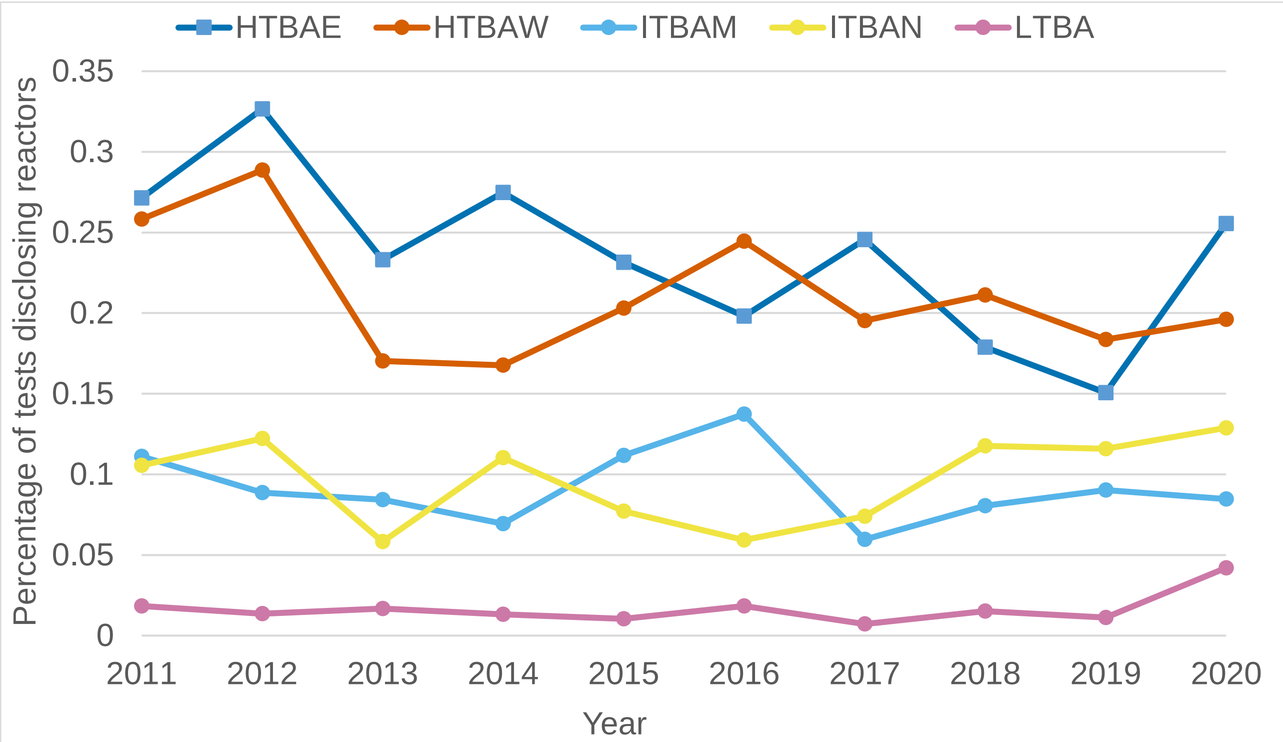

Figure 3.1.1: Percentage of SICCT cattle tests at standard interpretation that disclosed reactors, by TB Area (2011-2020)

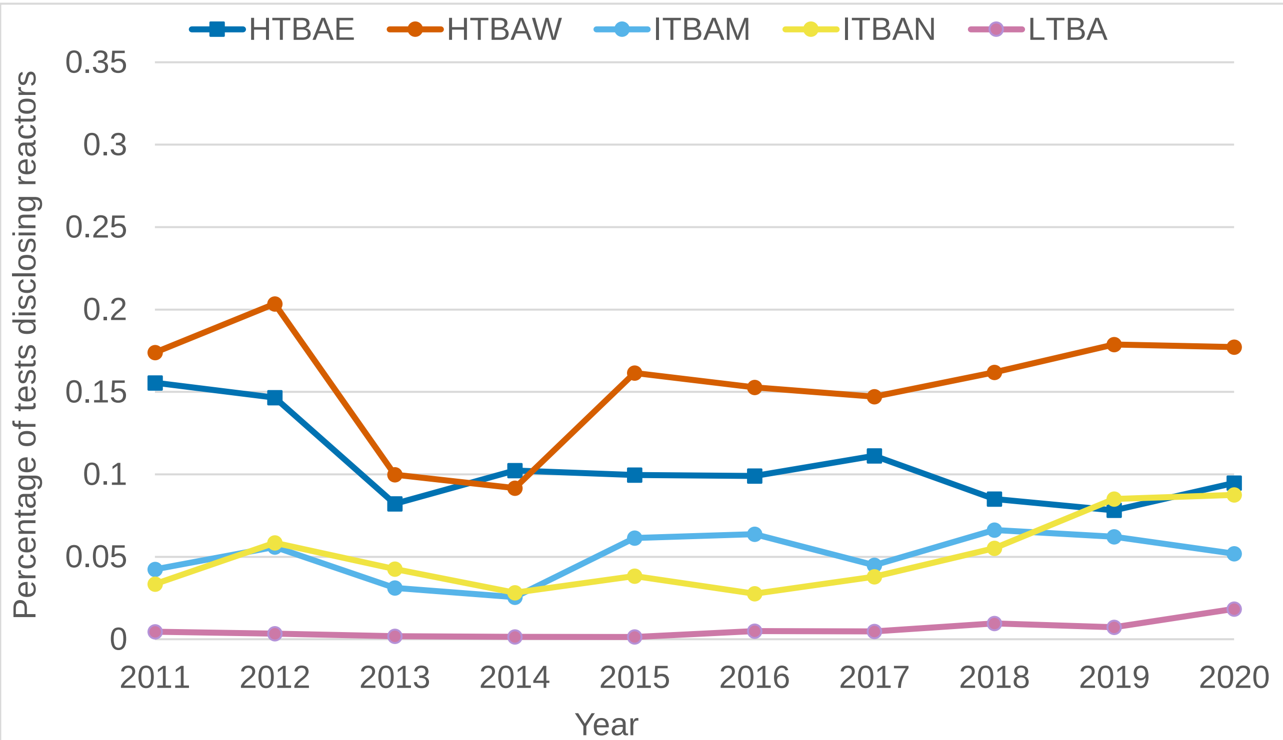

Figure 3.1.2: Percentage of SICCT cattle tests at severe interepretation that disclosed reactors, by TB Area (2011-2020)

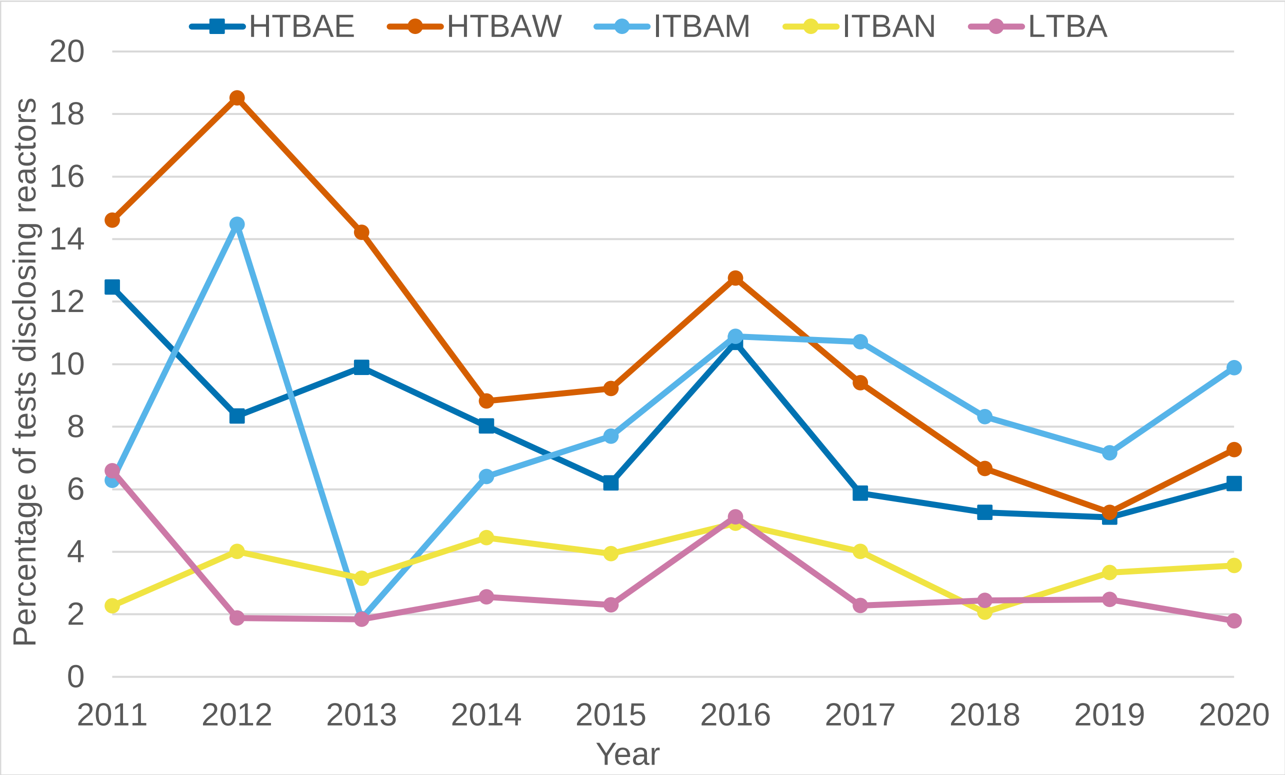

Figure 3.1.3: Percentage of IFN-γ cattle tests that disclosed reactors, by TB Area (2011-2020)

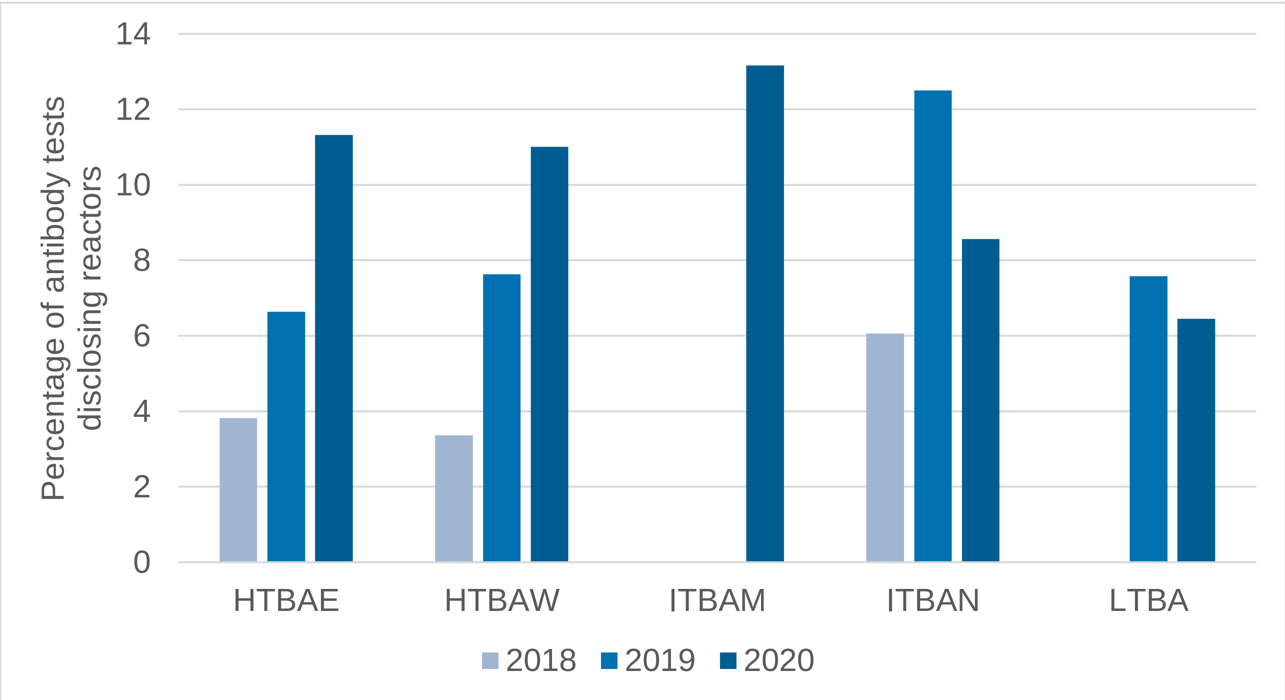

Figure 3.1.4: Percentage of antibody tests that disclosed reactors, by TB Area (2018-2020)

3.2 New TB incidents identified by different test types

In 2020, a total of 614 TB incidents were disclosed (552 OTF-W) and of these, 550 TB incidents were disclosed from routine surveillance testing (not through slaughterhouse surveillance) (See Appendix Table 4). Although Area Risk tests continue to disclose the largest number of TB incidents (35% in 2020), the number disclosed decreased by 21% compared to 2019. Area risk tests include testing of cattle herds contiguous to an OTF-W incident and at six and 12 months following. This decrease is likely linked to there being fewer new TB incidents in 2020.

The number of TB incidents disclosed by private, pre- and post-movement testing also decreased in 2020, by 25% compared to 2019.

In contrast, TB incidents disclosed by routine (whole herd) testing increased by 15% in 2020 compared to 2019. The percentage of TB incidents disclosed by different surveillance testing methods had otherwise not changed much in 2020 compared to 2019 and previous years (Figure 3.2.1).

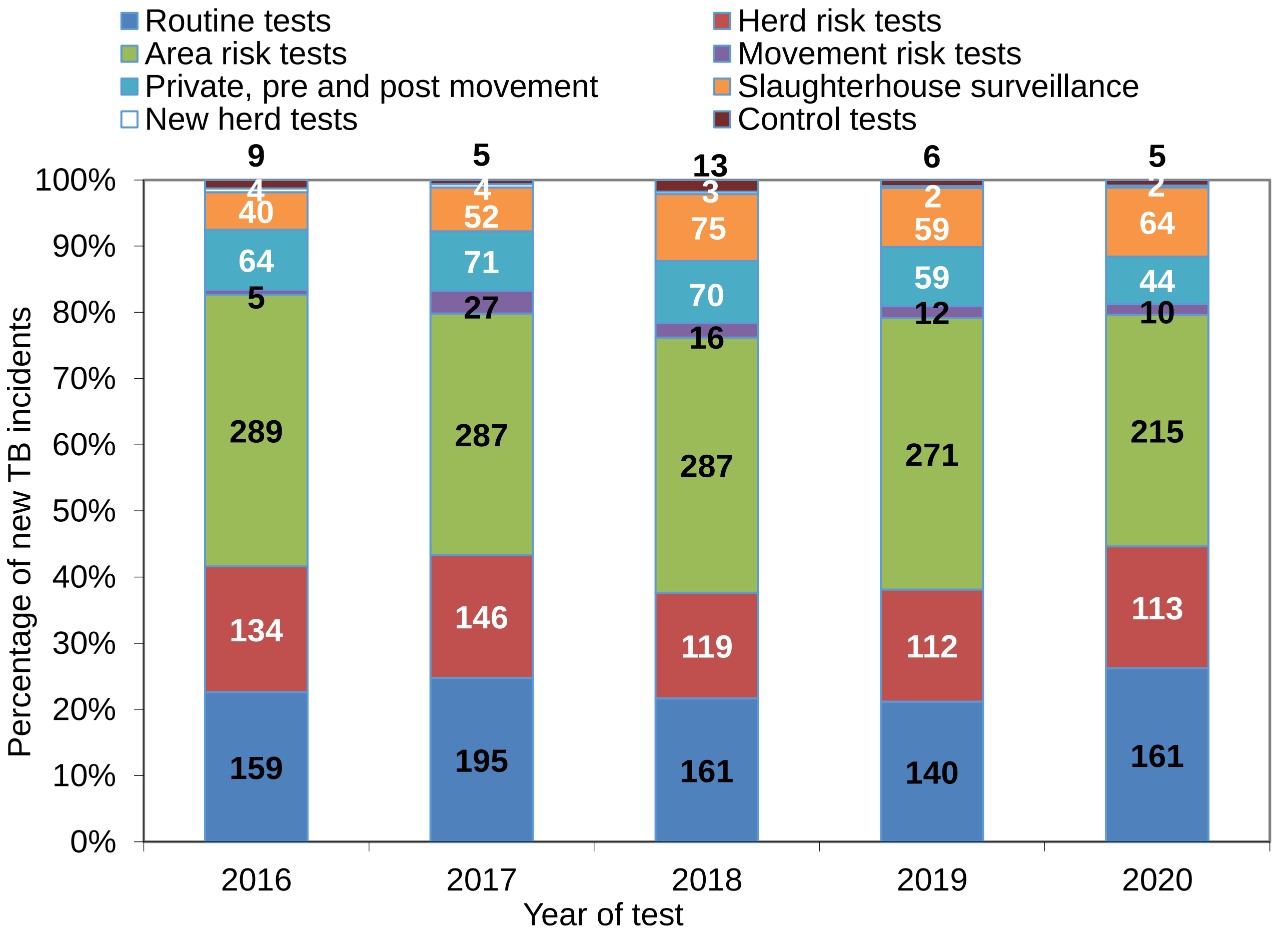

Figure 3.2.1: New TB incidents detected through different surveillance testing methods, 2016-2020

* Only one incident was detected as an "other" test type category in 2016 and is not presented here.

3.3 Animal level frequency of TB Infection

Over one million skin tests were performed on cattle in 2020, with the ratio of skin tests to animals tested being 1.6:1. In Wales, just over 5,000 (0.5%) animals that were skin tested were disclosed as a reactor and slaughtered (Table 3.3.1). The number of reactors per 1,000 animal tests varies by TB Area, but as expected is highest in the High TB Areas, followed by the Intermediate then Low TB Areas (Figure 3.3.1).

Just under 400 animals were slaughtered in Wales as inconclusive reactors (IRs), 83% of these were located in High TB Areas, with 64% in the HTBAW alone. This is likely to be associated with the number of persistent herd incidents where standard IRs are removed as reactors and culled. In 2020, 122 samples were submitted for culture during slaughterhouse surveillance with 61% found to be *M. bovis* positive (Table 3.3.2).

Table 3.3.1: Animal level frequency of reactors and inconclusive reactors in 2020

TB Area	Animals tested	Skin tests performed on animals	Animals slaughtered as reactors	% of animals disclosed as a reactor	Animals slaughtered as IRs[1]	% of animals disclosed as an IR
HTBAE	251,703	394,899	1,384	0.55	74	0.03
HTBAW	439,197	831,342	3,114	0.71	244	0.06
ITBAM	148,539	210,199	291	0.20	14	0.01
ITBAN	109,260	181,630	401	0.37	37	0.03
LTBA	226,496	266,676	161	0.07	13	0.01
Total Wales	**1,175,195**	**1,884,746**	**5,351**	**0.46**	**382**	**0.03**

[1]Includes 2 and 3 x IRs

Table 3.3.2: Culture results[1] from cattle with TB-like lesions detected during slaughterhouse surveillance, by TB Area, 2020

TB Area	No. samples submitted	*M. bovis* positive	*M. bovis* negative	Proportion *M. bovis* (%)
HTBAE	32	18	14	56.3
HTBAW	51	37	14	72.6
ITBAM	16	9	7	56.3
ITBAN	8	6	2	75.0
LTBA	15	5	10	33.3
Total Wales	**122**	**75**	**47**	**61.5**

[1] There were no contaminated samples recorded over the last five years, therefore they are not displayed in the table.

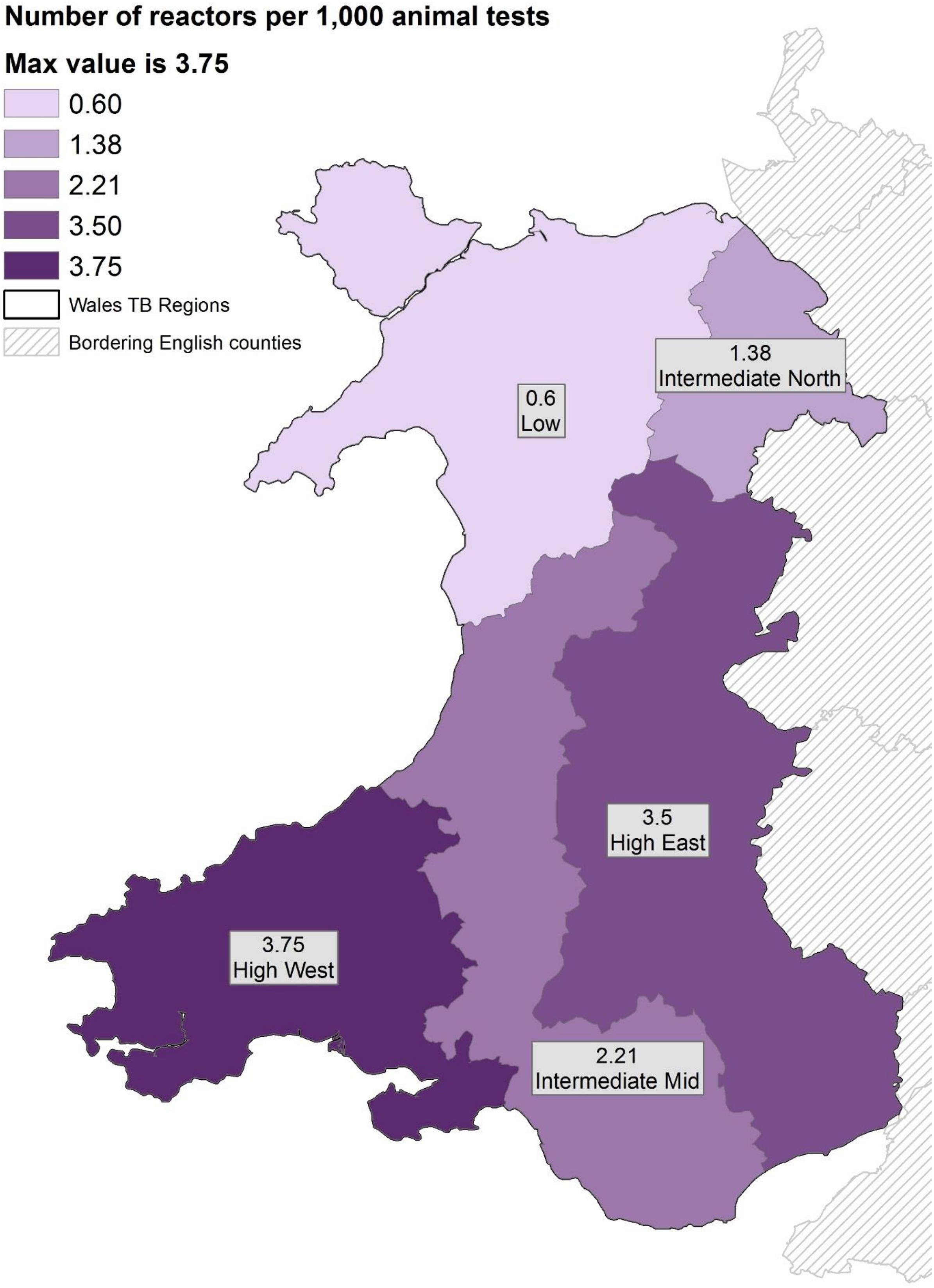

Figure 3.3.1: Reactors per 1,000 animal tests, 2020 (includes SICCT and IFN-γ tests)

3.4 Reactors in herd tests following detection of slaughterhouse cases

Figures 3.4.1 and 2 display ten-year trends in the mean and median number of reactors disclosed through skin testing and in the slaughterhouse at; (1) the first whole herd test following disclosure of an incident and (2) per incident that closed, respectively. Appendix tables 6 displays the data in more detail and by TB Area. There has been no change for the past three years in the median or mean number of reactors disclosed through skin testing, or median disclosed in the slaughterhouse. However, the mean number of reactors identified (at the first whole herd test following disclosure of an incident) in the slaughterhouse increased sharply in 2020 (8 reactors). This may be due to a small number of SHC incidents where a large number of reactors were disclosed at the first short interval test (for example 102 reactors in Clwyd and 158 in Gwent). Such outliers (especially with small sample size) inflate the mean, however the median is less affected and in 2020 showed no change.

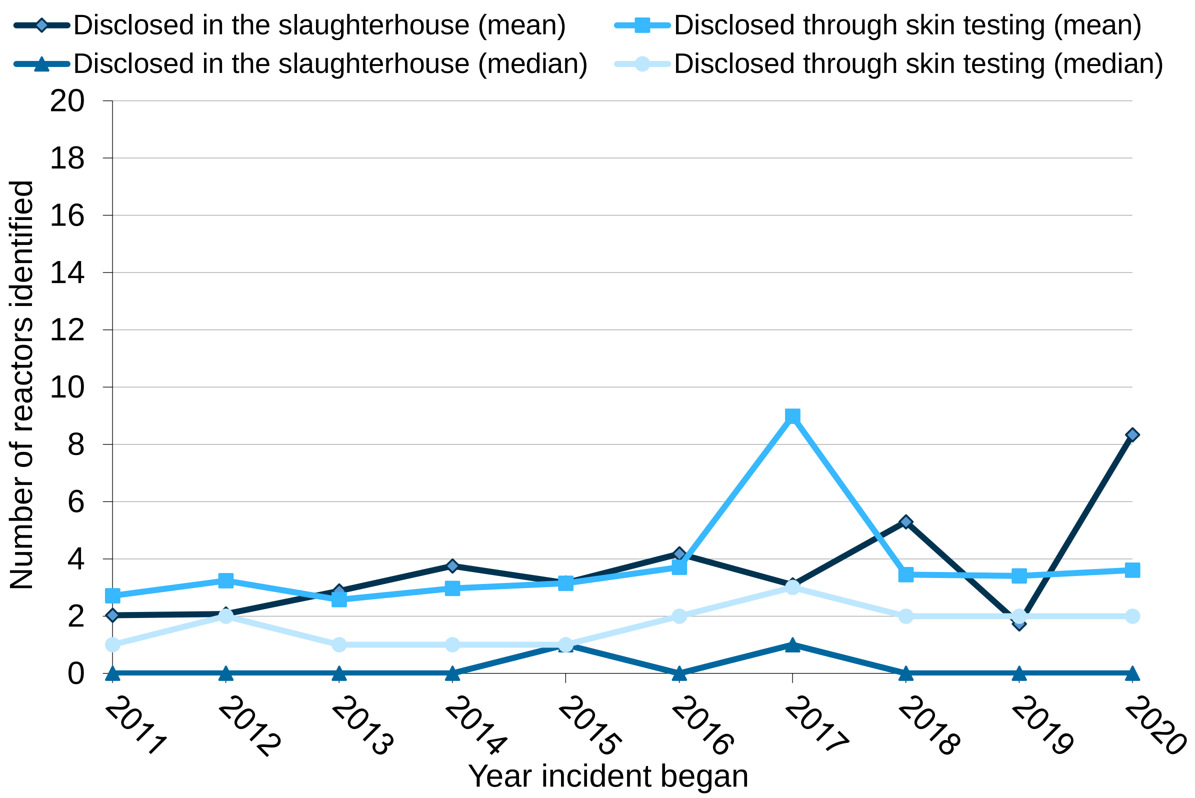

Figure 3.4.1: Reactors identified at the first whole herd test following disclosure of an incident, 2011 – 2020

The mean number of reactors identified per incident (either following a slaughterhouse case or surveillance (skin) testing that closed in each reporting year, is more variable due to outliers occurring in the data (Figure 3.4.2). For this reason, the median is generally a better indicator for changes in the data.

The median number of reactors disclosed through slaughterhouse inspection (for incidents closing in 2020) decreased to one following an increase over the previous two years, however this varied by TB Area (Appendix table 6). The median was one in the High TB Areas (where most incidents had been disclosed) but was higher in other areas, with a median of two reactors in the ITBAM, five in the LTBA and 14 in the ITBAN. In 2019, the median number in the ITBAM was zero, however the mean was particularly high, due to slaughterhouse incidents resulting from non-compliant official veterinarian (OV) testing. The number of incidents disclosed in the slaughterhouse is generally lower in the Intermediate and Low TB Areas compared to the High TB Areas.

The median number of reactors identified by skin testing during a TB incident, increased from three (since 2016) to four in 2020. For risk-based skin testing (testing during a TB incident), the median was higher in the HTBAW and ITBAN compared to Wales overall (seven reactors). For routine (whole herd) surveillance skin testing, the median number of reactors disclosed in each TB Area was one or two.

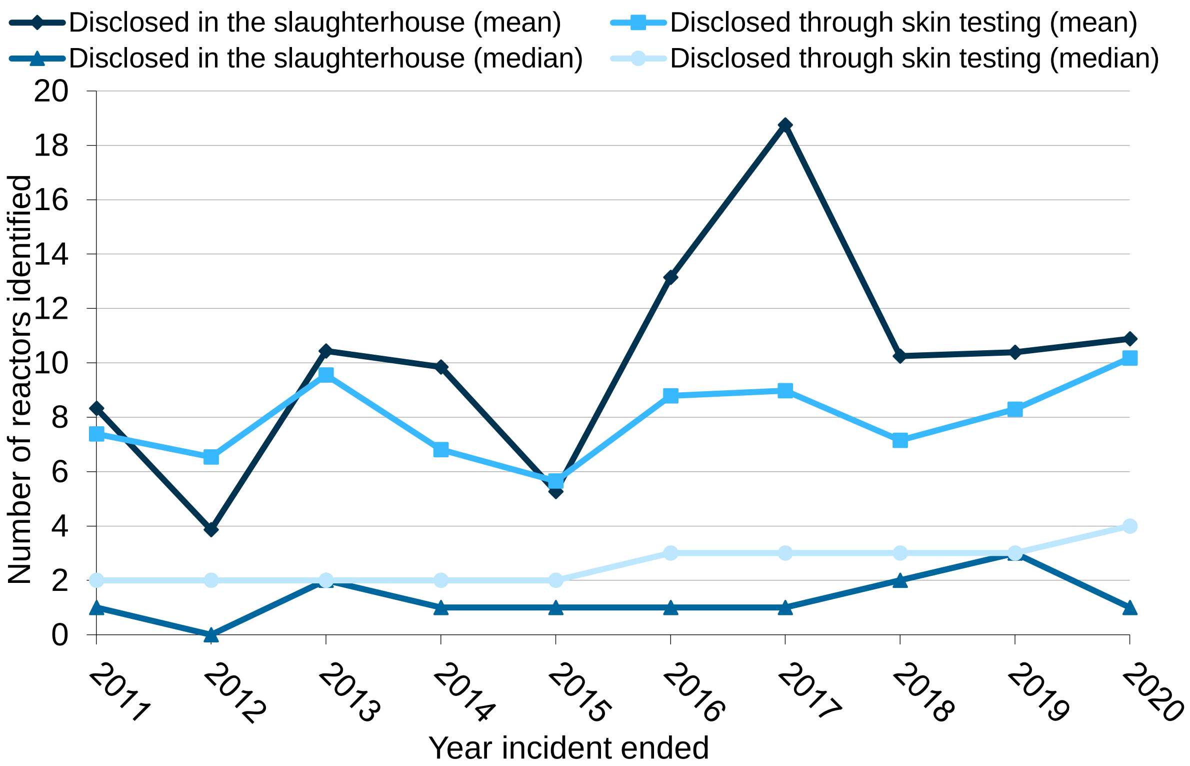

Figure 3.4.2: Reactors identified per incident that closed, 2011 – 2020

4. Incidence

Key Points:

- A total of 614 new TB incidents (OTF-W plus OTF-S) were disclosed in 2020, a decrease of 7% compared to 2019. This number differs to Defra's official statistics due to different data cleansing processes (detailed in Appendix 1).
- Despite a slight decrease in incidence per 100 herd years at risk (HYR) in Wales overall (6.6 in 2020 compared to 6.7 in 2019), there is variation by TB Area. In 2020, all TB Areas apart from the ITBAN and LTBA experienced a decline in the TB incidence rate.
- Incidence rates are highest in herd sizes of over 300 animals and this effect remains after adjusting for other risk factors (herd type and TB Area).
- Dairy herds had a significantly higher TB incidence rate compared to beef herds (14 TB incidents per 100 HYR), and this effect remained after adjusting for herd size and location.
- The ITBAN had more new TB incidents in 2020 compared to the ITBAM, for the first time since these TB Areas were defined.
- In 2020, a total of 268 TB incidents were disclosed by either contiguous, tracing or pre- and post-movement tests, equating to 44% of all TB incidents disclosed in Wales.
- In Wales overall, there was approximately 1,110.01 km^2 of spread since 2019 and 854.44 km^2 of retraction, resulting in a net change[1] of 255.57 km^2. Notably, large areas of spread were observed in the ITBAN and LTBA. Spread of the endemic area was also observed in the HTBAE and ITBAM. In other parts of the ITBAM, there were large areas of retraction which is consistent with the decline in incidence since 2019.
- Fifty per cent of TB incidents disclosed in the HTBAW and ITBAN in 2020 were in herds that had a TB incident within the last two years. The percentage of recurrent TB incidents also increased in the ITBAM, up to 30% in 2019 and 2020.
- In the HTBAE, the percentage of recurrent TB incidents was around 30% between 2017 and 2019 but increased to nearly 40% in 2020. In the LTBA, the percentage of recurrent incidents shows more variation due to a lower number of incidents, but in 2020 was around 8%.
- Herds with a history of TB (a TB incident occurring within previous two years) were more likely to have a TB incident in 2020, compared to herds with no TB history. Beef and dairy herds with TB history were twice as likely to have a TB incident in 2020 compared to herds with no TB history. Where there is no difference in recurrent TB incidents by herd type, this suggests that herd management does not play a factor.

[1] The net change refers to the area for which rate of spread could be calculated and does not include areas that are isolated from previous endemic areas.

- Smaller herds of 1-10 animals had significantly greater odds of experiencing a new TB incident in 2020 if they had history of TB in the last three years (OR=19.6), although the confidence intervals are very large due to such a small sample size (CI 4.8, 79.8). While larger herd size categories were twice as likely to incur a new TB incident where they had history of TB (compared to no TB history), the confidence intervals overlapped so it was not possible to discern any true differences (OR ranged from 2.0 to 2.6).
- The odds of a herd incurring a new TB incident in 2020 in herds with TB history was highest in the ITBAN (OR=4.6) followed by the ITBAM and HTBAW (OR=3.1 and 2.1 respectively). The increase in the odds of recurrence between herds with and without TB history was not statistically significant in the HTBAE and LTBA.
- The percentage of new TB incidents where reactors had previously been IRs was highest in the ITBAM and HTBAW (10.4 and 8.3% respectively) and closer to 2% in the ITBAN and HTBAE (1.7 and 1.5% respectively) having decreased in 2020. None were identified in the LTBA in 2020.

4.1 Summary of new TB incidents in Wales

The number of new TB incidents in Wales increased dramatically as a result of the interruption in testing during the Foot and Mouth disease (FMD) epidemic of 2001, up to 2009. As a result of TB Health Check Wales in 2008, a TB eradication programme was introduced in 2009. Following this and the implementation of annual testing of all herds (plus six-monthly in the IAA) from 2010, the number of new TB incidents in Wales has since been in decline. The number of new TB incidents per 100 unrestricted herds (12 month moving average) in 2020 is at the lowest point since around 2007 (Figure 4.1.1).

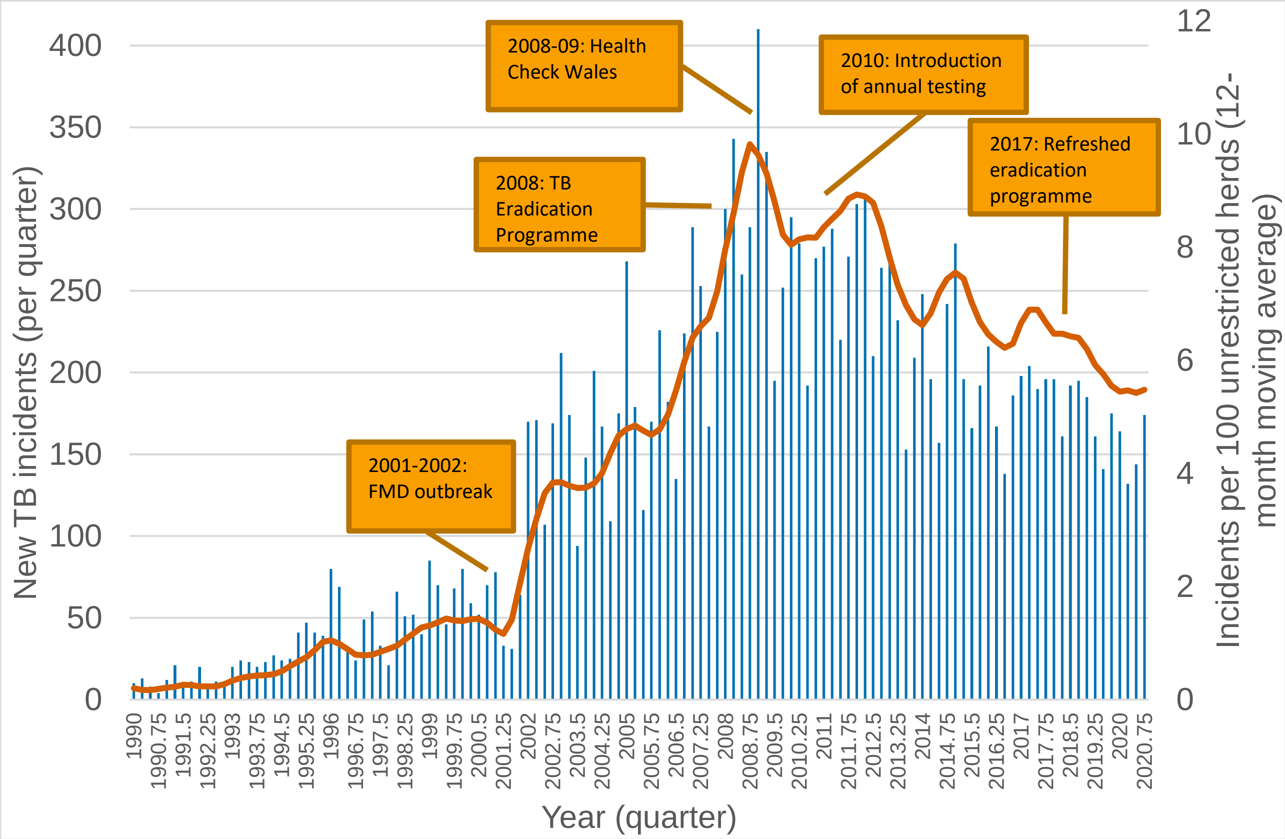

Figure 4.1.1: Number of new TB incidents each year, and 12 month moving average of incidents per 100 unrestricted herds, 1990-2020

The total number of TB incidents in Wales decreased in 2020 compared to 2019, which apart from 2012 and 2017, has been on a downward trend since the introduction of annual testing of herds in 2010 (Table 4.1.1, Figure 4.1.2). Most TB infected herds were in the High TB Areas. Most TB incidents in Wales are OTF-W and are concentrated in the Pembrokeshire area in the HTBAW and along the English/ Welsh border (HTBAE, Figure 4.1.3). The level of new infection (OTF-W herds) decreased in the High TB Areas and the ITBAM in 2020 but increased in the ITBAN and LTBA, linked to clusters of outbreaks located in Wrexham, North Powys and Denbigh.

Table 4.1.1: New TB incidents by TB Area in Wales, 2020 (2019 values and percentage change shown)

TB Area	Number of TB incidents 2020 (% change from 2019)	Number of TB incidents (2019)	Number of OTF-W incidents 2020 (% change from 2019)	Number of OTF-W incidents (2019)	Number of OTF-S incidents 2020 (% change from 2019)	Number of OTF-S incidents (2019)
HTBAE	201 (0)	201	189 (-3.6)	196	12 (-14.3)	14
HTBAW	253 (-17.9)	308	239 (-18.7)	294	14 (0)	14
ITBAM	48 (-36)	75	35 (-40.7)	59	13 (-18.8)	16
ITBAN	60 (33.3)	45	55 (48.6)	37	5 (-37.5)	8
LTBA	52 (32.4)	23	34 (88.9)	18	18 (260)	5
Wales overall	614 (-7.1)	661	552 (-8.6)	604	62 (8.8)	57

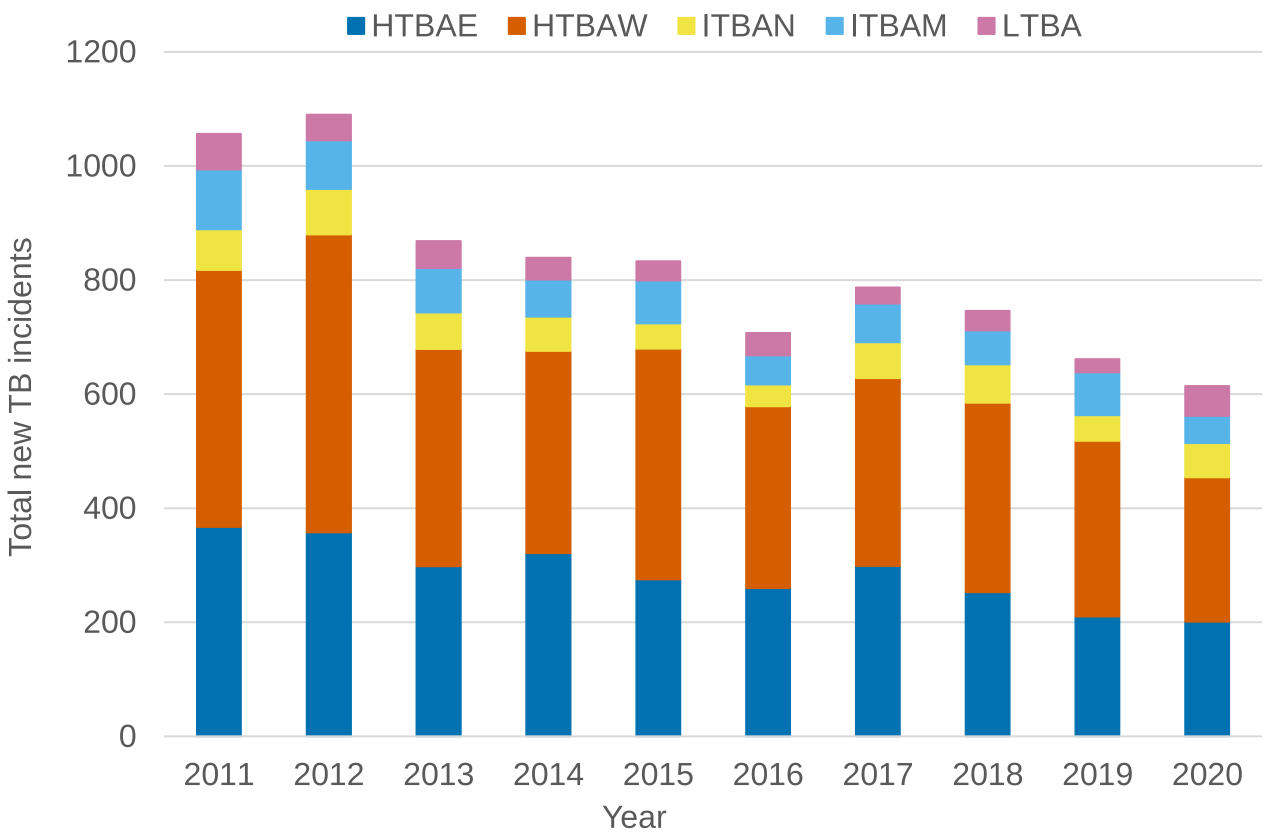

Figure 4.1.2: Annual trends in the total number of new TB incidents by TB Area, 2011-2020

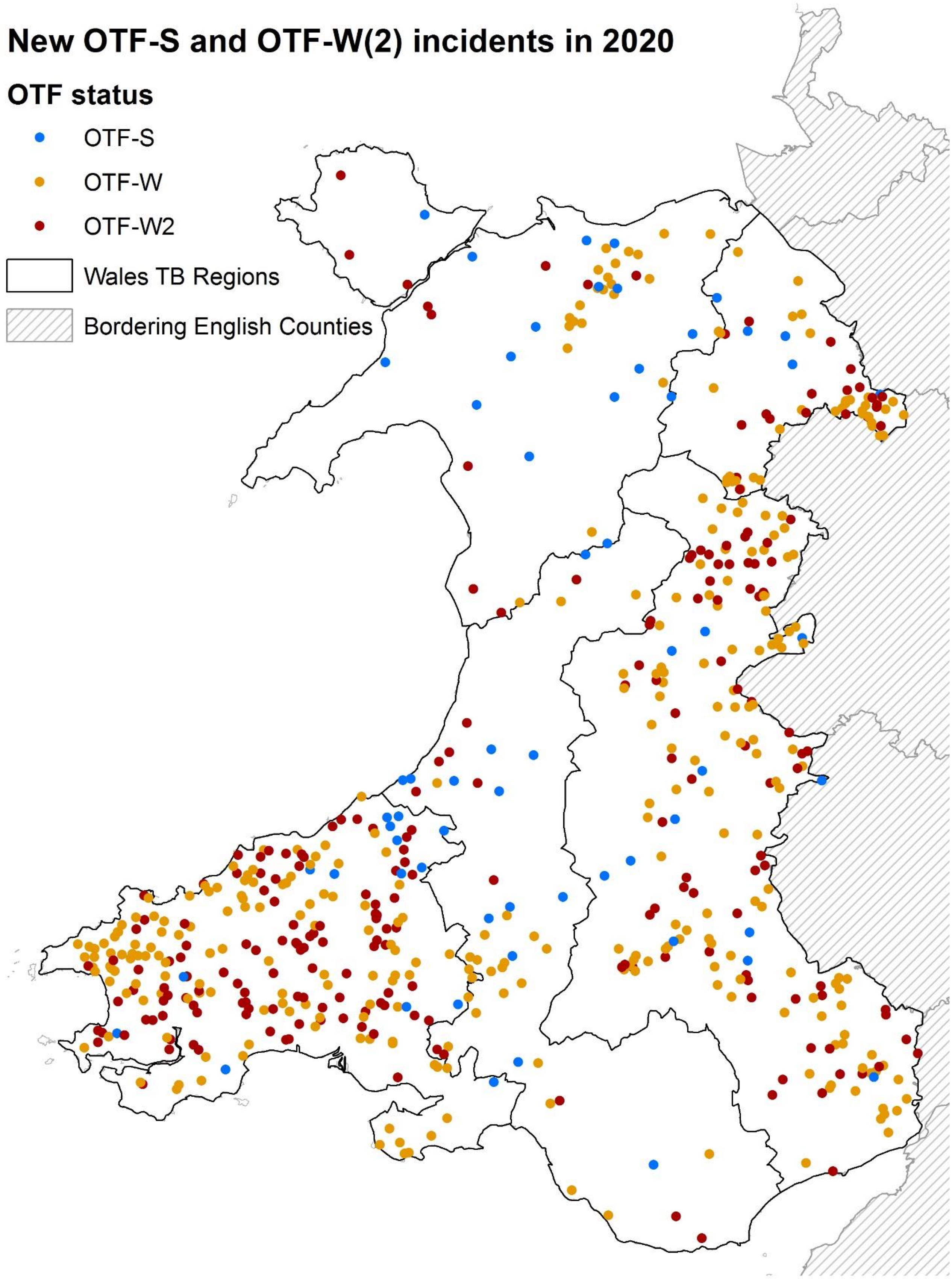

Figure 4.1.3: Geographical distribution of new OTF-W and OTF-S incidents occurring in Wales and bordering English counties, 2020

4.2 Bovine tuberculosis incidence

TB incidence is expressed as the number of new TB incidents per 100 unrestricted herds tested, per 100 live (or active) herds that are unrestricted at the start of the reporting period and as a rate, per 100 herd years at risk (HYR). Incidence rate per 100 HYR provides a reliable estimate as it accounts for variation in testing frequency over time. The methodology for calculating each measure of incidence is described in the supplementary document.

Incidence (across all measures) is highest in the HTBAW and HTBAE but decreased in both in 2020 compared to 2019. Incidence also reduced in the ITBAM but rose in both the ITBAN and LTBA, where clusters of infection are inflating TB incidence (Table 4.2.1). Enhanced control measures have been introduced to combat this increase, including those specific to persistent herd incidents and those recurrent at the six month check test*.

Table 4.2.1: Incidence of TB in Wales, 2020

New TB incidents per 100 susceptible herds at start of reporting period	**Total number of TB incidents 2020**	**Total number of TB incidents 2019**	**Number of OTF-W incidents 2020**	**Number of OTF-S Incidents 2020**	**Denominator (2020)**
HTBAE	7.3	*7.5*	6.8	0.4	2,760
HTBAW	8.1	*9.7*	7.6	0.4	3,128
ITBAM	2.4	*3.7*	1.7	0.6	2,005
ITBAN	6.6	*4.9*	6.1	0.6	904
LTBA	1.9	*0.8*	1.2	0.6	2,792
New TB incidents per 100 unrestricted herds tested	**Total TB 2020**	**Total TB 2019**	**OTF-W 2020**	**OTF-S 2020**	**Denominator[1] (2020)**
HTBAE	8.3	*8.5*	7.8	0.5	2,426
HTBAW	9.5	*11.2*	9.0	0.5	2,660
ITBAM	2.7	*4.2*	2.0	0.7	1,783
ITBAN	7.8	*5.7*	7.1	0.6	774
LTBA	2.2	*1.0*	1.4	0.8	2,356
New TB incidents per 100 herd years at risk	**Total TB 2020**	**Total TB 2019**	**OTF-W 2020**	**OTF-S 2020**	**Denominator[2] (2020)**
HTBAE	9.0	*9.3*	8.5	0.5	2,232
HTBAW	10.7	*12.4*	10.1	0.6	2,363
ITBAM	2.9	*4.4*	2.1	0.8	1,678
ITBAN	8.5	*6.0*	7.8	0.7	709
LTBA	2.2	*1.0*	1.5	0.8	2,329

[1] The herds tested denominator includes herds where any CPHH has had ≥one animal tested at any test during the year when not under restrictions, i.e., at or before the TB2 date.

* https://gov.wales/sites/default/files/publications/2021-05/bovine-tb-eradication-programme-frequently-asked-questions_0.pdf

[2] Number of 'herd-years at risk.'

4.3 Temporal trends in TB incidence in Wales

Although there is variation throughout the year, the number of new incidents per 100 unrestricted herds (in Wales overall) has plateaued in 2020 (Figure 4.3.1).

Temporal changes in the number of new incidents per 100 susceptible herds at the start of the reporting period (or live herds) and incidence rate per 100 HYR show a similar trend over time, with a decreasing trend since 2012, despite a small increase observed in 2017 (Figures 4.3.2a and b).

Incidence of OTF-S incidents has plateaued since 2016 after an initial decrease in 2011, as an artefact of OTF-S incidents being reclassified as OTF-W. This reclassification also narrowed the difference in incidence between OTF-W and total TB incidents which has remained around the same since 2017.

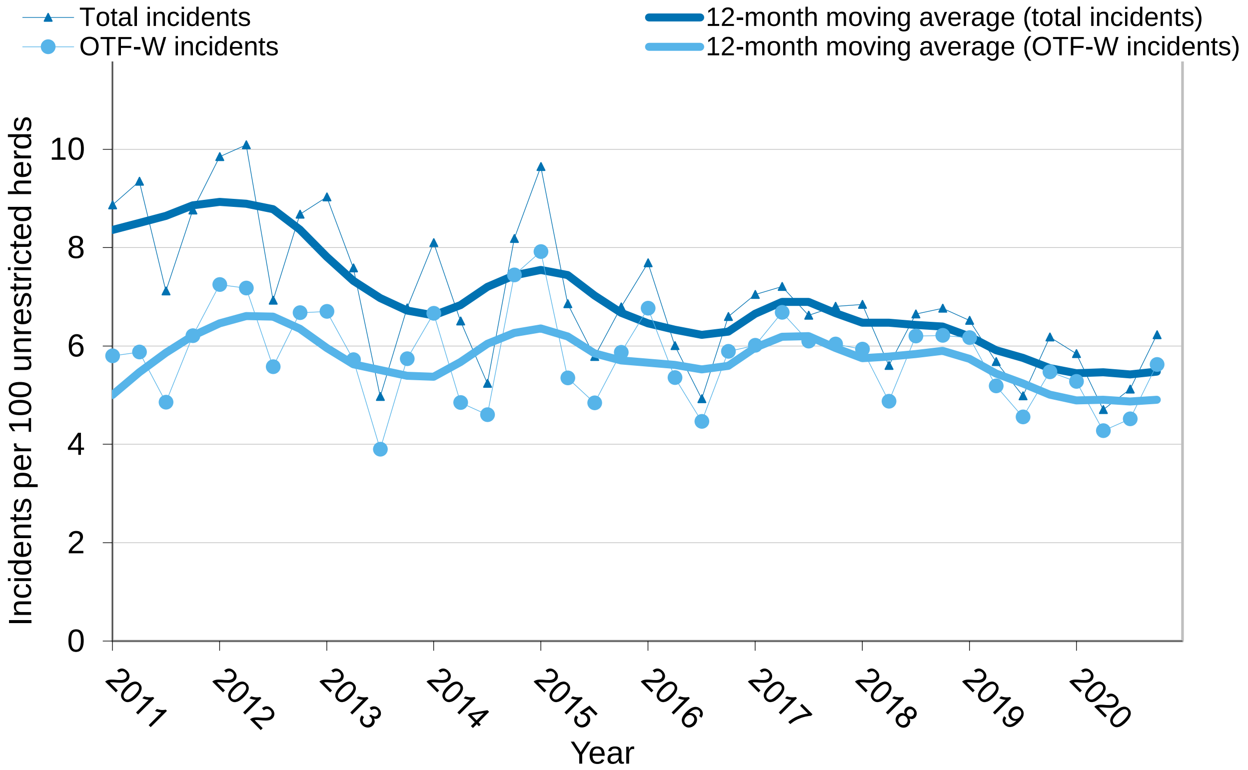

Figure 4.3.1: Quarterly number (and 12-month moving average) of total and OTF-W incidents per 100 unrestricted herds between January 2011 and December 2020

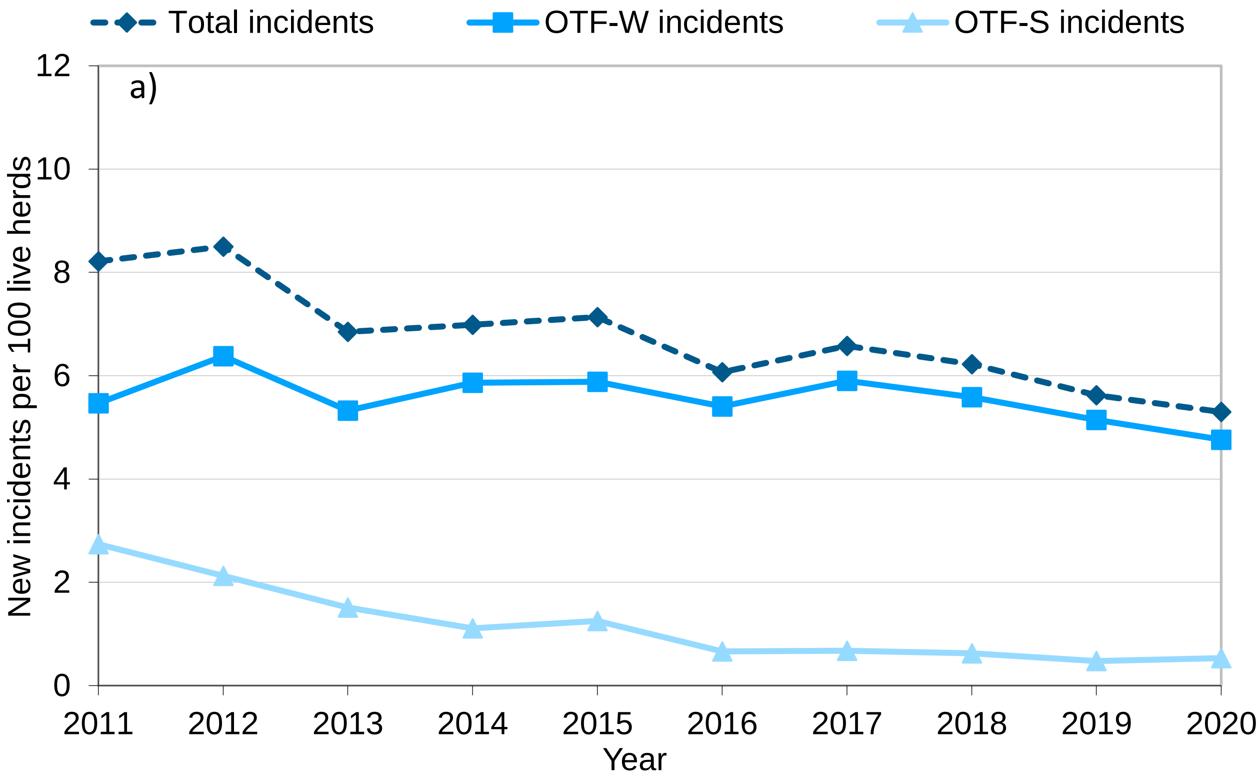

Figure 4.3.2a: Ten year trends in the total number of new incidents per 100 live herds

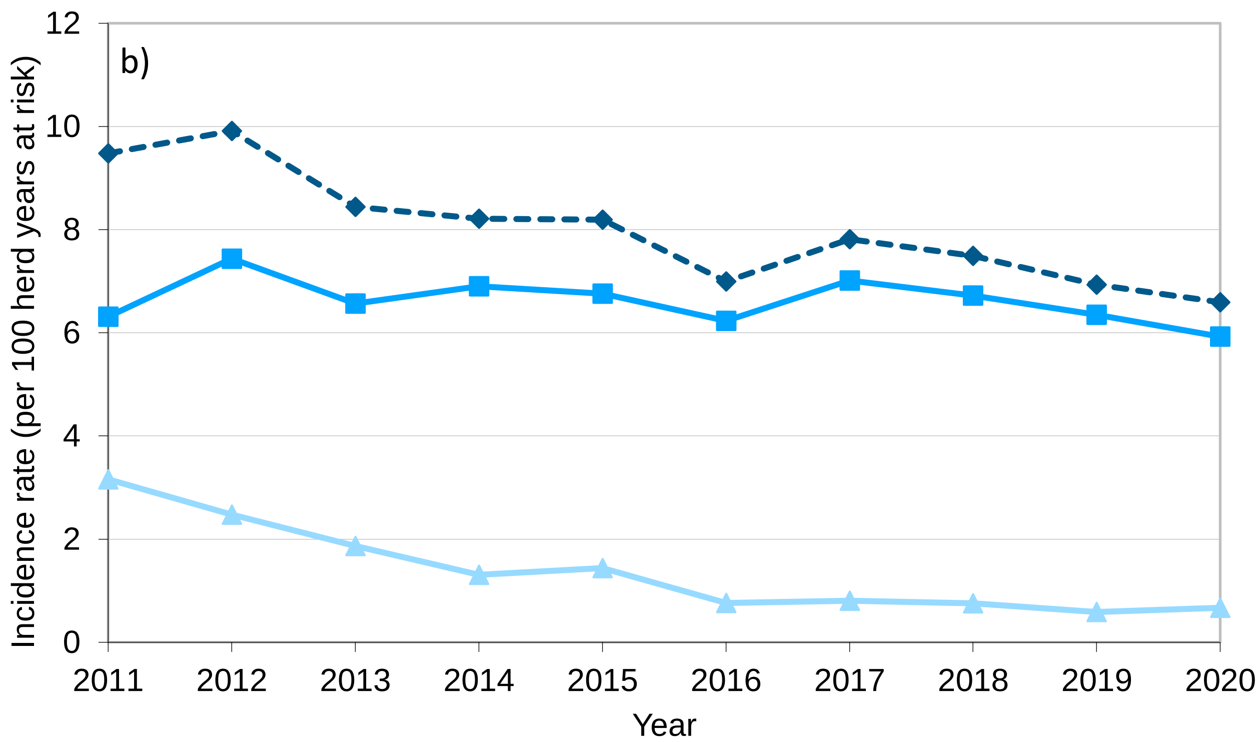

Figure 4.3.2b Ten year trends in the total number of new incidents per 100 herd years at risk

The small decrease in the number of new incidents per 100 unrestricted herds and per 100 HYR observed in Wales in 2020, masks variation by TB Area (Figures 4.3.3 and 4.3.4, respectively).

Incidence rate* has decreased in the HTBAE, HTBAW and ITBAM in 2020 compared to the previous year. In the ITBAN and LTBA, incidence rates have increased in 2020, to similar levels observed nine or ten years ago.

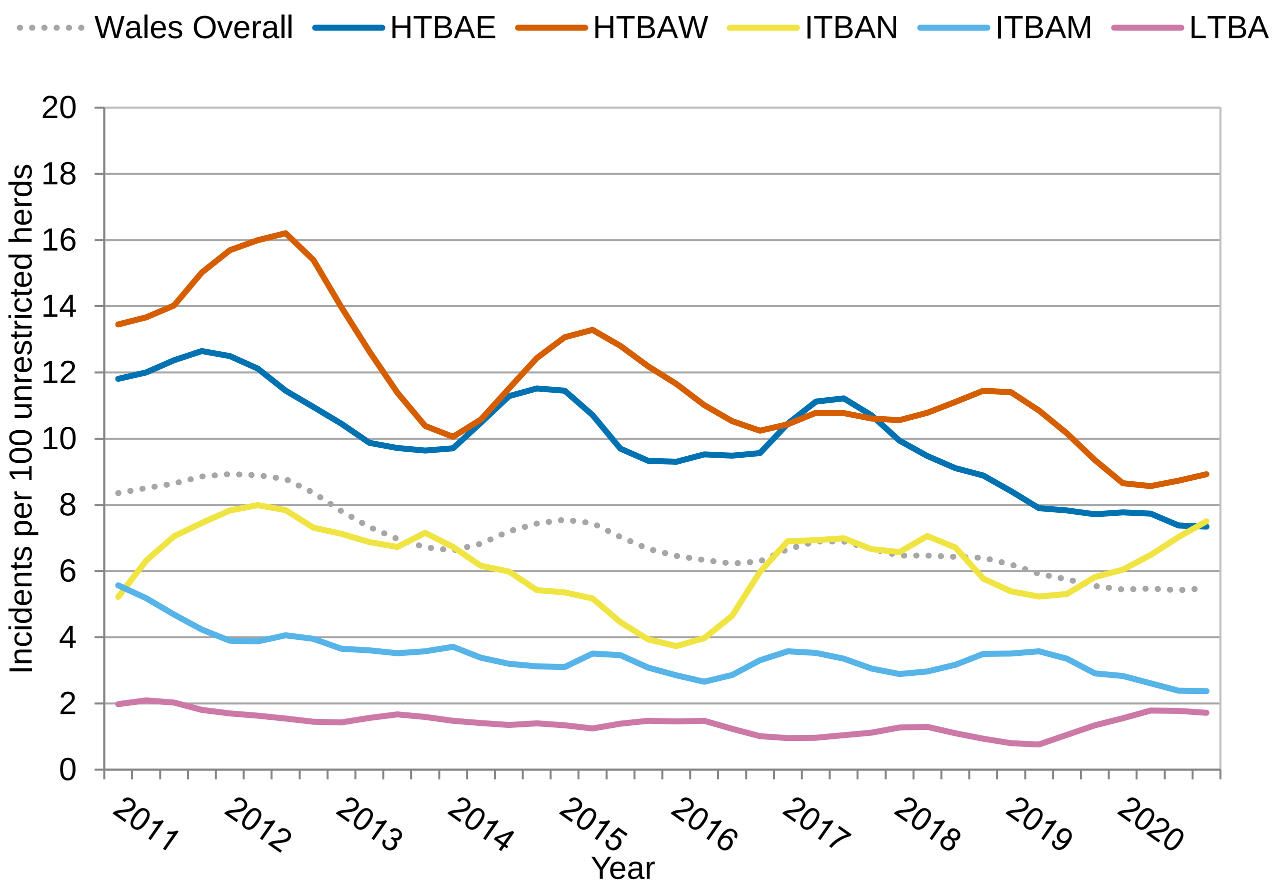

Figure 4.3.3: Trends in new incidents per 100 unrestricted herds, January 2011 – December 2020, by TB Area. The grey dotted line represents the overall trend in Wales[1,2]

[1] Quarterly (annualised), smoothed 12-month moving average

[2] New incidents per 100 unrestricted herds across the whole of Wales.

* The difference between incidence and incident rate is described in the supplementary document to this report

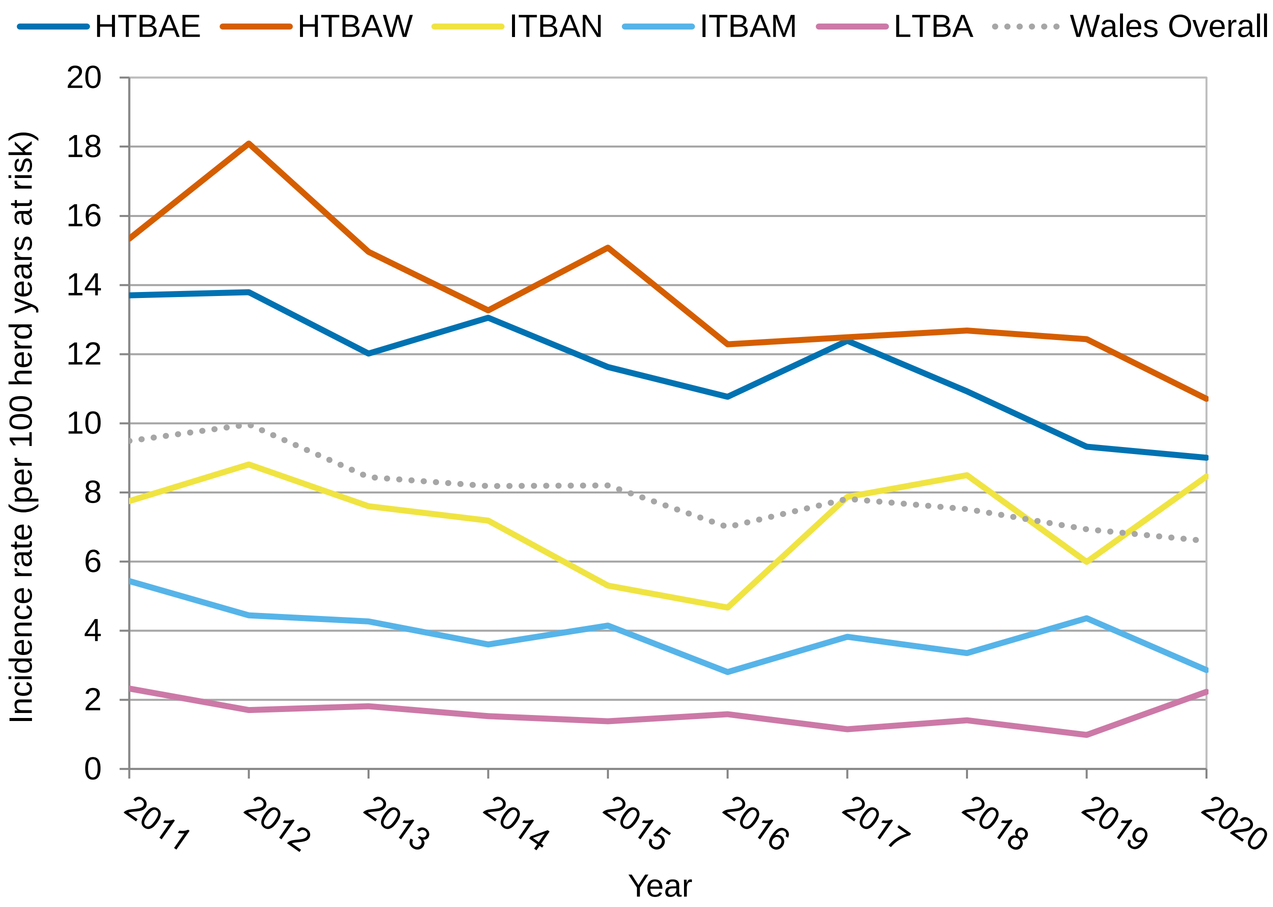

Figure 4.3.4: New incidents per 100 herd years at risk, 2011 – 2020, by TB Area. The grey dotted line represents the overall trend in Wales

4.4 Incidence of TB across Wales

Factors such as local herd density, herd size and type, TB infection history and geographic location are associated with a herd becoming infected with TB and therefore contribute to the spatial distribution of TB in Wales (Figure 4.4.1).

Herd size and local density of cattle herds have generally been positively associated with the risk of herds becoming infected with TB. There are areas of high cattle density in the HTBAE, HTBAW and parts of the ITBAM and ITBAN (Figure 1.1.1). The LTBA and the central mountainous ranges that are located throughout Wales (Snowdonia in the LTBA and the Cambrian Mountains and Brecon Beacons lying between the ITBAM and HTBAE) have the lowest cattle density and herd incidence. However, other factors such as local reservoirs of infection, contiguous herds, farm management and cattle movement may also affect the risk of TB infection. There are areas of high cattle density with low herd TB incidence (for example, in areas of the LTBA and west of the ITBAN).

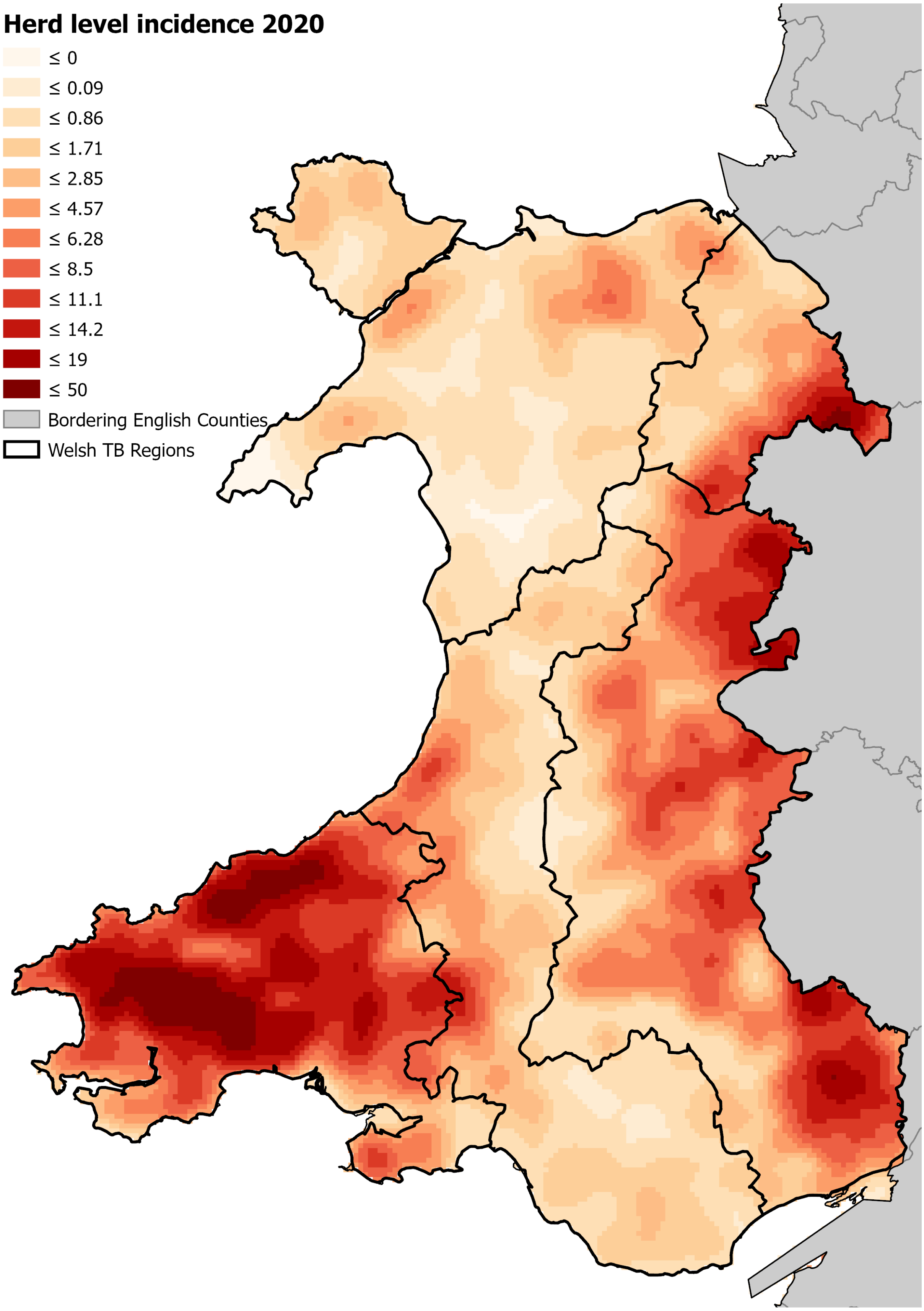

Figure 4.4.1: Herd level incidence of TB in Wales in 2020. Herd incidence is the average incidence in the 100 closest herds to each herd location which 'smooths' the effect of political boundaries

The map below (Figure 4.4.2) shows the spread and retraction of ‘endemically infected’ areas in Wales between 2019 and 2020. The definition of endemicity for the purpose of this map is described in more detail in the supplementary document. In brief, a geographical unit is considered endemic if there are at least three OTF-W incidents within a 7km radius within a two-year period. The geographical unit used to map the expansion and retraction of the endemic area in a 500x500m grid cell. This definition was developed under Defra-funded research project SE3045[*].

The output of this methodology can be influenced by areas of low cattle density and local purchasing behaviour, which in isolated cases may give the appearance of spread or retraction as the result of these factors, and not the endemicity of TB in cattle populations.

Figure 4.4.2 shows that nearly all the HTBAW is considered ‘endemically’ infected, albeit with small areas of retraction in the south and north. Similarly, a large proportion of the HTBAE is shown as a stable endemic area, with some areas of both spread and retraction along the west. In the remaining TB Areas, there are large parts not endemically infected, with pockets of ‘endemic’ infection. Large areas of spread can be seen in the ITBAN and LTBA particularly. Spread of the endemic area in the HTBAE and ITBAM has also been observed. In other parts of the ITBAM, this TB Area also shows areas with the greatest rate of retraction since the last period which would is consistent with the decline in incidence since 2019.

In Wales overall, there was calculated to be approximately 1,110.01 km^2 of spread since 2019 and 854.44 km^2 of retraction in other parts, resulting in a net change of 255.57 km^2. The net change refers to the area for which rate of spread could be calculated and does not include areas that are isolated from previous endemic areas.

[*] Brunton et al. (2015) https://www.sciencedirect.com/science/article/abs/pii/S1877584515000167?via%3Dihub

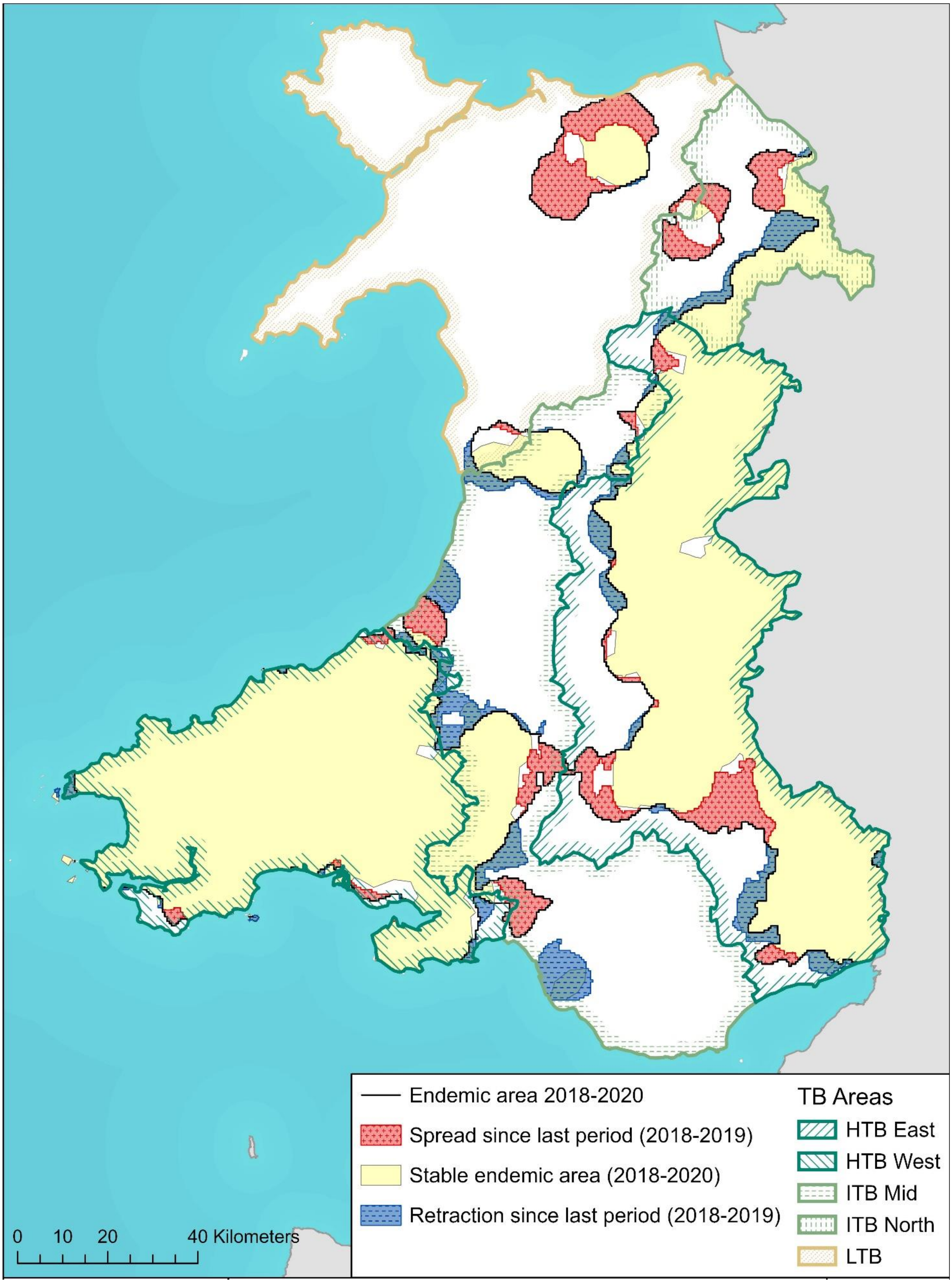

Figure 4.4.2: Spread and retraction of endemic TB areas in Wales

4.5 Variation in TB incidence by herd type, herd size and geographical area

A Poisson regression analysis was carried out to measure the association between factors known to be associated with TB and the incidence rate (Table 4.5.1; methodology described in supplementary document).

As documented in previous reporting years, incidence rates increase with herd size and are highest in herd sizes of over 300 animals, and this effect remains after adjusting for other risk factors (herd type and TB Area).

Incidence rates were highest in dairy herds (14 TB incidents per 100 HYR). A univariate analysis found that dairy herds had an incidence rate ratio (IRR) more than three times higher than beef herds. After adjusting for herd size and location, although still significant, the IRR had decreased to 1.4, indicating the strong evidence for the confounding effect (or association) of herd type and TB Area on herd size.

Incidence rates were highest in the HTBAW (this is the baseline category as incidence is highest in this TB Area). The IRR in the HTBAE and ITBAN was not significantly different to the HTBAW. This differs to previous years where the IRR in the ITBAN was significantly lower than in the HTBAW, reflecting the emerging clusters of infection identified in the ITBAN. In 2020, the IRR was significantly lower in the ITBAM and LTBA compared to the HTBAW, which is consistent with previous years and reflects the areas where incidence rates are lowest in Wales.

Table 4.5.1: Results from Poisson Regression of the association between TB incidence rate in 2020 and herd size, herd type and TB area

	Time at risk (years)	Number of new TB incidents	TB incidence rate (per 100 herd years)	Unadjusted[1] IRR	Adjusted[2] IRR[3]
Herd size					
1 – 10	1,204	10	0.83	0.03***	0.04***
11 – 50	3,272	85	2.60	0.11***	0.14***
50 – 100	2,117	136	6.42	0.26***	0.32***
100 – 200	1,563	144	9.21	0.38***	0.43***
200 – 300	578	88	15.23	0.62***	0.68**
>300	615	150	24.41	*Ref*	*Ref*
Herd type					
Beef	8,447	348	4.12	*Ref*	*Ref*
Dairy	1,858	259	13.94	3.38***	1.37**
Other/mixed	273	7	2.57	0.62[ns]	0.99[ns]
TB Area					
HTBAE	2,497	201	8.05	0.85 [ns]	1.12 [ns]
HTBAW	2,668	253	9.48	*Ref*	*Ref*
ITBAM	1,889	48	2.54	0.27***	0.38***
ITBAN	820	60	7.32	0.77 [ns]	0.81 [ns]
LTBA	2,704	52	1.92	0.20***	0.25***

*, **, *** and [ns] denote probability values of $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and $p > 0.05$ respectively with $p > 0.05$ interpreted as not statistically significant.

[1] Results of univariable Poisson regression analysis of the associations between herd size, herd type or geographical area and the incidence rate of new TB incidents.

[2] Results from Poisson regression analysis where the differences in the TB incidence rates were simultaneously adjusted for associations with herd size, herd type and/or geographical.

[3] The rate ratio is the incidence rate in each category / incidence rate in the reference category ['*Ref*']

4.6 Incidents disclosed in cattle moved into a herd (out of herd, or out of home-range genotypes)

A homerange refers to the geographical area that a specific genotype is most frequently recovered (see supplementary document for a more detailed definition). A 10km buffer is applied to each point where a genotype is located, creating polygons on the map (Figure 4.6.1).

Changes to note in 2020 compared to 2019 are the addition of a 17:a homerange in the LTBA. Also, 9:c in the HTBAW that wasn't observed in 2019, and an extension of 9:c in the southern part of the HTBAE. In 2019, there was a homerange for 17:c in Wales but this was no longer present in 2020. The homerange for genotype 22:a located mostly in the HTBAE bordering England has reduced in size in 2020 compared to 2019.

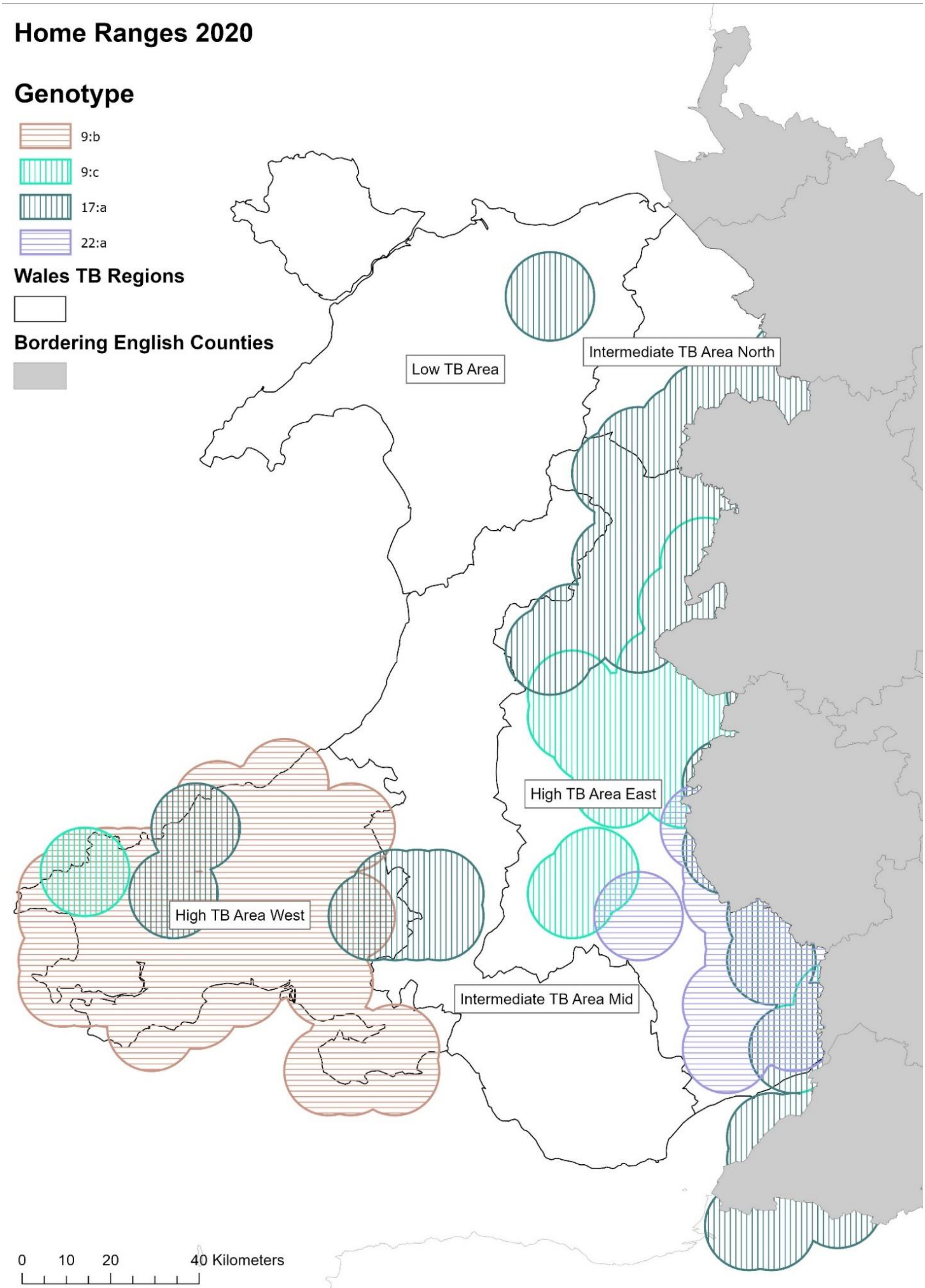

Figure 4.6.1: Homeranges for genotypes 9:b, 9:c, 17:a and 22:a

4.7 Incidents disclosed by trace testing, pre-movement or post-movement testing & contiguous testing

Tracing and contiguous tests are categorised under the surveillance stream for 'Area and Herd Risk', whereas pre- and post-movement testing falls under 'Trade and other'. Both are considered active surveillance through field testing of herds or individual cattle (see supplementary document for further information). It is important to note that tracing tests are not recorded if they are conducted at the same time as a routine surveillance test, therefore the total for tests conducted as part of this surveillance may not reflect all tests conducted for these purposes.

These tests are carried out where there is evidence that cattle are at greater risk of being infected, or for the purposes of trade.

In 2020, a total of 268 TB incidents were disclosed by either contiguous, tracing or pre- and post-movement tests, equating to 44% of all TB incidents disclosed in Wales (Appendix table 9). Area risk tests are carried out on herds contiguous to OTF-W incidents outside of their regular test frequency. In TB Areas in Wales apart from the LTBA, a large percentage of new TB incidents were disclosed through contiguous testing, the highest being in the HTBAE (nearly 44%), and in the ITBAN (40%). The HTBAW and ITBAM were both around 30% (Table 4.7.1).

Tracing tests can target higher risk herds and are often carried out on single animals or a proportion of a cattle herd. The importance of these tests is placed on the prevention of infection spread. However, the number of TB incidents disclosed from these tests is very low, with none disclosed in the ITBAM or ITBAN in 2020, and only nine incidents across the three remaining TB Areas.

Movement tests, as their name suggests, are carried out either prior to cattle movements, or following a cattle movement where cattle have either been moved to a holding that doesn't require a pre-movement test. In the LTBA, a post-movement test is required 60-120 days after an animal is moved into the LTBA. Just over 7% of TB incidents were disclosed from pre-movement testing in 2020 (44 in total). There were no TB incidents disclosed by post-movement testing in 2020 across Wales. By TB Area, the percentage of TB incidents that were disclosed via these tests varied from 3% in the ITBAN to 8.3% and 8.5% in the ITBAM and HTBAE, respectively.

Table 4.7.1: Total number of new TB incidents disclosed in 2020, by TB Area and total and percentage of TB incidents by contiguous, tracing and movement tests

TB Area	Total new TB incidents (2020)	Total (%) TB disclosed from contiguous tests	Total (%) TB disclosed from tracing tests	Total (%) TB disclosed from pre- and post-movement tests[1]
HTBAE	201	88 (43.8)	4 (2.0)	17 (8.5)
HTBAW	253	81 (32.0)	2 (0.8)	18 (7.1)
ITBAM	48	14 (29.2)	0 (0.0)	4 (8.3)
ITBAN	60	24 (40.0)	0 (0.0)	2 (3.3)
LTBA	52	8 (15.4)	3 (5.8)	3 (5.8)
	614	215 (35.0)	9 (1.5)	44 (7.2)

[1] Although the total is of pre- and post-movement tests, there were no TB incidents disclosed by post-movement testing in 2020.

4.8 Recurrent incidents

Recurrence of TB infection in cattle herds can result from persistence of infection from previous TB incidents, and because of newly introduced infection. The way recurrence is defined in this report is described in the supplementary document.

In 2020, recurrence was reported as herds with a new TB incident in 2020 that had experienced a TB incident in the previous two years. In previous reports, recurrence referred to a three-year history period. This is in line with Welsh Government's reporting of recurrent TB incidents (with a two-year history period) on their quarterly dashboard[1].

The percentage of OTF herds that had a TB incident in the previous two years remained relatively stable between 2016 and 2019, but in 2020, there was an increase in the HTBAE, HTBAW (both 20%) and the ITBAN (11%; Figure 4.8.1a). The percentage of OTF herds with a recurrent incident in 2020 in the ITBAM and LTBA was 7% and 2% respectively which was consistent compared to previous years.

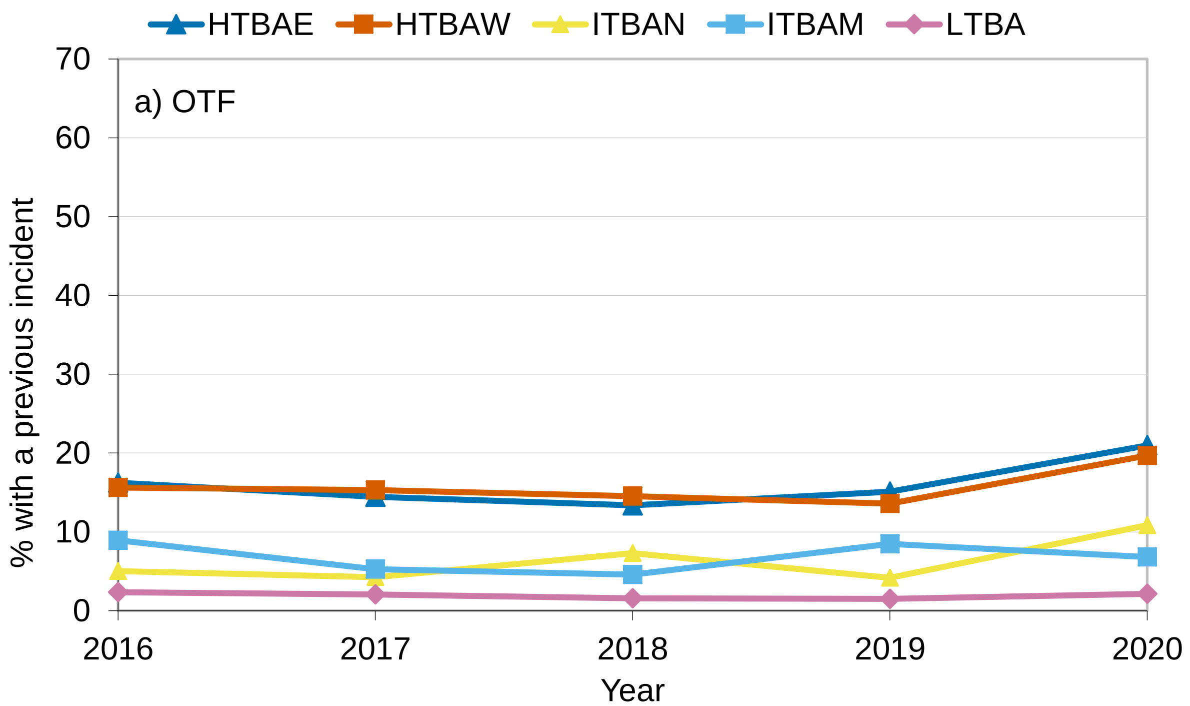

Figure 4.8.1a: Percentage of OTF herds in current period with any TB incident in the history period, by TB Area, 2016 – 2020

The percentage of herds with a TB incident in the reporting year that had previously disclosed TB infection in the previous two years is much higher compared to OTF herds,

[1] https://gov.wales/bovine-tb-dashboard

although variable across TB Areas (Figure 4.8.1b). Where infection rates have increased in the ITBAN, recurrence has also shown a sharp increase in the last two years (for new TB incidents disclosed in 2018 and 2019 which constituted two-year recurrence), reaching 50% in 2020, much like the HTBAW (51%). In the HTBAE, the percentage of recurrent TB incidents was stable at around 28% between 2017 and 2019, although increased again in 2020 (38%). After a decrease in 2017 in the ITBAM (from 30% in 2016 to 18%), the percentage of recurrent TB incidents each year has increased and reached 30% again in 2020. There are lower number of TB incidents disclosed in the LTBA and therefore the percentage of recurrent incidents has varied, but in 2020 was close to 8%.

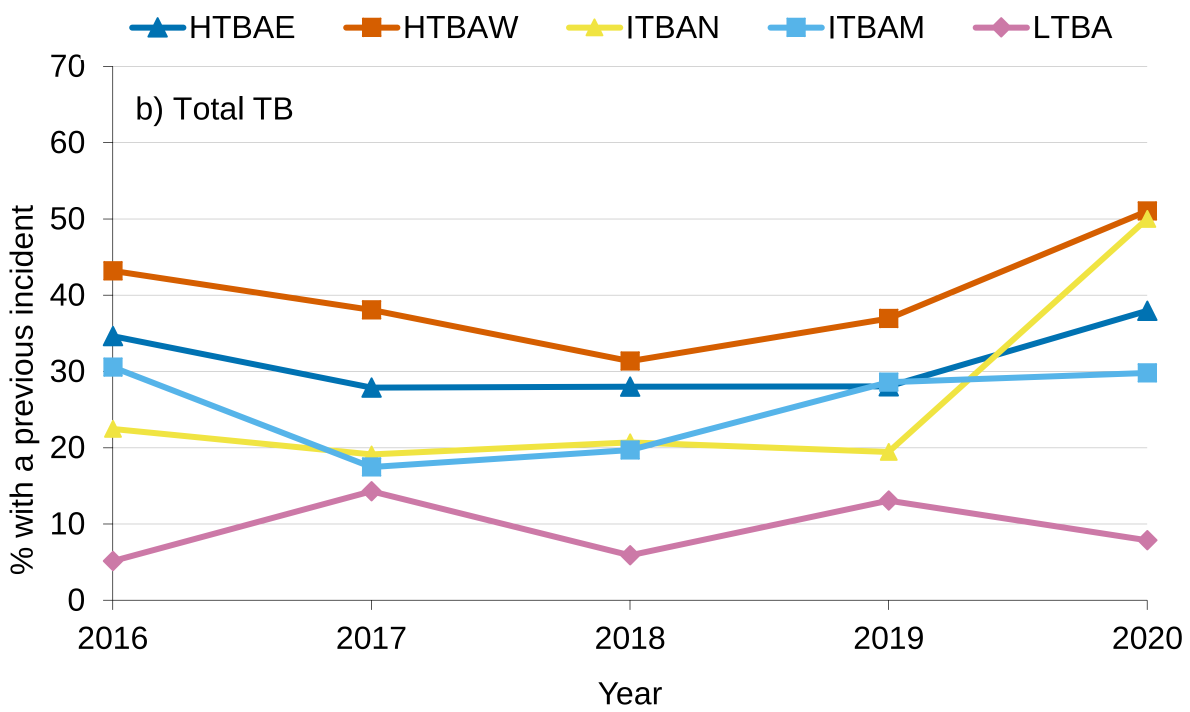

Figure 4.8.1b: Percentage of herds with any TB incident in the Current Period with any TB incident in the History Period, by TB Area, 2016 – 2020

A logistic regression is carried out each year to compare the odds of new TB incident occurring in herds with and without TB history (a previous TB incident in the last two years; (Table 4.8.1). In summary, the odds of a herd having a new TB incident were approximately double in herds with TB history compared to no TB history. This effect remained when adjusting the logistic regression for other variables such as herd type, size, and area, however there were some differences, as described below.

The odds of a new TB incident occurring in herds that had experienced a TB incident in the previous two years (history period) was consistently greater than in herds with no TB history. Herds of 1-10 animals had significantly greater odds of recurrence, however the confidence intervals are very large due to the small sample size in this category (odds ratio; OR=19.6; CI 4.8, 79.8). While larger herd size categories had significantly greater odds (apart from herd size 101-200) of incurring a new TB incident where they had history of TB (compared to no TB history), the confidence intervals overlapped so it was not possible to discern any true differences (OR ranged from 2.0 to 2.6).

Beef and dairy herds had similar odds of incurring a new TB incident (OR=1.8 and 2.1 respectively) in herds with a previous TB incident, compared to herds with no TB history. This suggests that production types do not affect recurrence in cattle. Although the OR was significant for 'other' cattle herds, the confidence intervals were extremely wide, based on the very small sample size (OR 19.2; CI 2.3, 160.7)

The odds of a new TB incident being disclosed in 2020 in herds with TB history was highest in the ITBAN (OR=4.3), followed by the ITBAM and HTBAW (OR=3.0 and 2.3 respectively). In the ITBAN, the OR has increased from 2.0 in 2019 to 4.3 in 2020, likely because of new clusters of TB infection being observed in the area (see chapter 9 for further information).

In the HTBAE and the LTBA, the increase in the odds of a new TB incident being disclosed was not statistically significant between herds with and without TB history in the previous three years.

Table 4.8.1: Logistic regression to determine the odds of a herd having a recurrent TB incident (from previous two years) in 2020 according to their TB history, by herd size, type and TB Area

	TB incident[1] Herds	**TB incident[1]** Incident in 2020 (%)	**No TB incident[1]** Herds	**No TB incident[1]** Incident in 2020 (%)	**Odds ratio (adjusted)[2]**	**95% CI for odds ratio**	**95% CI for odds ratio**
Herd Size							
1 - 10	35	3 (8.6)	2,070	7 (0.3)	19.6***	4.8	79.8
11 - 50	208	17 (8.2)	3,637	87 (2.4)	2.6**	1.5	4.5
51 - 100	242	31 (12.8)	2,004	102 (5.1)	2.0**	1.3	3.1
101 - 200	263	37 (14.1)	1,440	105 (7.3)	1.4ns	1.0	2.2
201 - 300	147	33 (22.4)	470	46 (9.8)	2.0*	1.2	3.3
>300	203	65 (32)	458	61 (13.3)	2.0**	1.4	3.1
Undetermined	0	0 (0)	1	0 (0)			
Herd type							
Beef	665	75 (11.3)	8,143	265 (3.3)	1.8***	1.4	2.4
Dairy	428	109 (25.5)	1,558	138 (8.9)	2.1***	1.5	2.8
Other	5	2 (40)	379	5 (1.3)	19.2**	2.3	160.7
TB Area							
HTBAE	398	50 (12.6)	2,262	145 (6.4)	1.2ns	0.9	1.7
HTBAW	483	105 (21.7)	2,414	142 (5.9)	2.3***	1.7	3.1
ITBAM	95	10 (10.5)	1,879	37 (2)	3.0**	1.4	6.3
ITBAN	77	19 (24.7)	788	35 (4.4)	4.3***	2.3	8.1
LTBA	45	2 (4.4)	2,737	49 (1.8)	1.3ns	0.3	5.5
Total	1,098	186 (16.9)	10,080	408 (4)			

*, **, *** and ns denote levels of statistical significance of p≤0.05, p≤0.01, p≤0.001, p>0.05 (not significant), respectively.

[1] Herds under restriction any time in the history period unless the restriction lasted for more than four months into 2020; in which case the herd was excluded from analyses. The History Period is defined as the 24 months preceding the start date of the recurrent incident or, where no recurrent incident has occurred in a herd, is the 24 months prior to the mid-point of the Current Period.

[2] The odds that herds under movement restrictions in the 24-month history period had a new TB incident in 2020 when compared with herds that had no history of movement restrictions in the previous 24 months.

The spatial distribution of recurrent OTF-W incidents (particularly in those with either one or two previous OTF-W incidents) are relatively stable over the last five years, tending to be concentrated in the HTBAE and HTBAW where the total number of new OTF-W incidents is highest (Figure 4.8.2).

In 2020, there were no new OTF-W incidents in herds that had experienced three previous OTF-W incidents in the last two years in Wales. There was one recorded in the English bordering counties. Across Wales, a total of 12 OTF-W incident herds had two previous OTF-W incidents in the last two years, and 178 had one previous OTF-W in the last two years.

In the HTBAW there were eight new OTF-W incidents identified in herds that had experienced two previous OTF-W incidents in the previous two years. The distribution of recurrent OTF-W incidents (with one previous OTF-W incident in the previous two years) was homogeneous across the entire TB Area, and higher in frequency compared to the HTBAE and other TB Areas.

In the HTBAE, recurrent TB incidents tended to be more concentrated along the eastern border with England and were particularly concentrated in the northern area bordering the ITBAN. Three OTF-W incidents were recorded in herds that had two previous OTF-W incidents within the last two years.

In the ITBAN, the number of recurrent TB incidents increased in 2020, and were particularly concentrated in the southernmost part neighbouring the HTBAE and in the eastern corner bordering England (Wrexham/ Maelor area (CL8)).

In the ITBAM there were fewer recurrent TB incidents in 2020. Recurrence in the LTBA is low, with only one new OTF-W incident in 2020 in a herd that had experienced an OTF-W incident in the previous three years.

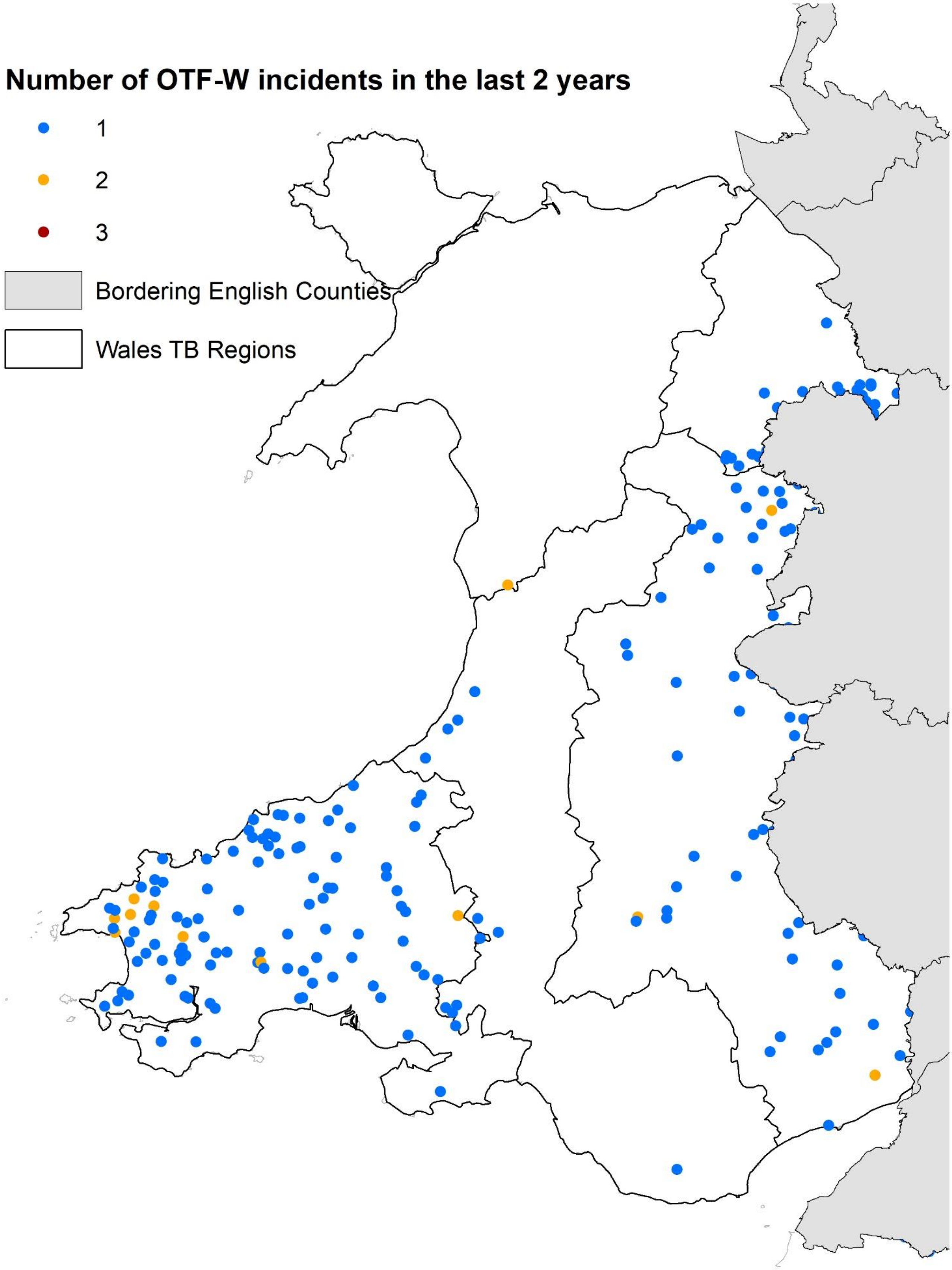

Figure 4.8.2: Herds with new bovine TB incidents in 2020 that had an OTF-W incident in the previous two years (recurrent incident herds)

TB incidents up to and including the 6M test where reactors had been IRs in previous TB incidents

Inconclusive reactors (IRs) are cattle which have a reaction to bovine tuberculosis from the SICCT test, but not large enough to be classified as a reactor, where the result is neither negative nor positive (see supplementary document for additional definition of IRs and chapter 7 for detail on the fate of IRs in 2020).

IRs can act as a predictor for the presence of TB infection in a herd. The following table (4.8.2) shows the number of TB incidents with reactors (or 2- or 3-times IRs) that had been an IR in a preceding TB incident, which ended within nine months of the current (2020) TB incident. Figure 4.8.3 gives a spatial representation of the data described below.

The preceding TB incident would have included reactors (or SHC), not just IRs. This can give an indication of where there could be uncleared infection, leading to recurrent infection.

In 2020, the percentage of new TB incidents where reactors had previously been IRs differs somewhat to 2019, with decreases observed in the HTBAE and ITBAN and an increase in the HTBAW and ITBAM. This percentage change is mostly affected by the denominator (total new TB incidents), since the number of TB incidents where reactors had previously been IRs has been relatively stable.

The percentage increase in the HTBAW and ITBAM, reflects where the highest number of reactors were identified, and the maximum number of reactors identified in any single TB incident. No reactors (that had previously been IRs) were identified in the LTBA in 2020.

Table 4.8.2: Number of TB incidents up to and including the six monthly test, where reactors had previously been IRs

TB Area	Number of TB incidents where reactors had previously been IRs	% of total new TB incidents where reactors had previously been IRs	Total Reactors (where reactors have previously been an IR)	Max Reactors*	Mean Reactors	Total new TB incidents (2020)
HTBAE	3	1.5	6	2	2	201
HTBAW	21	8.3	56	11	2.7	253
ITBAM	5	10.4	23	10	4.6	48
ITBAN	1	1.7	5	5	5	60
LTBA	0	0.0	0	0	0	52

*Max Reactors: the highest number taken in any single TB incident in each TB Area

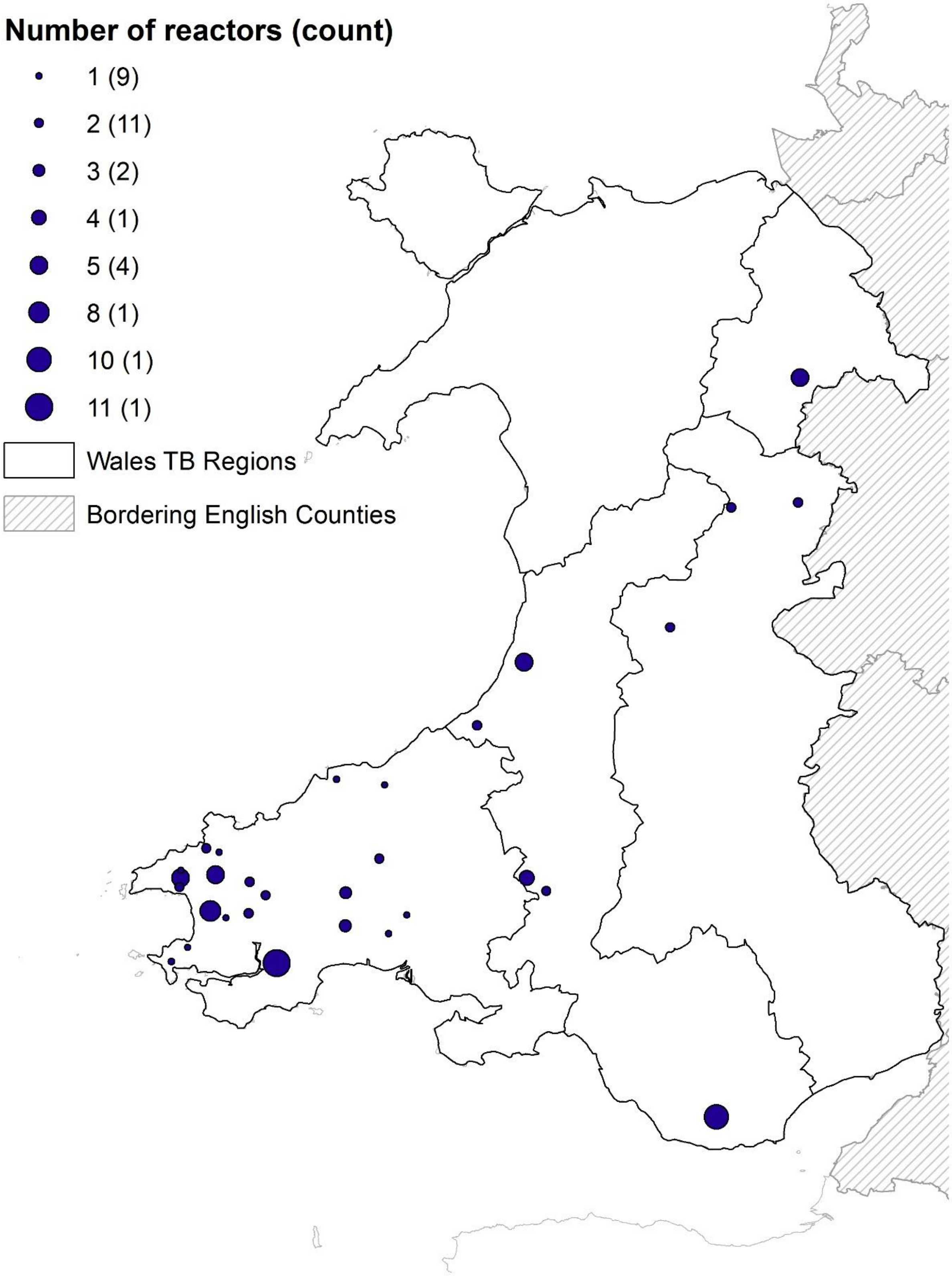

Figure 4.8.3: Number of TB incidents up to and including the six monthly test, where reactors had been IRs in previous TB incidents, 2020

5. Bovine tuberculosis prevalence in Wales

Key Points:

- Six per cent of Welsh herds incurred a new TB incident in 2020 and 5.3% of herds were under movement restrictions in mid-December 2020.
- Prevalence remained highest in the HTBAW where over half of all TB incidents are located. The 5% decrease in prevalence observed in Wales overall in 2020 compared to 2019 is driven by the decrease observed in the HTBAE and HTBAW which still make up most TB incidents in any given year.
- Prevalence increased in the ITBAN in 2020 and surpassed that observed in the HTBAE, as well as the average for Wales overall.
- The median duration of OTF-W incidents that have closed in Wales has been increasing since 2015, up to 256 days in 2020.
- The median duration of OTF-W incidents was highest in the ITBAN (300 days), followed by the ITBAM and HTBAW at around 280 days and the HTBAE (213 days). Duration of OTF-W incidents in the LTBA have been more variable due to the smaller number disclosed each year, but in 2020 this was 232 days.
- OTF-S incidents had a median duration of around 100 days in 2020, which was consistent across all TB Areas.
- In 2020 A total of 451 TB incidents in Wales existing prior to 2020 closed (477 in 2019), with 78% located in the High TB Areas.
- A total of 47 TB incidents that closed in 2020 were classed as persistent (all OTF-W), a 21% increase upon 2019. The majority (81%) were in the HTBAE (10) and HTBAW (28) and the remainder distributed as follows: ITBAN (6), ITBAM (2) and the LTBA (1).
- The number of new recurrent TB incidents (new TB incident within nine months (<275 days) of the end of the previous incident) has been relatively stable since 2015 (around 100 new recurrent incidents; 94 in 2020).
- There has been an increasing trend in the number of ongoing persistent incidents (TB incidents still open at the end of the year and >550days) to 154 in 2020).
- The number of new persistent TB incidents (those reaching 550 days in the reporting year) reached 206 in 2020.
- The plateaus and increases observed in the various measures for persistence suggest that infection may not be being removed effectively in persistent TB herds. This may also be related to farm management factors as well as a change in test requirements prior to lifting movement restrictions.
- In 2020, there were 198 ongoing TB incidents that had started prior to 2020 in Wales (201 in 2019) and 89% were in the High TB Areas.

5.1 Bovine tuberculosis prevalence

Prevalence of TB refers to the percentage of cattle herds under movement restrictions (herds restricted due to a TB incident) at a certain period (in this case, mid-December 2020). The method used to calculate prevalence are described in detail in the supplementary document.

Spatial and temporal patterns of TB prevalence may vary according to the dynamics of the disease, considering environmental conditions and cattle population demographics. This chapter also describes the situation regarding how long herds were under movement restrictions due to TB in 2020 and looks at temporal trends in the duration of TB incidents over a ten-year period.

In Wales, a total of 615 herds were under movement restrictions in mid-December 2020 (Table 5.1.1a). Most herds under restrictions were in the HTBAW, followed by the HTBAE. The total number of herds under restrictions decreased by 5% in 2020 compared to 2019, however there is wide variation by TB Area with increases observed in the ITBAN and LTBA.

As in 2019, 6% of Welsh herds incurred a new TB incident in 2020, and 5.3% were under movement restrictions in mid-December 2020 (Table 5.1.1b). Prevalence in the ITBAN (surpassing the HTBAE) and LTBA increased in 2020 and decreased in the remaining TB Areas as well as for Wales overall. Despite the decrease in 2020, prevalence remained highest in the HTBAW where over half of all TB incidents are located.

Table 5.1.1a: Herds under restriction (mid-December), 2020

TB Area	Total incidents	% change (2019/2020)	OTF-W	OTF-S
HTBAE	162	-8.0	158	4
HTBAW	320	-8.6	311	9
ITBAM	40	-23.1	33	7
ITBAN	63	21.2	61	2
LTBA	30	76.5	27	3
Wales total	615	-4.9	590	25

Table 5.1.1b: Prevalence of TB in Wales, 2020

TB Area	Total incidents per 100 live herds	% change (2019/2020)	OTF-W incidents per 100 live herds	OTF-S incidents per 100 live herds	Total number of herds[1]
HTBAE	5.9	-6.3	5.7	0.1	2,766
HTBAW	10.2	-7.3	9.9	0.3	3,130
ITBAM	2.0	-20.0	1.6	0.3	2,005
ITBAN	7.0	25.0	6.7	0.2	904
LTBA	1.1	83.3	1.0	0.1	2,800
Wales total	5.3	-3.6	5.1	0.2	11,605

[1] This is the number of ‘live’ herds in mid-December 2020 so differs from the herd number given in Chapter 1.

5.2 Temporal trends in TB prevalence in Wales

The percentage of Welsh cattle herds under movement restrictions due to a TB incident over the last ten years has shown some variability (Figure 5.2.1). In 2011 and 2012, there was a sharp increase as a result of the 2008 TB Health Check Wales and subsequently the implementation of annual testing of all cattle herds from January 2010. This period was followed by a sharp decrease and has since stabilised. Over this time, the number of active (or live) herds (the denominator for this measure) decreased from around 13,000 to 11,500 in 2016 (and now fluctuates between 11,500 and 12,000 herds). The number of herds under movement restrictions has fluctuated between 600 and 700 per year. Prevalence had been increasing from 2017 to mid-2019 (maximum 5.6%) but has since decreased to 5.3% of herds under movement restrictions in 2020 (Figure 5.2.2).

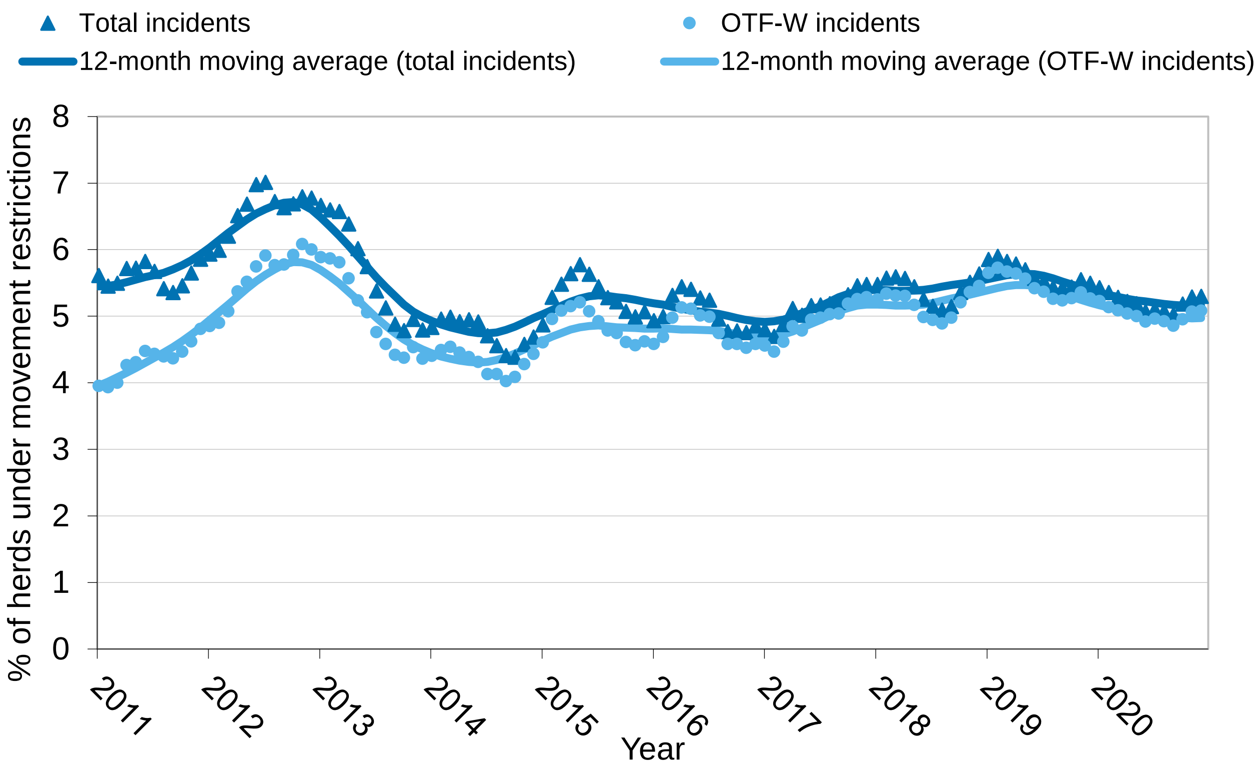

Figure 5.2.1: Percentage of herds that were under movement restrictions between January 2011 and December 2020 (12-month moving average)

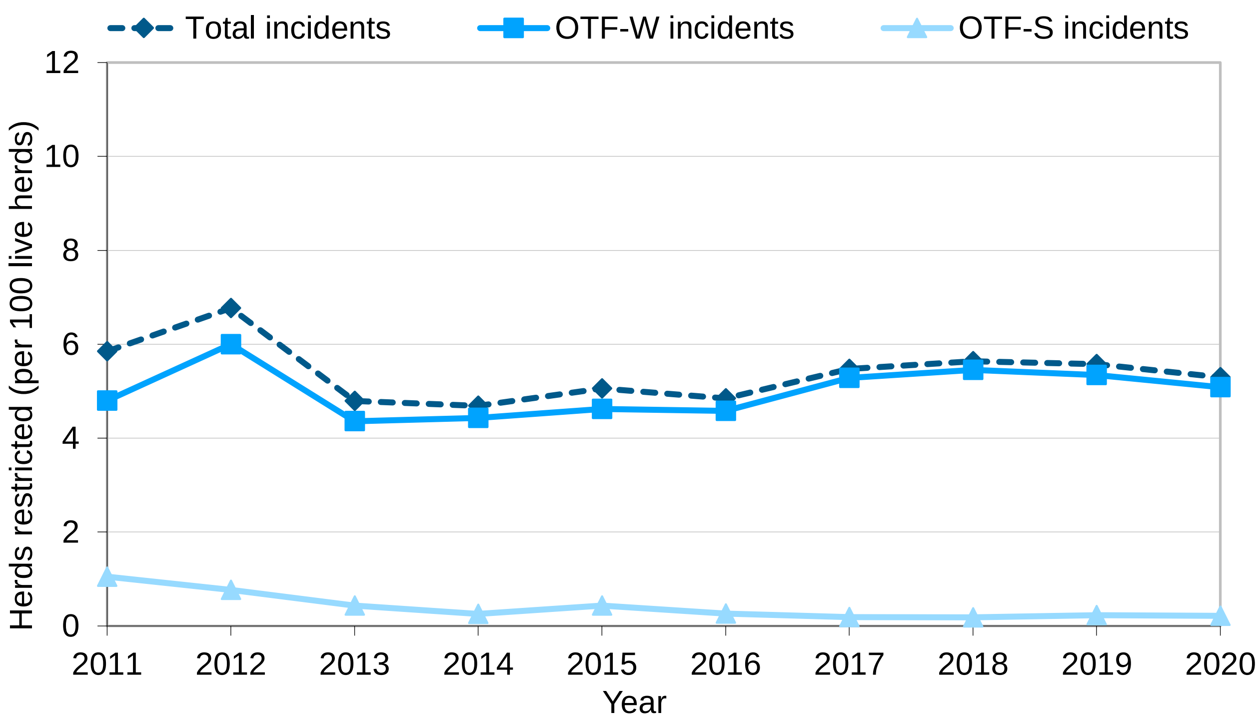

Figure 5.2.2: Point prevalence of herds under movement restrictions in Wales, December of each year (2011-2020)

5.3 Prevalence of TB across Wales

Figure 5.3.1 shows the percentage of herds under movement restrictions, by TB Area for the past ten years. Changes to prevalence are driven by the changes in the HTBAE and HTBAW which still make up most TB incidents disclosed in any given year.

Prevalence in the ITBAM and LTBA have remained relatively stable for the past nine years or more (2% in the ITBAM from 2012 onwards, and less than 1% in the LTBA since at least 2010, although has increased slightly and was closer to 1% in 2020).

Prevalence in the ITBAN has continued to increase since 2017 and in 2020 surpassed the country average for Wales and the HTBAE (6% in the ITBAN).

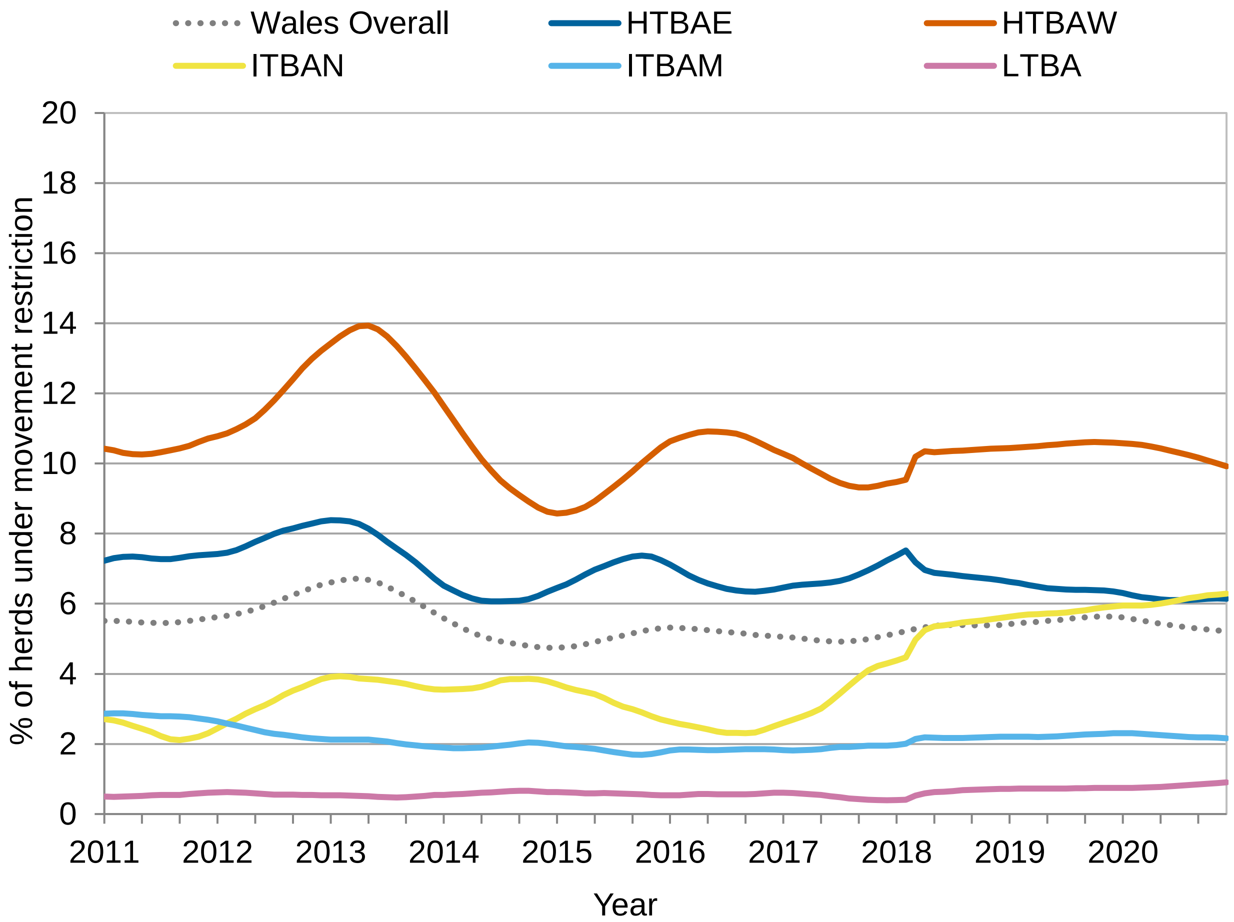

Figure 5.3.1: Trends in herds under movement restrictions, January 2011 – December 2020, by TB Area. The grey dotted line represents the overall trend in Wales[1]

[1] Quarterly (annualised), smoothed 12-month moving average

5.4 Bovine TB incident duration and the annual trend in median duration

The length of time a herd is under movement restrictions due to TB poses a socioeconomic burden on both the farmer and government managing the TB incident. However, restrictions are necessary to prevent transmission of infection from the herd, to ensure the necessary tests are carried out to remove infection from the herd, to provide evidence that animals are free of TB infection in the herd, and to reduce the risk of recurrent infection.

There is variation in the duration of movement restrictions across TB Area and differences in the management of OTF-W and OTF-S incidents may contribute to this. Two clear short interval tests are required before restrictions are lifted in OTF-W incidents compared to one with OTF-S incidents (Figures 5.4.1 and 5.4.2). The supplementary document gives further detail on duration of TB incidents in Wales, and appendix table 11 gives further detail relating to the number of TB incidents according to the median duration and number of open persistent incidents.

The median duration of OTF-S incidents was close to 100 days for all TB Areas, with a total of 66 closed TB incidents classified as OTF-S.

A total of 576 TB incidents that closed in 2020 were classified as OTF-W with the median duration for all TB Areas falling between 200 and 300 days. In Wales overall, the median duration of OTF-W incidents has been increasing since 2015, to 256 days in 2020.

The median duration of OTF-W incidents was highest in the ITBAN at 300 days, followed by the ITBAM and HTBAW (287 and 277 days respectively). In the HTBAE the median duration has remained around 200 days for the past ten years (213 days in 2020). In the LTBA, the median duration is more variable where there are fewer incidents disclosed (232 days in 2020). In the ITBAN, the number of persistent herd incidents was highest in 2020 (n=6) compared to previous years where there was been one or two (three in 2014) and in some years none (see Table 5.5.2 in the section on persistent TB incidents).

The median duration of persistent TB incidents generally falls between 600 and 800 days in each reporting year, with a few exceptions. For example, in the ITBAM, the median duration was much higher, at 1,502 days in 2012 and 1545 days in 2014. In 2020, the median duration of persistent TB incidents increased in the HTBAE to 974 days and 920 days in the HTBAW.

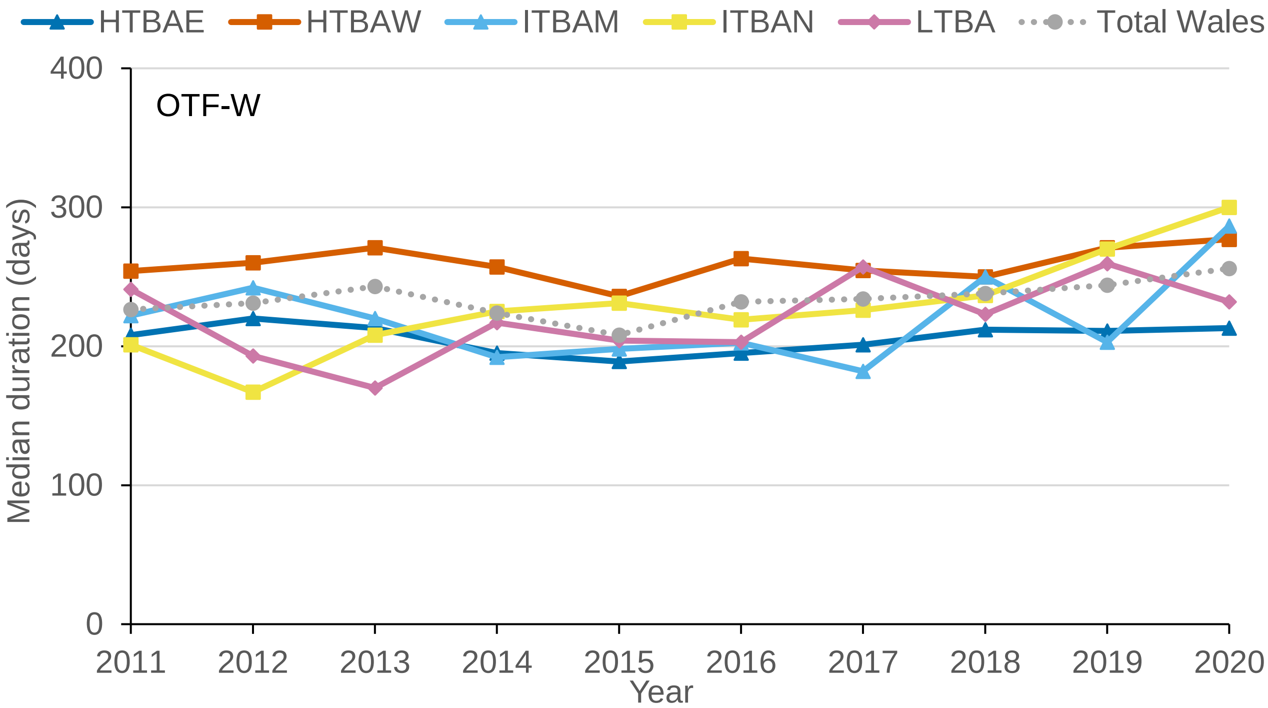

Figure 5.4.1: Median duration of OTF-W incidents ending between 2011 and 2020, by TB Area. The grey dotted line represents the overall trend in Wales

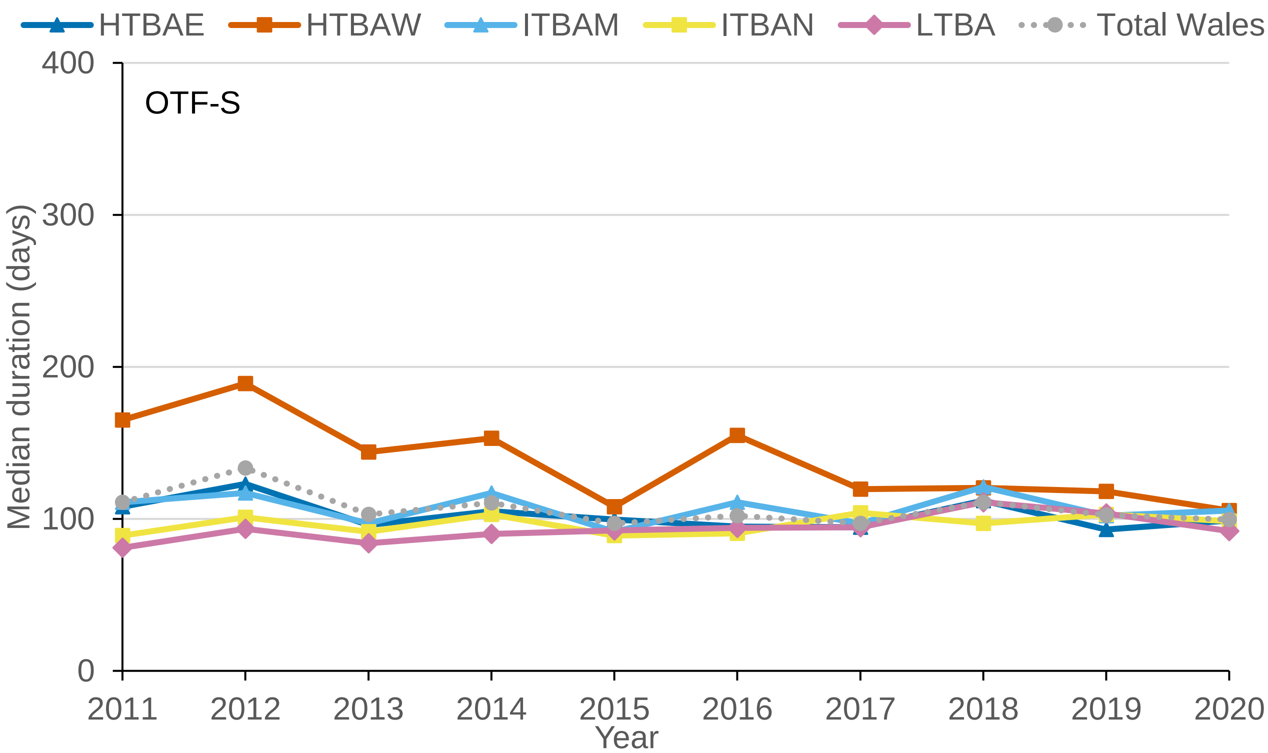

Figure 5.4.2: Median duration of OTF-S incidents ending between 2011 and 2020, by TB Area. The grey dotted line represents the overall trend in Wales

5.5 Variation in TB duration by TB-free status, herd type, herd size and geographical area

Table 5.5.1 shows the results of a linear regression which is carried out to indicate the size and direction of the associations between predictors (herd size, herd type and TB Area) and the outcome (incident duration). The materials and methods in the supplementary document provide further detail on the methods used for the linear regression and selection of reference categories for the analysis.

TB incidents classified as OTF-S were significantly shorter in duration compared to OTF-W, in part due to the difference in management of OTF-W and OTF-S incidents and the time taken to complete the necessary tests to clear a herd and remove restrictions (as previously described). Herds classed as OTF-W are required to have two clear short-interval tests to confirm the herd is clear of infection.

The median duration of movement restrictions following a TB incident increased with herd size (significantly shorter in herds < 300 animals, than herds > 300 animals, where herd size likely increases density-dependent transmission of TB). After adjusting for herd type and TB Area, this effect was not statistically significant in larger herds, but the higher trend for the risk of infection duration in larger herds remained.

Dairy herds were significantly more likely to be under movement restrictions for longer in 2020, even after adjusting for herd size and TB Area, which is consistent with previous years. This suggests that, even though dairy herds tend to be larger in size than beef herds, this is not the only factor why they are likely to be under movement restrictions for longer. For example, some dairy herds are managed less intensively than others. Suckler herds are managed less intensively than fattening units, but the throughput on fattening units is more rapid. In dairy herds, some adult animals remain on the farm and are likely to be more intensely managed compared to suckler cows and in most cases, for longer periods.

Herds in the HTBAE, ITBAM and LTBA were under movement restrictions for significantly shorter periods of time compared to the HTBAW, although after adjusting for herd size and type, this effect only remained statistically significant in the HTBAE. The duration of movement restrictions in the ITBAN was not significantly different to the HTBAW. Where the number of persistent TB incidents in the ITBAN has increased in 2020 (six), this will likely be connected to the duration of movement restrictions in this TB Area not being significantly different to the HTBAW.

Table 5.5.1: Linear regression analysis of factors associated with incident duration (days), 2020

	Total closed incidents	Mean duration (days)	Median duration (days)	Unadjusted[1] coefficient[3] (number of days)	95% CI	95% CI	Adjusted[2] coefficient[3] (number of days)	95% CI	95% CI
OTF status									
OTF-W	576	324	256	*Ref*			*Ref*		
OTF-S	66	121	100	-203***	-266	-140	-156***	--222	-89
Herd size									
1 – 10	14	199	155	-208**	-346	-69	-95^{ns}	-236	46
11 – 50	114	246	189	-161***	-224	-97	-75*	-146	-3
51 – 100	143	256	203	-151***	-212	-91	-69*	-136	-1
101 – 200	173	310	251	-97**	-155	-40	-38^{ns}	-99	23
201 – 300	74	310	252	-97**	-169	-25	-45^{ns}	-117	27
> 300	124	407	319	*Ref*			*Ref*		
Herd type									
Beef	373	251	203	*Ref*			*Ref*		
Dairy	259	380	293	128***	89	168	70**	21	120
Other/mixed	10	227	159	-24^{ns}	-180	132	25^{ns}	-129	179
TB Area									
HTBAE	212	263	203	-93***	-138	-48	-52**	-98	-6
HTBAW	277	356	270	*Ref*			*Ref*		
ITBAM	62	262	247	-93**	-163	-24	-57 ^{ns}	-125	11
ITBAN	50	331	270	-25^{ns}	-100	51	-36^{ns}	-110	38
LTBA	41	179	144	-177***	-259	-95	-82 ^{ns}	-166	2

*, **, *** and ns denote levels of statistical significance of $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$ and not significant respectively. [1] Results of univariable linear regression analyses of the duration of TB incidents that ended in 2020 on each of the independent variables (OTF status, herd size, herd type or geographical area). [2] Results of multivariable linear regression analyses of the duration of TB incidents that ended in 2020 on the OTF status, herd size, herd type or geographical area, adjusted for the effects of other independent variables. [3] The coefficient was derived from the duration variable.

Herds under movement restrictions for more than 550 days are classed as persistent herds. TB incidents that are under restrictions for long periods of time are costly to both the government and industry, therefore are targeted with enhanced measures to clear infection[8]. Factors such as purchasing of animals, transmission from wildlife or contiguous herds and limitations of test sensitivity (failure to detect all infected animals), may all contribute to TB incidents taking longer to resolve.

A total of 47 TB incidents that closed in 2020 were classed as persistent (all OTF-W) which was a 21% increase compared to 2019 (Figure 5.5.1). Similarly to previous years, OTF-W incidents of very long duration (over 18 months) tend to be clustered in the HTBAW (28) and in the HTBAE (10).

The number of persistent TB incidents in the ITBAN increased from two in 2019 to six in 2020. Two persistent TB incidents closed in the ITBAM in 2020 (three in 2019), and one in the LTBA (none in 2019).

[8] https://gov.wales/sites/default/files/publications/2017-11/wales-bovine-tb-eradication-programme.pdf

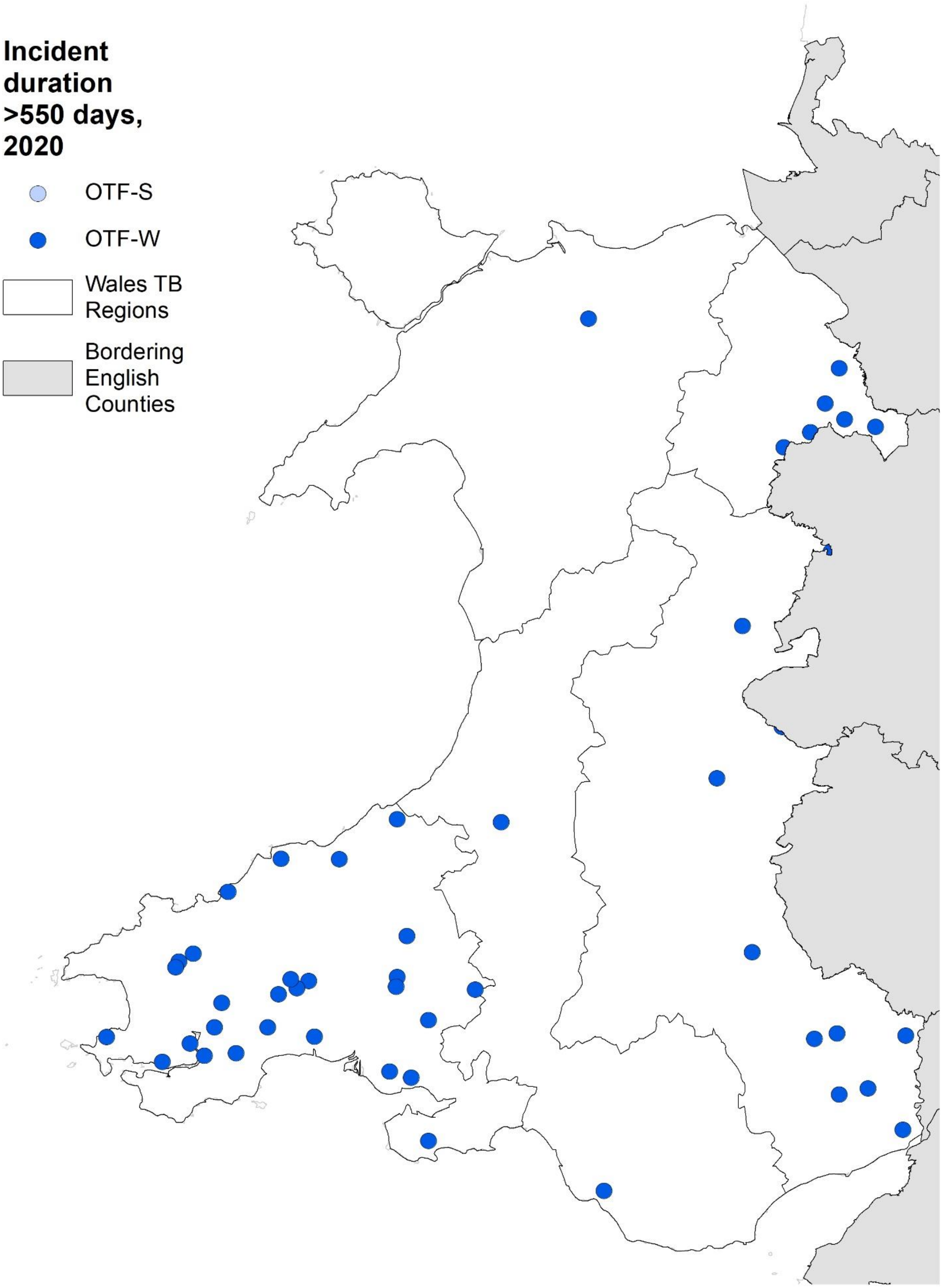

Figure 5.5.1: Persistent TB incidents of over 550 days duration, closing in 2020, by OTF status

From 2015, the total number of persistent TB incidents that have closed (in the year where duration exceeded 550 days), and the number of new recurrent TB incidents (new TB incident within nine months (<275 days) of the end of the previous incident) has remained stable (around 100 new recurrent incidents; Figure 5.5.2). However, there has been an increasing trend in the number of ongoing persistent incidents (TB incidents still open at the end of the year and >550 days) to 154 incidents in 2020. The number of new persistent TB incidents (those reaching 550 days in the reporting year) has shown more variation year on year and reached 206 incidents in 2020. This increase in persistence, as well as lack of change suggests that infection in these persistent TB herds is not being removed but may also be related to farm management factors.

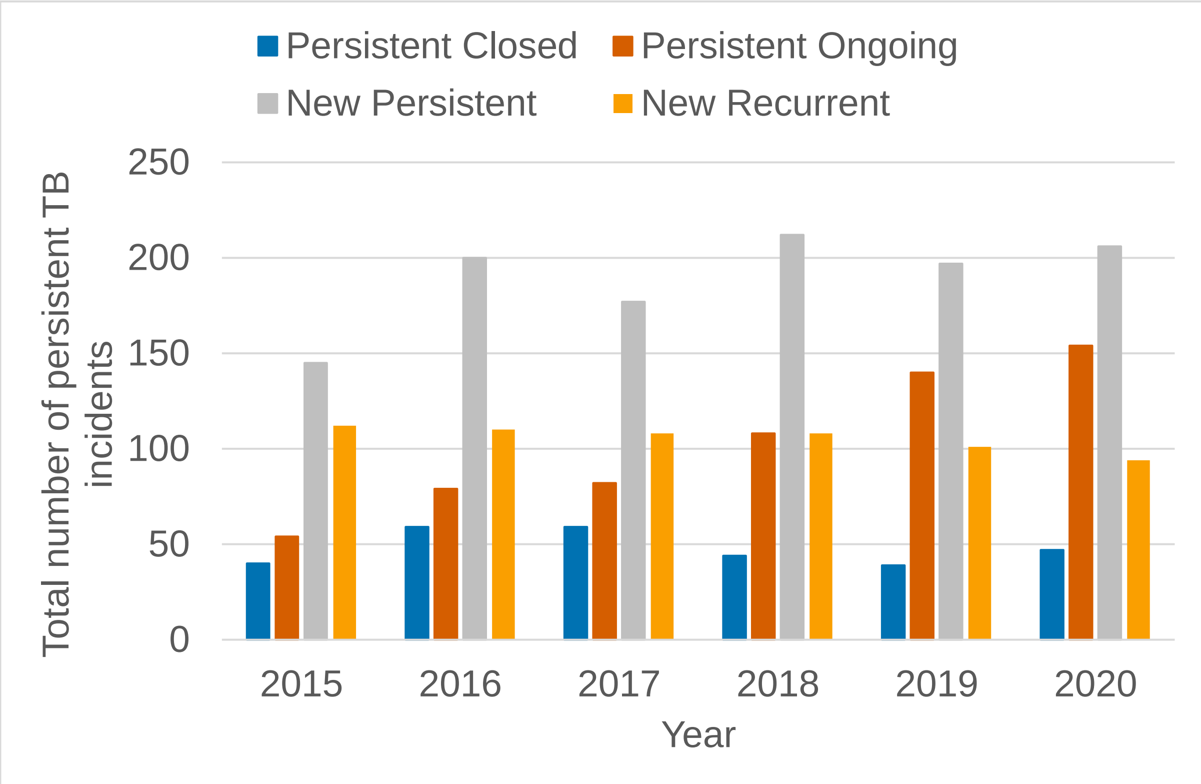

Figure 5.5.2: Total number of persistent TB incidents (closed, ongoing and new) and new recurrent incidents (2015-2020)

Most closed incidents that were classed as persistent have been in the High TB Areas, in particular the HTBAW (Table 5.5.2). There has been some variation year on year, but since 2018 the total in the HTBAW has been relatively stable. In the ITBAN, where there has been few persistent incidents, this has increased to six in 2020. There was also one persistent incident in the LTBA in 2020 whereas for all previous years since 2011, there were none.

Table 5.5.2: Total number of closed TB incidents that were classed as persistent (>550 days) by TB Area, 2011-2020

	HTBAE	HTBAW	ITBAM	ITBAN	LTBA	Total
2011	21	55	5	1	0	82
2012	14	49	2	0	0	65
2013	28	82	3	2	0	115
2014	15	63	2	3	0	83
2015	10	29	1	0	0	40
2016	14	42	2	1	0	59
2017	14	42	3	0	0	59
2018	14	26	3	1	0	44
2019	10	24	3	2	0	39
2020	10	28	2	6	1	47

5.6 Summary of new, closed and ongoing incidents in Wales

A total of 451 TB incidents in Wales closed during 2020 (477 in 2019), having begun prior to 2020. Incidents closing in 2020 were mostly located in the HTBAW and HTBAE (78%), slightly lower than reported in 2019 (81%; Table 5.6.1).

There was a total of 198 ongoing TB incidents that had started prior to 2020 in Wales (201 in 2019), and 197 were OTF-W incidents.

Ongoing incidents are those of longer duration as they have begun prior to the reporting year and have not yet been resolved. Most ongoing TB incidents were disclosed in the HTBAW and HTBAE (89%).

The distribution of new TB incidents disclosed in 2020 is shown in the following table for information only, as it has been described in chapter three of this report.

Table 5.6.1: The number of new, closed and ongoing TB incidents by TB Area in Wales, 2020

TB Area		Total incidents	OTF-W	OTF-S
HTBAE	New incidents in 2020	201	189	12
	Closed[1] incidents in 2020	136	129	7
	Ongoing[2] incidents in 2020	44	44	0
	Incidents starting and ending in 2020	76	68	8
HTBAW	New incidents in 2020	253	239	14
	Closed[1] incidents in 2020	216	211	5
	Ongoing[2] incidents in 2020	129	128	1[3]
	Incidents starting and ending in 2020	61	52	9
ITBAM	New incidents in 2020	48	35	13
	Closed[1] incidents in 2020	43	35	8
	Ongoing[2] incidents in 2020	9	9	0
	Incidents starting and ending in 2020	19	13	6
ITBAN	New incidents in 2020	60	55	5
	Closed[1] incidents in 2020	39	37	2
	Ongoing[2] incidents in 2020	14	14	0
	Incidents starting and ending in 2020	11	7	4
LTBA	New incidents in 2020	52	34	18
	Closed[1] incidents in 2020	17	15	2
	Ongoing[2] incidents in 2020	2	2	0
	Incidents starting and ending in 2020	24	9	15
Wales overall	New incidents in 2020	614	552	62
	Closed[1] incidents in 2020	451	427	24
	Ongoing[2] incidents in 2020	198	197	1[3]
	Incidents starting and ending in 2020	191	149	42

[1] Closed incidents began prior to 2020 but ended during 2020
[2] Ongoing incidents began prior to 2020 and were still ongoing at the end of 2020
[3] Unclassified incident (OTFS-1) that began in 2015.

6. PME outcomes, WGS clades and/or genotypes

Key Points:

- There was a 15% reduction in the number of cattle slaughtered for TB control in 2020 compared with 2019, whereas in the previous five years an increasing trend had been observed. The initial increase in reactors was primarily attributable to increases in IFN-γ testing, which is more sensitive than the SICCT test. A decrease may be attributable to the concomitant decrease observed in the number of IRs and DCs slaughtered, likely because of policy changes.
- Of the 10,680 cattle slaughtered in 2020 for TB control, 83.6% were reactors to either the skin test, IFN-γ or antibody test, 11.6% were IRs and 4.8% were DCs. In 2020, the total reactors disclosed included 646 from antibody tests which is more than double compared to 2019 (272).
- In 2020, lesions were detected in 12% of slaughtered animals in Wales although this varied depending on the reason for disclosure; reactors (13%), IRs (3%) or DCs (6%).
- Of the 2,618 samples from animals with no detected lesions (NDLs) and for which culture results were available, 1.5% (40) were *M. bovis* positive overall.
- In 2020, around 93% of cultured samples from animals with detected lesions (DLs) were *M. bovis* positive, however this varies by TB Area. Up to 2017 the percentage was stable at around 95-97% but has since decreased to closer to 90%.
- The percentage of skin and blood test reactors with DLs continues to decrease from 16% in 2018 to just over 13% in 2020. The decrease observed in 2019 (to 12%) was thought to be from increased IFN-y testing.
- The percentage of DCs with DLs had decreased in 2017 but increased again slightly year on year to the same level in 2020 as observed in 2016 (5.7%).
- The trend of decreasing 1xIRs with DLs observed since 2015, (due to policy change in 2016 to remove 1xIRs in persistent TB incidents) was reversed, with an increase in 2020 (2% in 2020 compared to 0.9% in 2019).
- In 2020, the most predominant and frequently found genotypes in Wales were 9:b located mostly in the HTBAW and 17:a in the HTBAE in particular, although this genotype showed further spread across TB Areas. A notable change in 2020 was a cluster of genotype 17:a emerging in the LTBA compared to 2019. This genotype also increased in frequency in the ITBAN in 2020.

6.1 Lesion status of suspected TB cases that were slaughtered

Figure 6.1.1 shows the percentage of slaughtered cattle in Wales with detected lesions (DLs), according to whether the suspected TB case was a dangerous contact (DC), reactor, or inconclusive reactor (IR, including 1xIR, 2xIR or 3xIR). Appendix table 13 gives a detailed breakdown of the lesion status at post-mortem examination (PME) of all suspected TB cases that were slaughtered for different TB control reasons in 2020, by TB Area.

In 2019, the percentage of reactors (including reactors to skin test, IFN-γ and antibody tests) with DLs had decreased from 16% to just over 12%, increasing slightly in 2020 to 13%. The decrease from 2018 to 2019 was considered to be in part due to increased IFN-γ testing detecting infected animals earlier.

The percentage of DCs with DLs decreased in 2017 compared to the previous year but continued to increase in each subsequent reporting year to the same level (5.7%) in 2020 as reported in 2016.

The percentage of 1xIRs with DLs had been decreasing since 2015, (due to policy change in 2016 to remove 1xIRs in persistent TB incidents). However, there was an increase in 2020 (2% in 2020 compared to 0.9% in 2019). The percentage of 2xIRs with DLs increased from 4% in 2016 to 8.4% in 2019 but has since decreased to 6.6% in 2020.

The decrease in the number of animals slaughtered as IRs may be in part because of a change in policy in January 2020 from removing all standard and severe IRs in a persistent herd TB incident, to only removing standard IRs and testing severe IRs when positive to IFN-y and antibody tests.

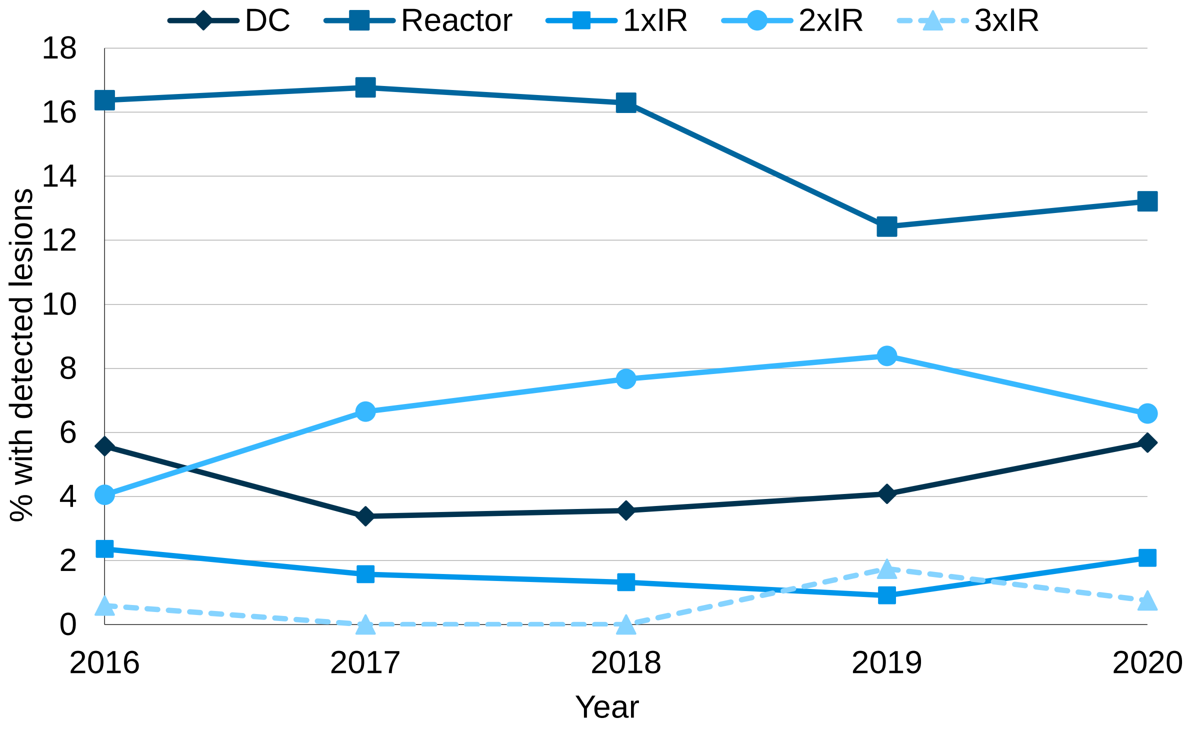

Figure 6.1.1: Percentage of slaughtered cattle with detected lesions[1], 2016 – 2020

[1] Where lesion status was known, lesion status was not recorded in around 0.4% of slaughtered suspect TB cases

There were 10,680 cattle slaughtered in 2020 for TB control (Figure 6.1.2). This is a 15% decrease compared to 2019, after a general increasing trend over the past five years. This initial increase in reactors has been attributed to increases in IFN-γ testing, which is more sensitive than the SICCT test. [9] [10] [11] This may also be due to severe interpretation in persistent herds yielding more severe reactors.

Of the total cattle slaughtered in 2020, 84% (8,929) were reactors to either the skin test or IFN-y. This also included 646[12] reactors to the antibody test. The number of animals classed as reactors by antibody tests has more than doubled in 2020 compared to 2019 (272). Twelve per cent of cattle slaughtered were IRs (1,240) and 5% (511) DCs. In

[9] de la Rua-Domenech, R, Goodchild, AV, et al. (2006) Ante mortem diagnosis of tuberculosis in cattle: A review of the tuberculin tests, interferon assay and other ancillary diagnostic techniques. Research in veterinary science (81): 190-210. 0.1016/j.rvsc.2005.11.005

[10] Karolemeas K, de la Rua-Domenech R, Cooper R, Goodchild AV, Clifton-Hadley RS, et al. (2012) Estimation of the Relative Sensitivity of the Comparative Tuberculin Skin Test in Tuberculous Cattle Herds Subjected to Depopulation. PLOS ONE 7(8): e43217. https://doi.org/10.1371/journal.pone.0043217

[11] Nuñez-Garcia J., Downs S.H., et al. (2018) Meta-analyses of the sensitivity and specificity of ante-mortem and post-mortem diagnostic tests for bovine tuberculosis in the UK and Ireland. Preventive Veterinary Medicine (153) 94-107, https://doi.org/10.1016/j.prevetmed.2017.02.017

[12] Note that the data for figure 6.1.2 is based on the year the cattle of the test, whereas the data from the table relates to the year the cattle were slaughtered. Therefore, there may be some differences in the totals recorded.

addition, there were 63 slaughterhouse cases where retrospective evidence of TB was identified in cattle from OTF herds (which would have been subject to active surveillance, or skin testing).

This distribution of reasons for cattle removal for TB differs from England where 93.7% of cattle removed were reactors, 3.2% IRs and 3.1% DCs. The higher percentage of animals removed as IRs in Wales could be in part due to all IRs in persistent incidents being slaughtered (as part of the ongoing Action Plan Process). This is in comparison to England where only 2xIRs are removed.

In 2020, lesions were detected in 12% of slaughtered animals in Wales, although this varied depending on method of disclosure; reactors (13%), IRs (3%) or DCs (6%). This also varied depending on the interpretation of skin tests (standard or severe) or IFN-y. Appendix table 13 details this variation by TB Area and splits up reactors according to standard, severe, IFN-γ positive and antibody positive.

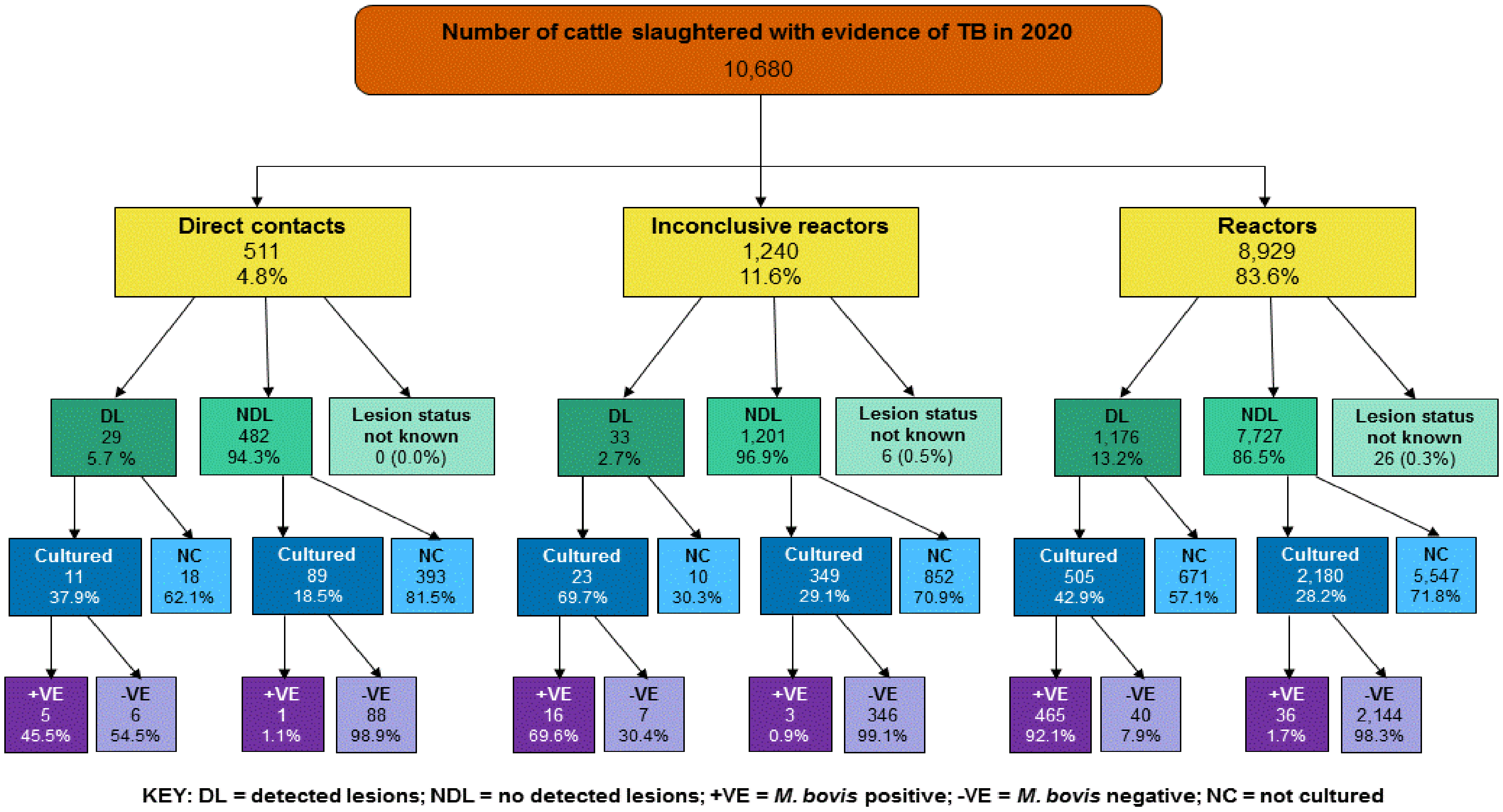

Figure 6.1.2: Total number of TB suspected cattle slaughtered in 2020 (regardless of when the incident started), and the lesion and culture results for animals slaughtered according to various TB risks (reactors, inconclusive reactors (IRs) or direct contacts (DCs)).

Figure 6.1.3 shows the ten-year trends for the number of cattle slaughtered for suspected TB (reactors, IRs and DCs). The 15% reduction in the total number of slaughtered animals in 2020 can be attributed to a decrease in the number of IRs and to a lesser extent DCs (1,240 IRs in 2020 compared to 3,130 in 2019), since the number of reactors has continued to increase for the last three years. Figure 6.1.4 shows the five-year trend in the number of IRs slaughtered for suspect TB, split by 1x, 2x and 3x IRs (plus DCs). The overall decrease in 2020 is mostly due to a large decline in the total 1xIRs.

The increase in the number of reactors can be attributed to the increase in the use of IFN-y testing, which is used to clear infection in recurrent and persistent TB herds and to prevent disease from becoming established in low incidence areas. The increase could also be because of increased use of severe interpretation in persistent TB incidents.

The number of IRs slaughtered had been increasing since 2016 (had previously been relatively stable for the six years prior to this), but in 2020 the total has dropped.

The large increase in the number of IRs recorded up to 2019 was primarily associated with the way some IRs were recorded in the SAM database. During 2016, official veterinarians were directed to apply more sensitive testing procedures in certain circumstances, and this included removing IRs. Until April 2017, it was not possible to record these cases as IRs on SAM in such a way as to enable the intended removal and compensation processes to take place. In 2020 there was a drop in IRs, which is potentially due to changes in policy

The number of DCs is much lower, and despite seeing an increase in 2016 and 2017, has since been decreasing back to totals observed around 2015 and before.

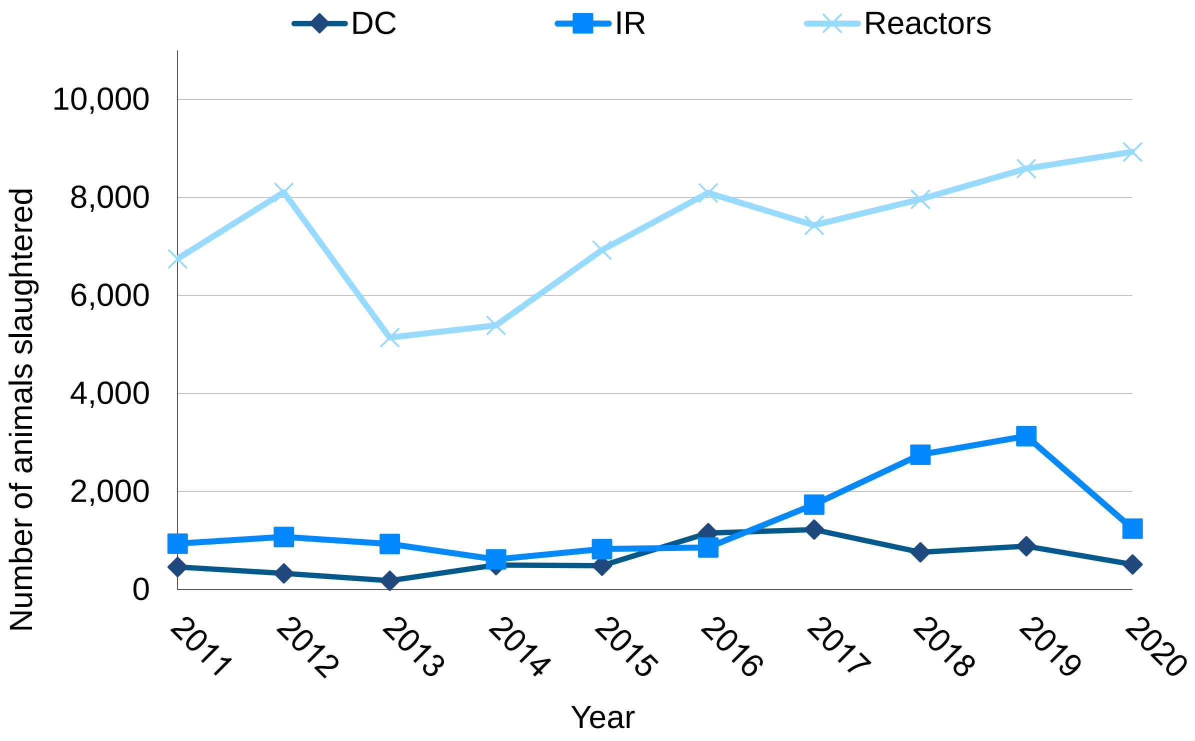

Figure 6.1.3: Reactors, inconclusive reactors and direct contacts slaughtered for suspected TB, 2011 – 2020

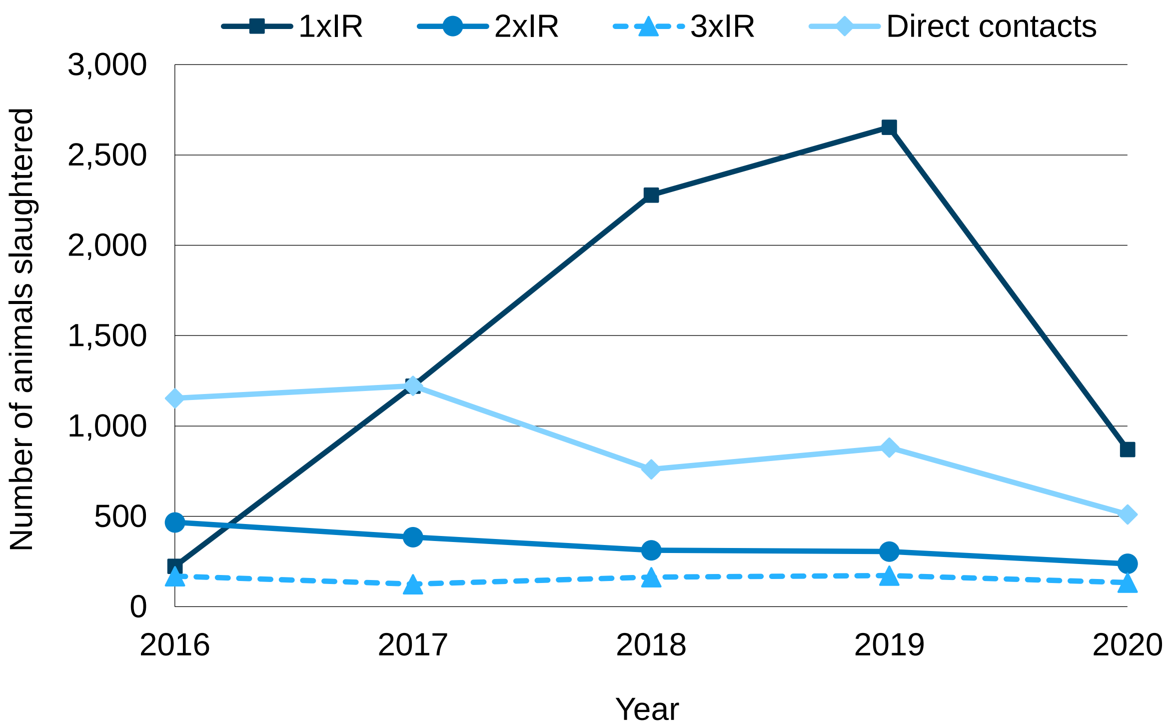

Figure 6.1.4: Inconclusive reactors[13] and direct contacts slaughtered, 2016 – 2020

6.2 Culture results of animals with detected lesions or no detected lesions

In multiple-reactor incidents, only limited numbers of samples from reactors are cultured to isolate *M bovis*. Generally, samples are taken for culture from no more than three animals with DLs per incident. Usually only one culture positive isolate from each incident is processed for genotyping (spoligotyping and VNTR typing - see section 6.3) or Whole Genome Sequencing (WGS). In addition, if the OTF status of the herd is withdrawn and a genotype is available, no further sampling is routinely undertaken from additional DL reactors and DCs. In 2020, additional sampling was carried out in EMPB herds in 2020.

In 2020, 92% of DL samples (465) from reactors with culture results were *M. bovis* positive. Up to 2017, this was around 95-97% but this decreased below 90% in 2017/18. The percentage has since increased and remained around 92-93% since 2019. In England, the average was 94% in 2020[14], although does not reflect the variation by risk area (for example, in the Low Risk Area (LRA), the variation is much greater due to the low numbers of DL samples). Overall, culture positive results are much lower for Wales than for England due to the comparative number of DLs vs. NDLs that are submitted for culture.

A total of 2,618 samples from NDL reactor cattle were submitted for culture in 2020. Forty (1.5%) were confirmed to be *M. bovis* positive. It is important to remember that this does not mean that the remaining 98.5% were not infected, since many infected animals do not necessarily have DLs or yield positive culture results. If reactors to the TB test are identified in the early stages of disease, they are less likely to have lesions and positive culture results. Since 2010, there has been a gradual decline in the percentage of NDLs that were culture positive for *M. bovis*, despite an increase occurring in 2014 (Figure 6.2.1).

Of the 3,160 animals where both the lesion status and culture result were known, 526 (17%) had direct evidence of TB; either having DLs and/ or being culture positive (i.e., all DL and NDL animals with positive results only.

[13] Animals having two successive tests giving inconclusive reactor measurements are generally considered to be skin test reactors but may be described as “IRs After 2 [or more] tests as IR” to distinguish them from other reactors in some parts of this report. IRs may be re-classified as reactors when interpreted severely.
[14] https://www.gov.uk/government/publications/bovine-tb-epidemiology-and-surveillance-in-great-britain-2020

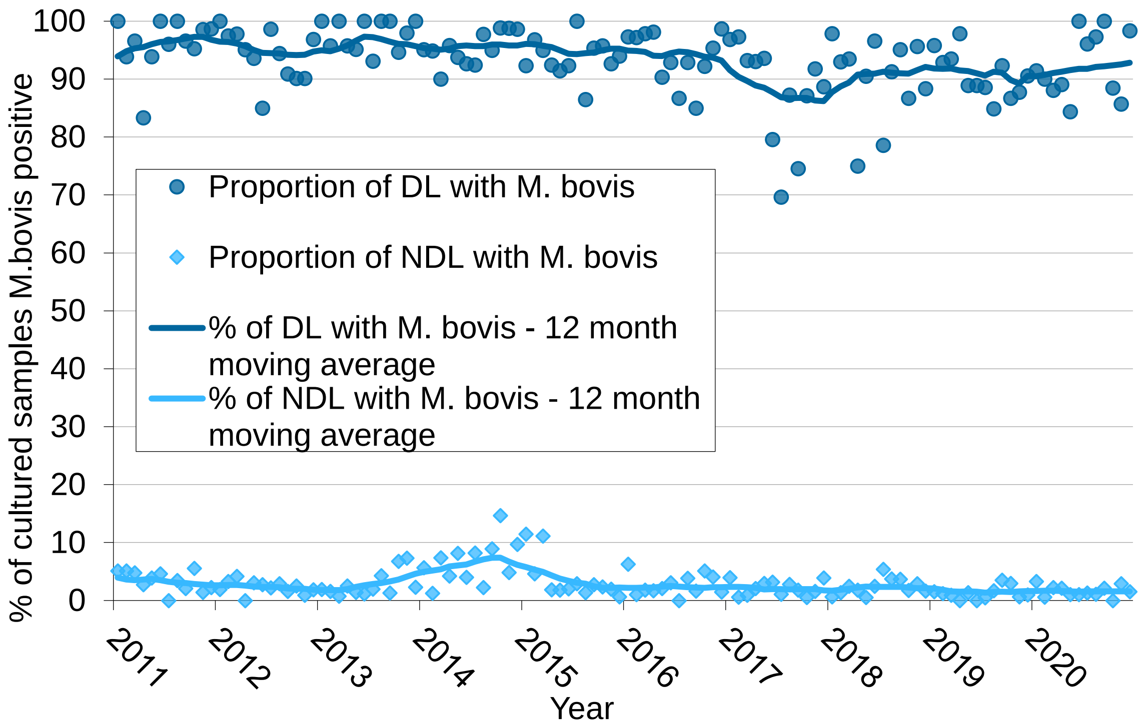

Figure 6.2.1: Monthly percentage of reactor culture samples from which M. bovis was obtained, 2011 – 2020

The percentage of submitted samples that were *M. bovis* positive by culture varied by TB Area and by test type (reactor to the SICCT at standard or severe interpretation, IFN-γ and antibody (IDEXX); Figure 6.2.2). Note: the IDEXX figures are not shown in this figure as there was only one positive result by culture in the HTBAW in 2020. There was a total of 646 reactors to the antibody test, with 122 cultured.

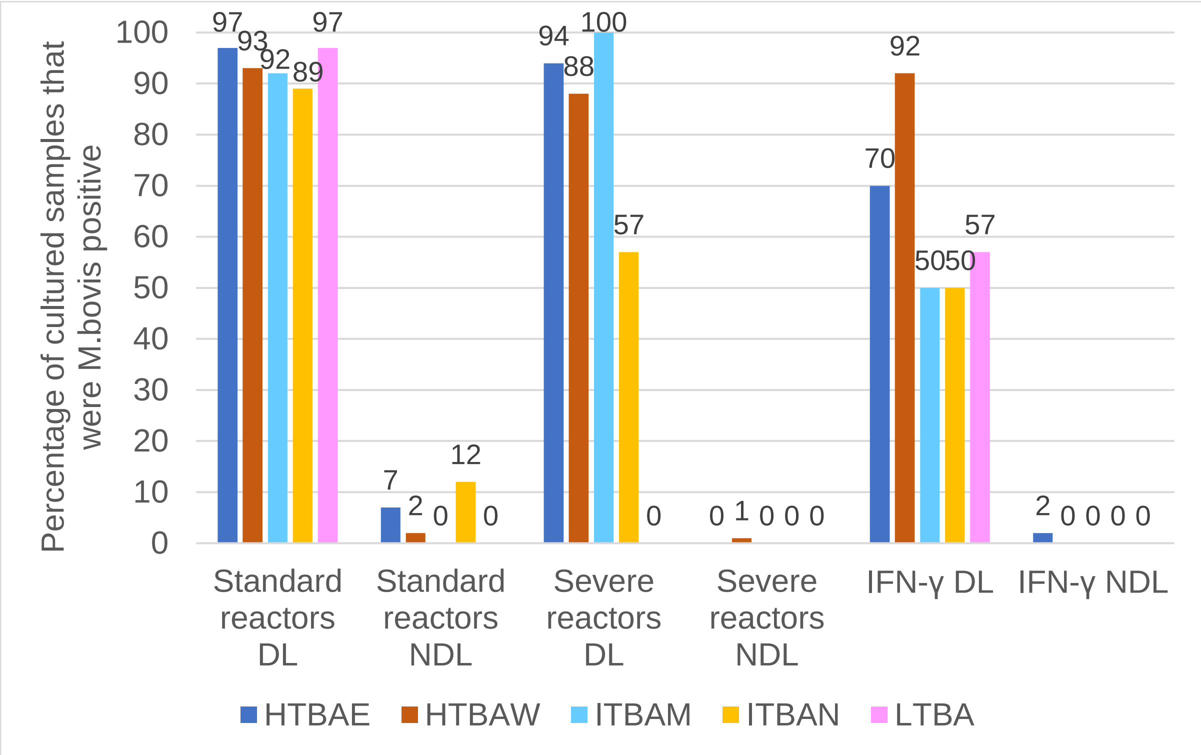

Figure 6.2.2: Percentage of samples submitted for culture where *M. bovis* was isolated in 2020, by TB Area

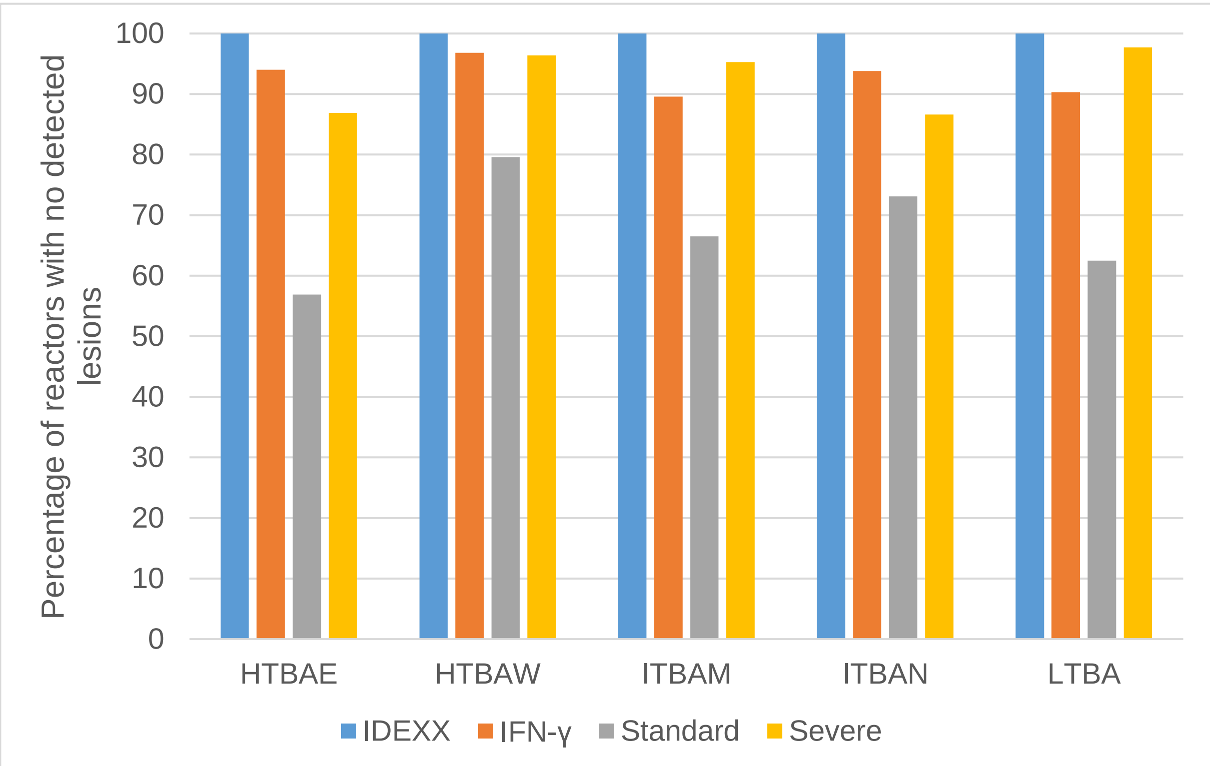

Figure 6.2.3: Percentage of reactors with no detected lesions in 2020, by TB Area

6.3 Overview of the isolates in the spoligotype database (Wales only)

The APHA has a database of genotypes for over 15,000 isolates of TB from Wales (from 1988 to end 2020). These genotyped isolates of *M. bovis* show clear geographical clustering (Figures 6.3.1 and 6.4.1). Since 2002, the combination of spoligotype and the variable number of tandem repeat (VNTR) profile is known for most OTF-W incidents. In combination with home range maps (see Figure 4.6.1 in Chapter 4), the genotype of *M. bovis* can help to determine the origin of infection, for example if the farmer has purchased animals from an area where the prevalent genotype differs from the local one.

Figure 6.3.1 shows the current distribution of cattle genotypes. As in 2019, the most predominant and frequently found genotypes in 2020 were 9:b located mostly in the HTBAW and 17:a in the HTBAE in particular, although this genotype showed further spread across TB Areas. The homerange genotypes typically within Wales are 9:b, 9:c, 17:a and 22:a (see figure 4.6.1). The number of out-of-homerange genotypes present in Wales in 2020 is consistent with what was observed in 2019.

A notable change in 2020 was a cluster of genotype 17:a emerging in the LTBA compared to 2019. This genotype also increased in frequency in the ITBAN in 2020.

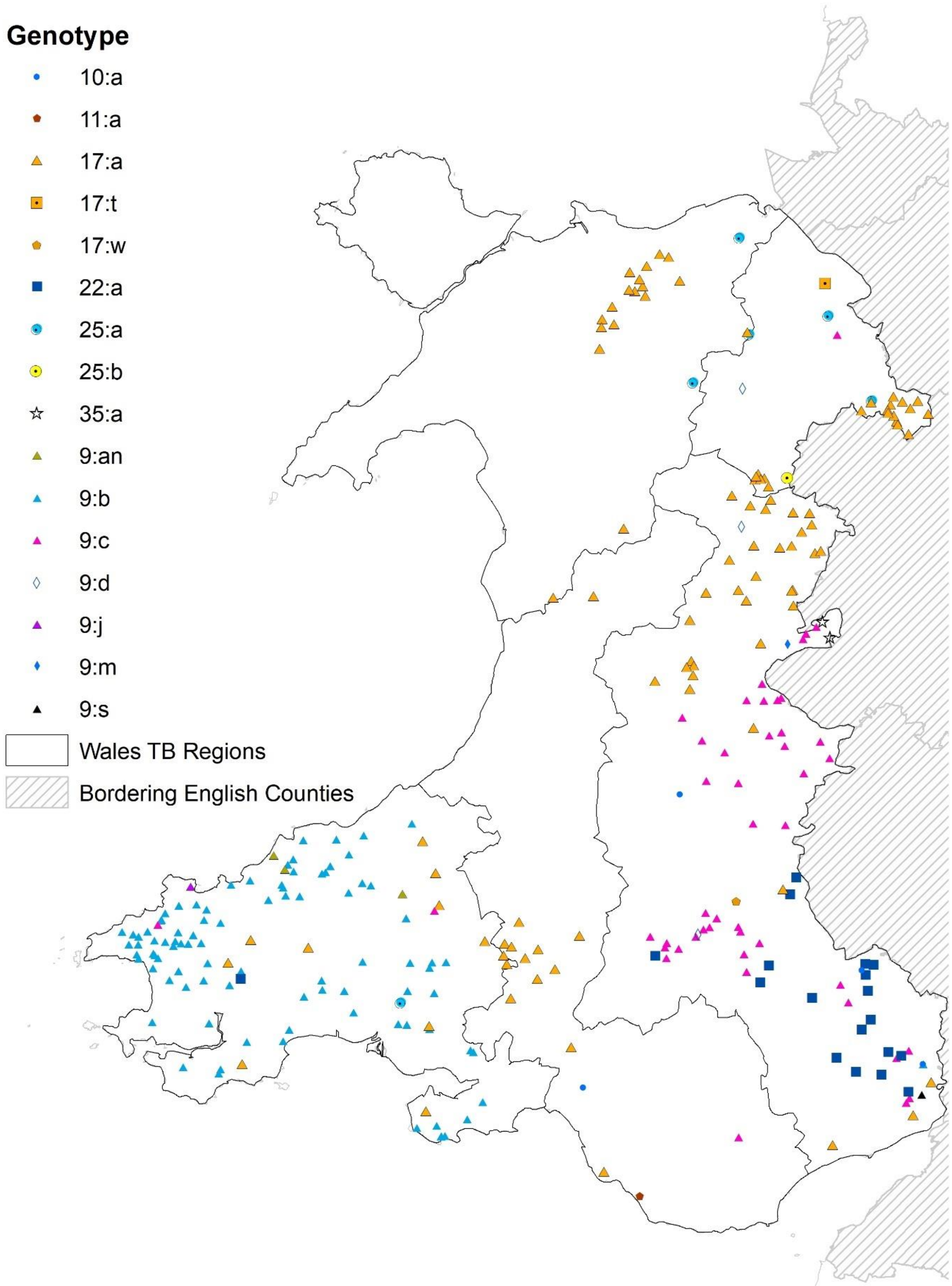

Figure 6.3.1: Geographical distribution of cattle genotypes found in Wales in 2020

Table 6.3.1 indicates the number of bovine and non-bovine isolates that were genotyped for each year (from 1988 to 2020). Isolate genotype (spoligotyped and VNTR) data (using characterization of 6 standard genomic loci) was available for 92% of these.

In 2020, a total of 397 bovine and 37 non-bovine isolates were genotyped. The number of bovine isolates genotyped has been around a similar number for the past five years. The number of non-bovine isolates genotyped has generally been quite variable but has been around 40 for the last three years.

Table 6.3.1: The frequency of bovine and non-bovine isolates genotyped by year 1988 to 2020

Year	Bovines**	Non-bovines
1988	1	2
1989	8	0
1990	9	0
1991	48	0
1992	58	0
1993	51	4
1994	128	5
1995	122	2
1996	180	11
1997	143	21
1998	202	10
1999	276	6
2000	291	1
2001	381	0
2002	258	2
2003	1,010	2
2004	675	1
2005	814	3
2006	809	59
2007	867	12
2008	1,095	32
2009	964	5
2010	722	13
2011	555	17
2012	606	11
2013	445	14
2014	543	17
2015	468	37
2016	365	22
2017	348	18
2018	433	39
2019	377	43
2020	397	36
unknown year*	0	7
Total:	**13,235**	**402**

*Seven *M. microti* isolates from cats originating from the Glamorgans do not have a year assigned.

** Year the bovine incident commenced.

6.4 Genotype frequency in cattle TB incidents

There were 397 isolates from cattle for incidents in Wales that started in 2020 and all were spoligotyped (2019 = 377). Full genotype (spoligotype plus 6 VNTR loci) was obtained for 92% of these isolates (2019 = 95%). The 367 cattle isolates with full genotype represent 285 separate TB incidents in cattle herds in Wales (2019 = 324). An average of 1.29 isolates were spoligotyped per TB incident (2019 = 1.11). [NB. Three TB incidents had two different genotypes.]

The frequency and percentage of each genotype found in the 285 TB incidents (367 individual cattle) from 2020 are shown in Table 6.4.1. Genotypes 17:a, 9:b, 9:c and 22:a, which made up over 91% of Welsh isolates in 2020, have home ranges in Wales.

Table 6.4.1: Frequency and percentage of genotypes in OTF-W incidents in cattle, 2019 and 2020

Genotype	2020		2019
	Frequency	Percentage	Percentage
17:a	135	36.8	33
9:b	115	31.3	35
9:c	57	15.5	15
22:a	27	7.4	8.4
25:a	6	1.6	1.4
10:a	4	1.1	1.7
9:d	3	0.8	0.8
9:an	3	0.8	0.3
17:g	3	0.8	0
35:a	2	0.5	0.3
11:a	1	0.3	1.4
9:j	1	0.3	0
9:m	1	0.3	0
9:s	1	0.3	0
9:7-2-5-5*-3-2.1	1	0.3	0
9:7-5-2-4*-2-3.1	1	0.3	0
17:t	1	0.3	0
17:w	1	0.3	0
25:b	1	0.3	0
35:3-3-3-4*-3-3.1	1	0.3	0
129:7-5-2-4*-3-3.1	1	0.3	0
NT:7-5-5-5*-3-2.1	1	0.3	0
Total	367	-	

[1] For 2019, not all genotypes are shown in this table if they did not appear again in 2020. The overall total for 2019 was 359.

The geographical distribution of the major spoligotypes identified in OTF-W incidents in 2020 is presented in Figure 6.4.1. The most common spoligotype in Wales (9) had two main clusters: one in the south west corner of Wales in the HTBAW (genotype 9:b) and the other mainly located in Mid Powys in the HTBAE (genotype 9:c). Spoligotype 9 is much less common over the border in England where 17 predominates, although there is a spillover in bordering English counties to the HTBAE that can be observed. Spoligotype 17 is the second most common type in Wales. There is a cluster seen in the LTBA where there has been an increase in TB incidents disclosed. This is also observed in the ITBAN around the area bordering England and the HTBAE.

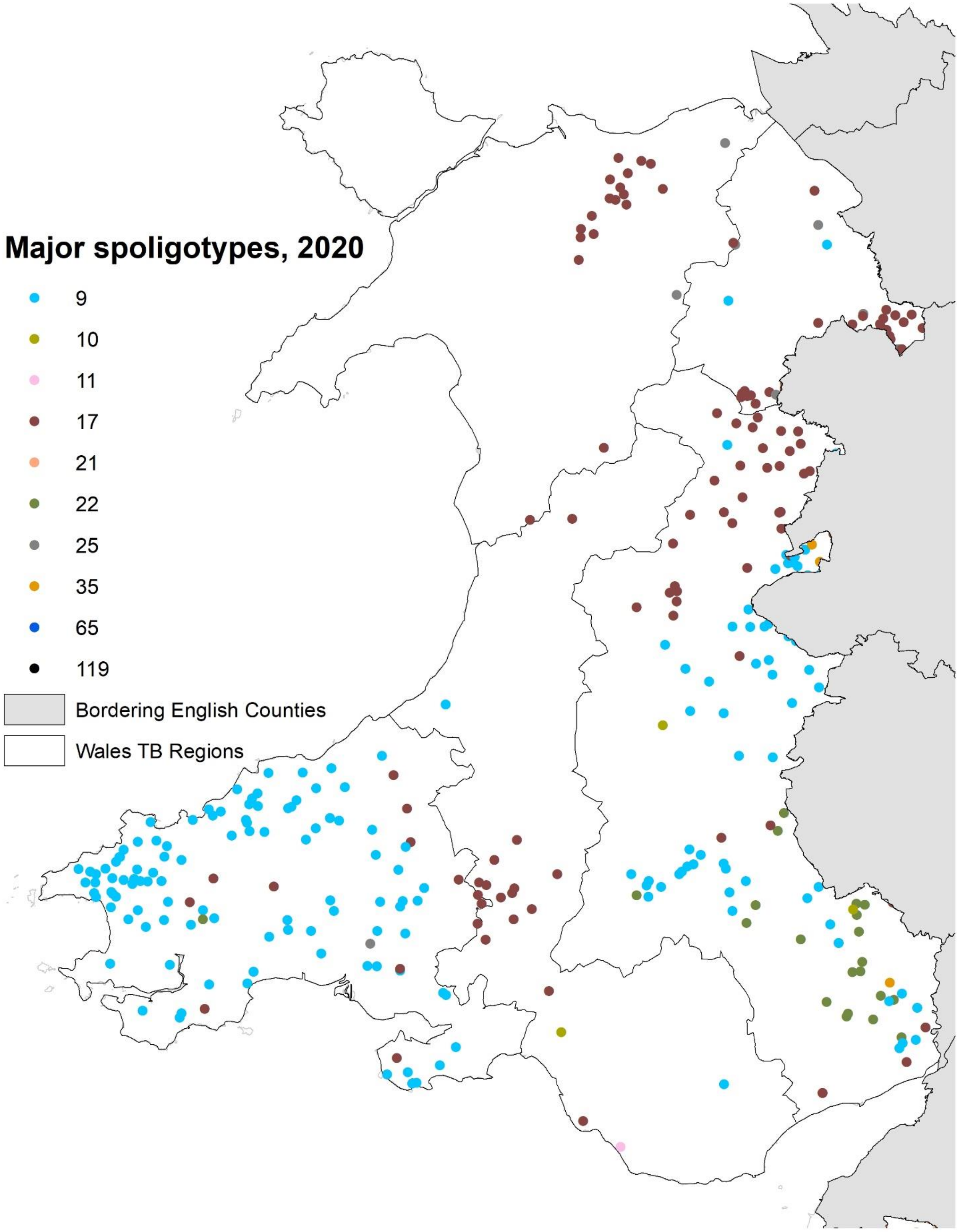

Figure 6.4.1: Geographical distribution of the major spoligotypes in Wales and English bordering counties in 2020

6.5 Non-bovine farm animals and wildlife isolates from Wales in 2020

Thirty-six non-bovine isolates were genotyped in 2020 (43 in 2019; Table 6.5.1). This total included 23 badger samples (38 in 2019), twelve deer (from two incidents) and one alpaca sample.

Complete genotype was available for all 23 badger isolates, with two of the 23 being out of home range. All deer isolates with complete genotype were within home range and a single alpaca with complete genotype was within home range.

Table 6.5.1: Distribution of *M. bovis* isolates from animal hosts other than cattle and badgers, in 2020

TB Area	Alpaca	Badger*	Deer
HTBAE	0	8	3
HTBAW	1	10	9
ITBAM	0	1	0
ITBAN	0	3	0
LTBA	0	0	0

***** One badger isolate is not included in this table as information on the TB Area was not known (total for 2020 in Wales overall was 23).

7. Fate of inconclusive reactors (IRs)

Key points:

- In 2020, the percentage of IR-only herds disclosing a new TB incident at the test after an IR retest that was negative (within 15 months) ranged from 5% (LTBA, ITBAM) to 22% (ITBAN).
- The number of IRs per 1,000 animal tests was highest in the HTBAW, where the density of IRs was highest, followed by the ITBAM and HTBAE.
- In 2020, most IR-only herds that had a new TB incident (disclosed by either the IR retest or at the test subsequent to a previously negative IR test) were located in the HTBAW and HTBAE, with the majority being OTF-W rather than OTF-S. OTF-S incidents were mostly distributed around the ITBAM and HTBAE.
- 81% (2,279) of the 2,804 IR animals in IR-only herds that had an inconclusive reaction to the skin test in 2020, tested negative at the first retest, and 53% (1,207) of these remained negative during the follow up period. A further 501 IR-only cattle were routinely slaughtered, with 497 screening negative in the slaughterhouse.
- Significantly more IR-only herds compared to non-IR only herds (15.3%, n=109) went on to have a TB incident at the next whole herd test, in 2020.
- In 2020, a new TB incident was disclosed at the IR-retest in 126 (15%) herds with IR-only test results in an otherwise clear test.
- The percentage of IR-only herds with any subsequent incident continued to decrease in 2020. This may be due to the use of IFN-y and IDEXX antibody testing in managing IR herds which may have resulted in *M. bovis* infected animals being identified sooner.

7.1 Understanding the fate of IRs

Determining what happens to IRs at the animal level is crucial for reviewing the policy applied to these animals. A flow-diagram identifying the fate of IRs considering testing history and slaughterhouse surveillance has been developed (Figure 7.1.1).

From October 2017 the refreshed eradication strategy in Wales was launched which included a regionalised approach to managing TB in cattle, with the introduction of five TB Areas. The IR policy in Wales was reviewed in 2019 and revised/ implemented in early 2020. All cattle disclosed as IRs at standard interpretation in persistent herd incidents are removed as reactors. Cattle recorded as 2x standard IRs and 3x IRs are removed. Cattle disclosed as IRs at severe interpretation of the skin test are subject to both IFN-y and antibody testing (using IDEXX). In herds with an action plan, the exit strategy for IR herds is to test severe IRs using IFN-y and to use the IDEXX test if any are IFN-y positive. In hotspot areas of the LTBA and the ITBAN, the exit strategy is to IFN-y test severe IRs.

The cohort of animals included in the following figure are those with an inconclusive reaction at the initial TB test in an OTF herd where no reactors were detected (i.e., outside of an incident) and these animals were followed for 15 months after the initial test (taken in 2019). Figure 7.1.1 is split into two sections.

The initial IR sequence (above the grey line) follows animals through to testing negative or becoming a 2xIR, 3xIR, reactor or being removed. The subsequent IR sequence (below the grey line) describes what happens to animals that test negative at IR retesting. An IR can test negative at the first or third retest, and this is represented by the two streams in the subsequent IR sequence.

If an animal becomes a 2xIR using the standard interpretation of the test (and was a standard IR on both occasions), it is removed for slaughter. If it becomes a 2xIR using the severe interpretation of the test (at least once), it has a second retest using the IFN-γ test. Passing that triggers another skin test and if the animal becomes a 3xIR, it is removed for slaughter as a reactor.

Of the 2,804 IR-only animals that had an inconclusive reaction to the skin test in 2019, 2,279 (81%) tested negative at the first retest in 2020, and over half (1,207; 53%) of these remained negative during the follow up period. A further 501 were routinely slaughtered, with 497 determined to have no detectable lesions upon slaughterhouse post-mortem inspection.

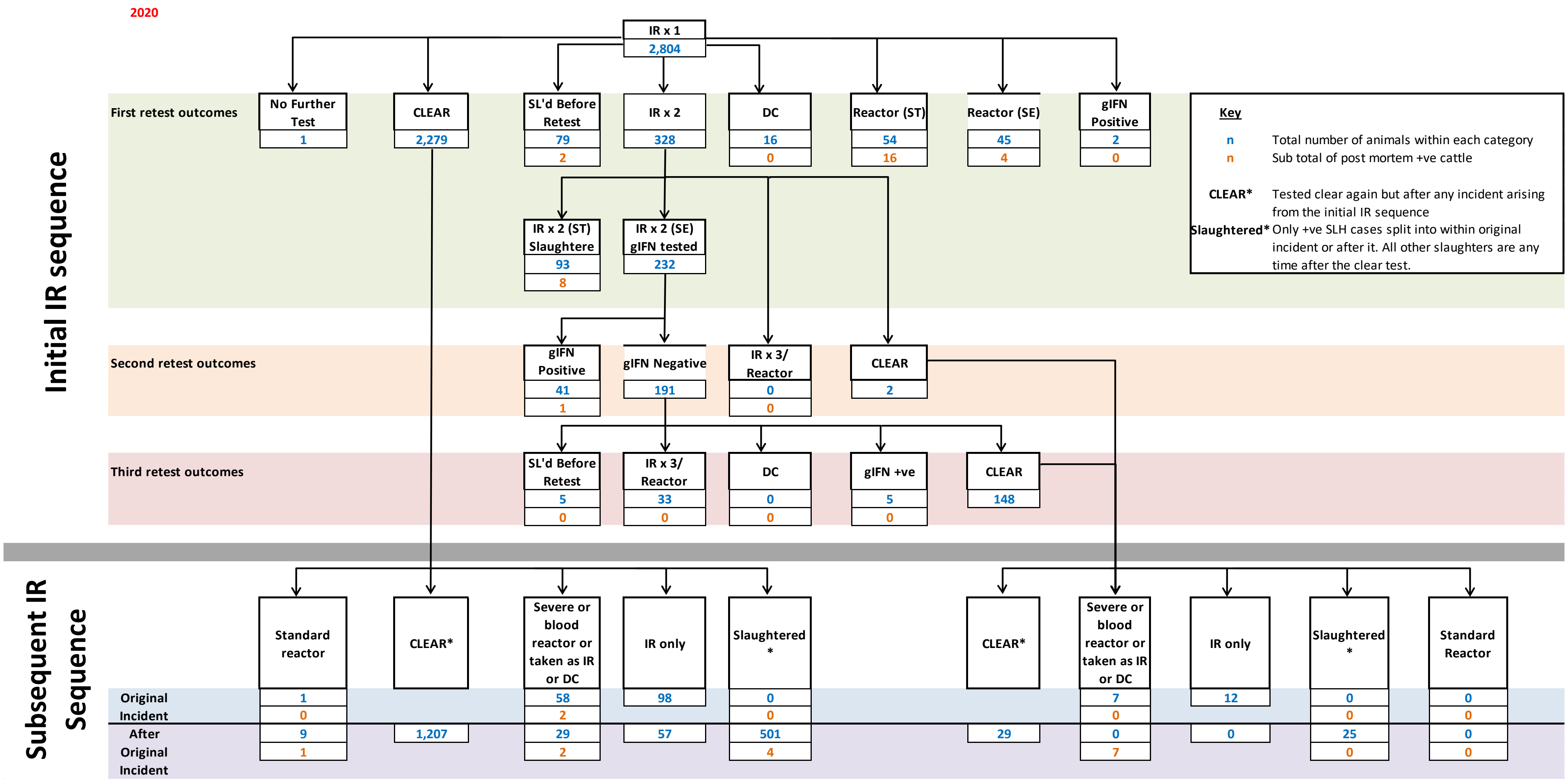

Figure 7.1.1 Flow diagram illustrating the fate of animals which had an inconclusive reaction to the SICCT test in 2020

7.2 Inconclusive reactor herds that subsequently suffered an incident

This section analyses the fate of herds in the 15 months following an initial herd test (IR-only test). The criteria are described in detail in the glossary and definitions section in the supplementary document. It is important to quantify IR-only herds that suffer subsequent incidents, as animals in these herds may have been infected with *M. bovis* at the time of the IR-only test.

In 2020, from a total of 856 IR-only herds, 103 (12%) went on to have an OTF-W incident and 23 (3%) had an OTF-S incident at the IR retest. The remaining 730 (85%) were negative at the IR-retest.

Of the 730 herds that tested negative at an IR retest, 713 subsequently had a whole herd test (WHT) within the 15-month follow up period. Significantly more IR-only herds (15.3%, n=109) went on to have a TB incident at the next WHT, compared to non-IR herds in 2020 (4.6%; 397/8,592) ($p<0.001$, z-test to compare proportions; see Appendix table 14). The percentages observed in 2020 were like those observed in recent years.

Figures 7.2.1 and 7.2.2 show the 10-year trends in the percentage of IR-only herds that went on to have a TB incident at the IR retest or subsequent whole herd test since 2011, where there has been a sustained drop in the herd-level failure rate at IR retest.

The percentage of IR-only herds that went on to have a TB incident at the IR-retest has continued to decrease since 2011, bar a small increase observed in 2013 and 2018 (total TB and OTF-W incidents). The initial decrease was related to the change in the way incidents were classified from 2011. Up to 2011, the percentage of IR-only herds with a subsequent OTF-W incident was around nine per cent. This increased to 17% in 2013 from more herds being classified as OTF-W from 2011 onwards (See Appendix 1 for details on classification of TB incidents).

Between 2013 and 2018, the percentage of IR-only herds with an OTF-W incident at the IR-retest remained relatively stable, between 14% and 17% but has since decreased to 12% in 2020 (Figure 7.2.1).

The percentage of IR-only herds with a TB incident (total TB or OTF-S) has been decreasing in most years, to 15% and 3% in 2020, respectively. The decrease in OTF-S incidents disclosed at an IR-retest is a result of more herds being classified as OTF-W, and the management of OTF-S incidents where a further short-interval test is always required.

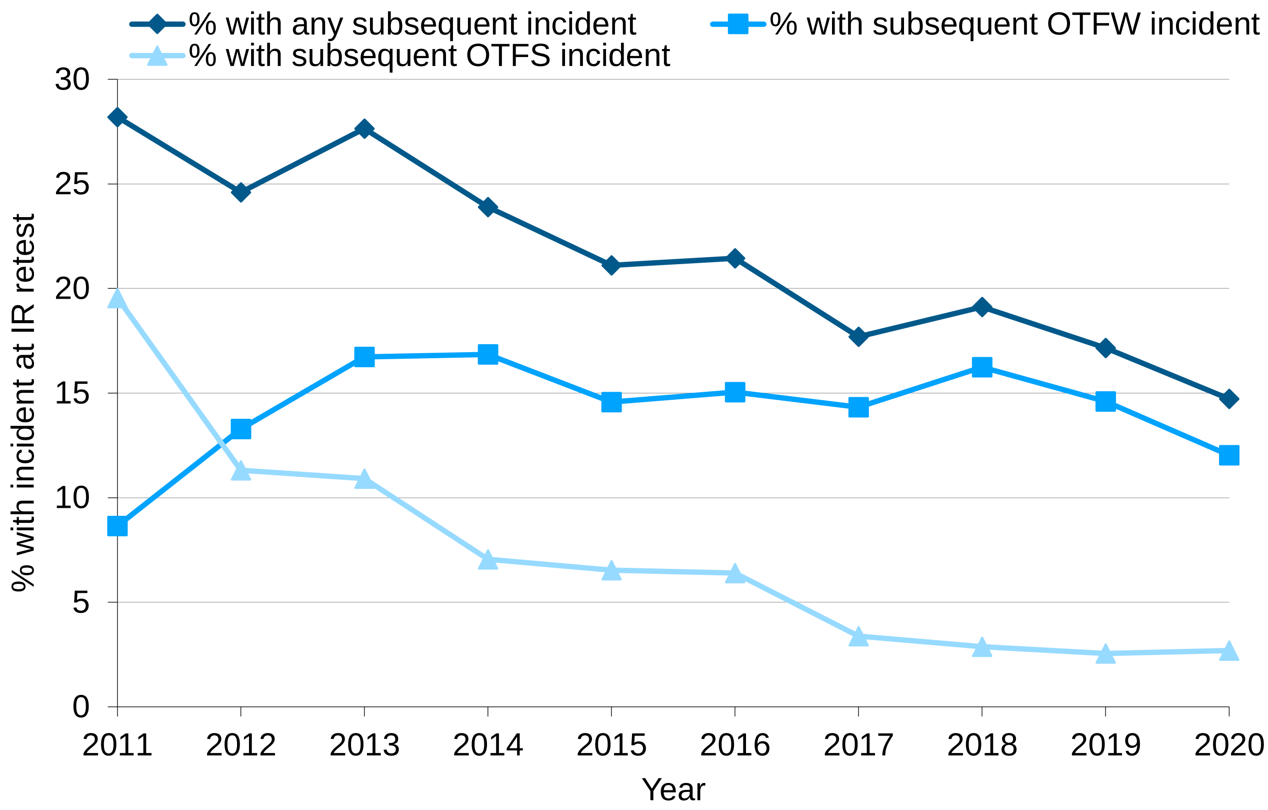

Figure 7.2.1: Percentage of IR-only herds with a TB incident at the IR-retest

The percentage of IR-only herds with a new TB incident following an IR-retest result that was negative (Figure 7.2.2) has followed a similar trend to IR-only herds with a TB incident at the IR-retest. This similarity in the two figures suggest that the IR-retest was not predictive of new TB incidents.

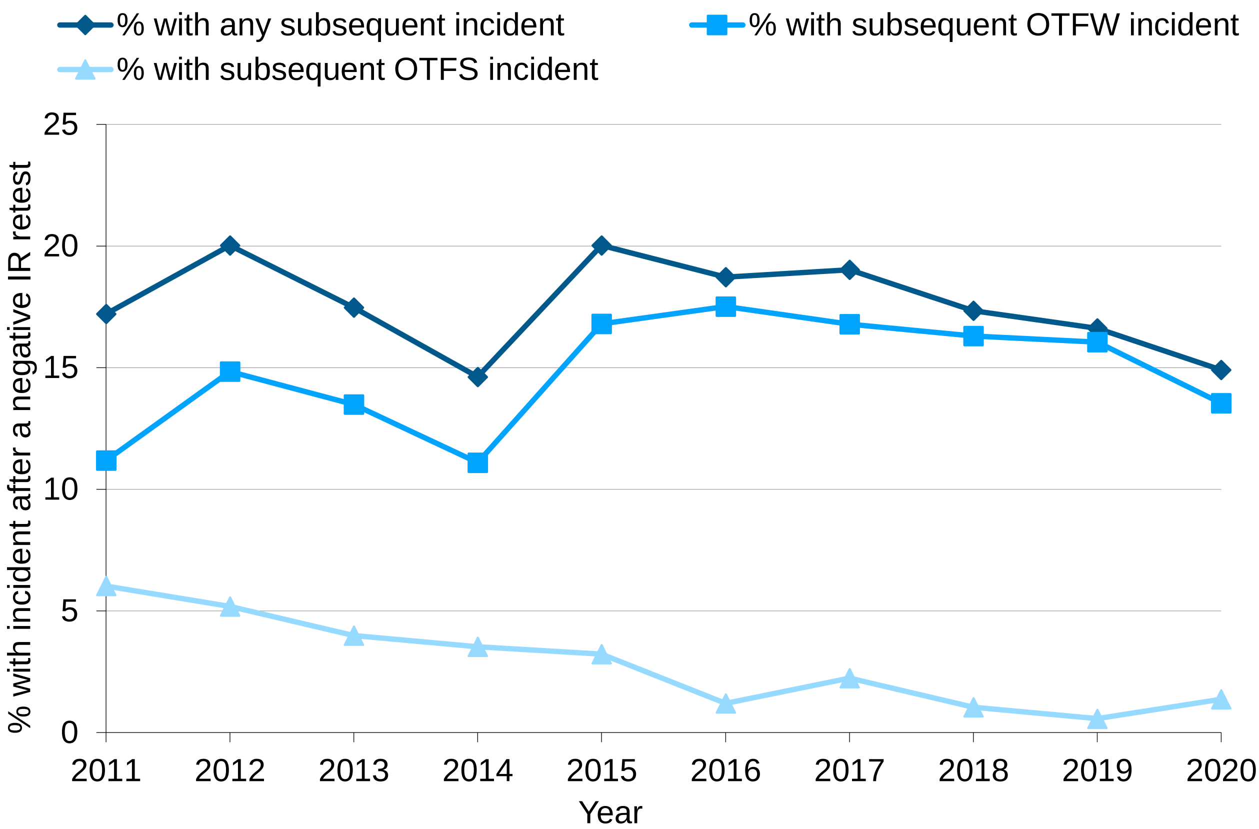

Figure 7.2.2: Percentage of herds that had a new TB incident following an IR-retest[1] result that was negative

[1]Herds that did not have a whole herd test within the 15-month follow up period were excluded from the denominator

Figures 7.2.3 a-c show five-year trends for a) the percentage of IR-only herds with no subsequent TB incident, b) the percentage of IR-only herds with a new TB incident at retest and c) the percentage of IR-only herds with a new TB incident at the test subsequent to a negative IR-retest within fifteen months.

In all TB Areas, most IR-only herds have no subsequent TB incident within the 15-month follow-up period after an initial herd test (72.5% for Wales overall in 2020). The percentage is higher in the ITBAM and LTBA (81% and 85%, respectively). The increasing trend in these two TB Areas is considered due to the IR policy of IFN-y testing severe IR herds in hotspot areas. The percentage was similar in the HTBAW and ITBAN to Wales overall, at 71%, and lowest in the HTBAE (65%, Figure 7.2.3a).

In Wales overall, 15% of IR-only herds went on to have a TB incident at the IR-retest (similar percentage to the ITBAM). The percentage ranged between 9% (ITBAN) and 21.5% (HTBAE) across TB Areas in 2020 (Figure 7.2.3b).

In Wales overall, 15% of IR-only herds went on to have a TB incident at the test following a negative IR-retest. This varied by area (5% in the LTBA and ITBAM) and 22% in the ITBAN in 2020. In the HTBAE and HTBAW the percentages were very similar (18 and 19% respectively; Figure 7.2.3c).

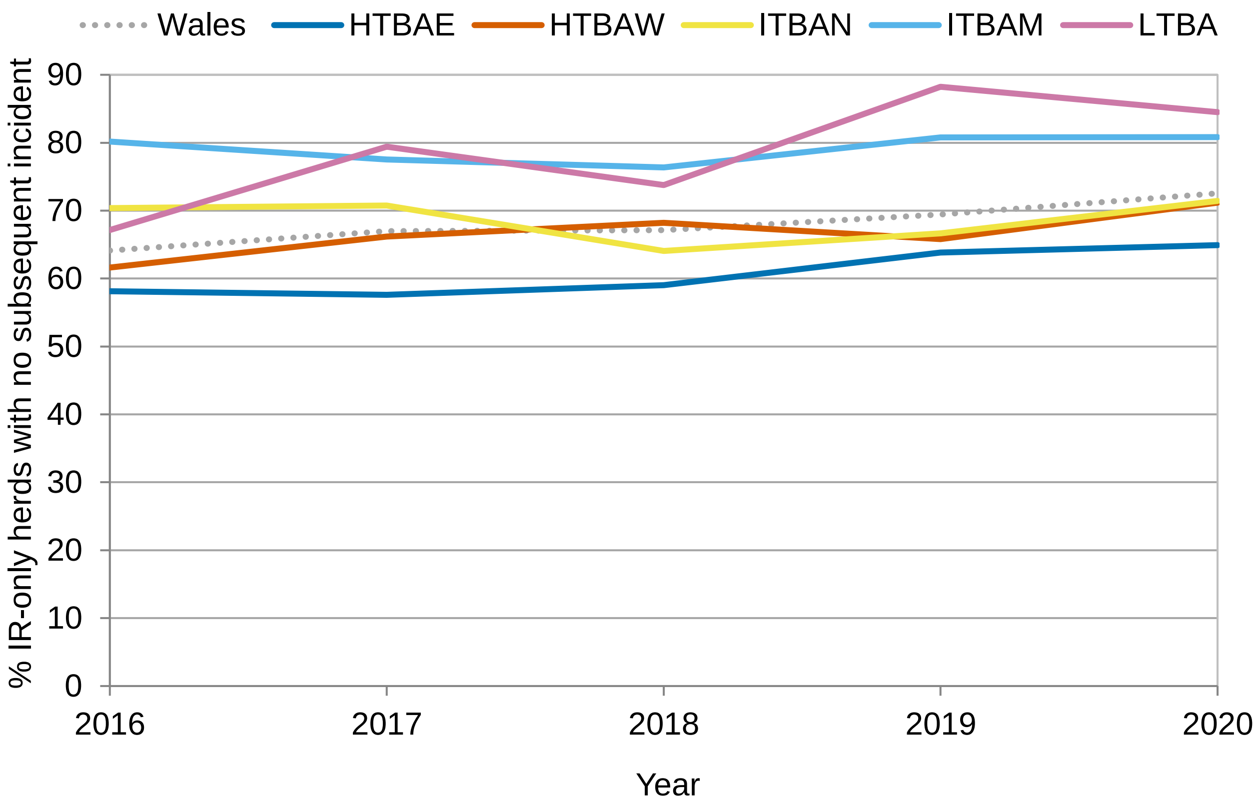

Figure 7.2.3a: IR-only herds with no subsequent TB incident within 15 months, by TB Area (2016 to 2020)

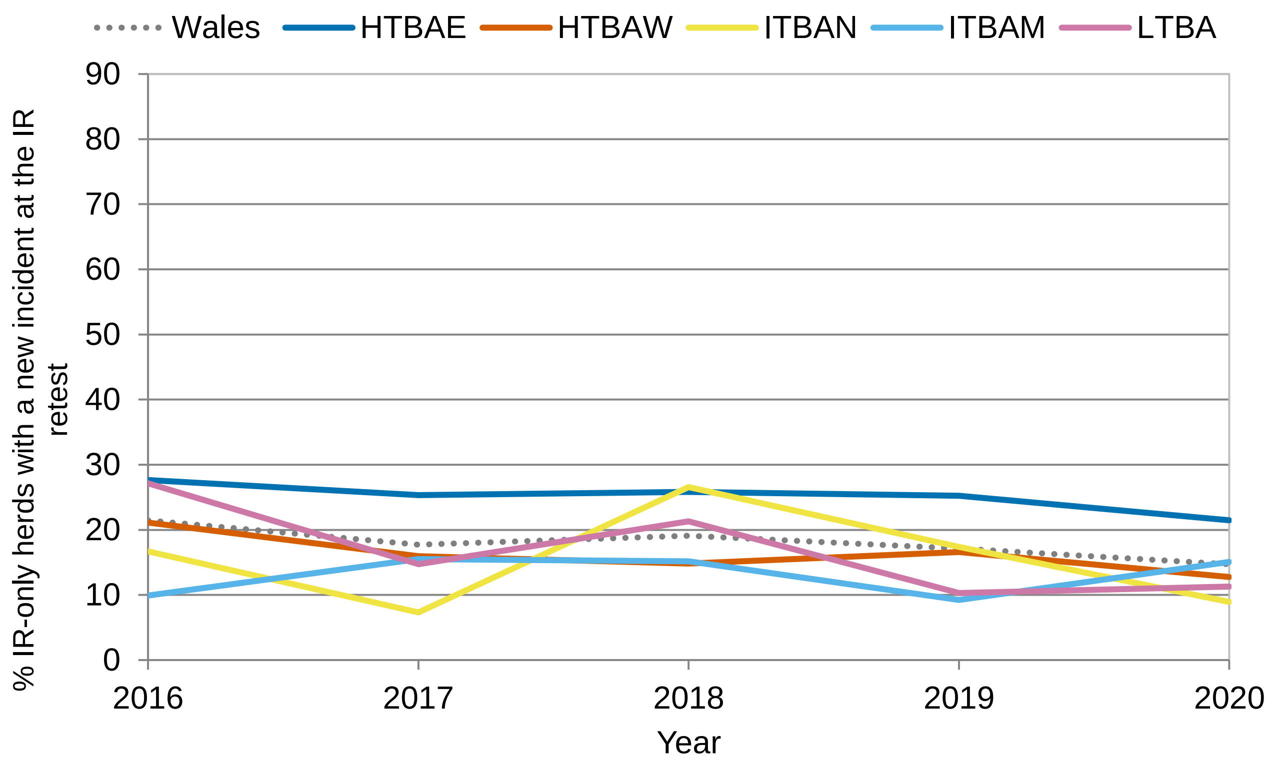

Figure 7.2.3b: IR-only herds with a new TB incident at the IR retest, by TB Area (2016 to 2020)

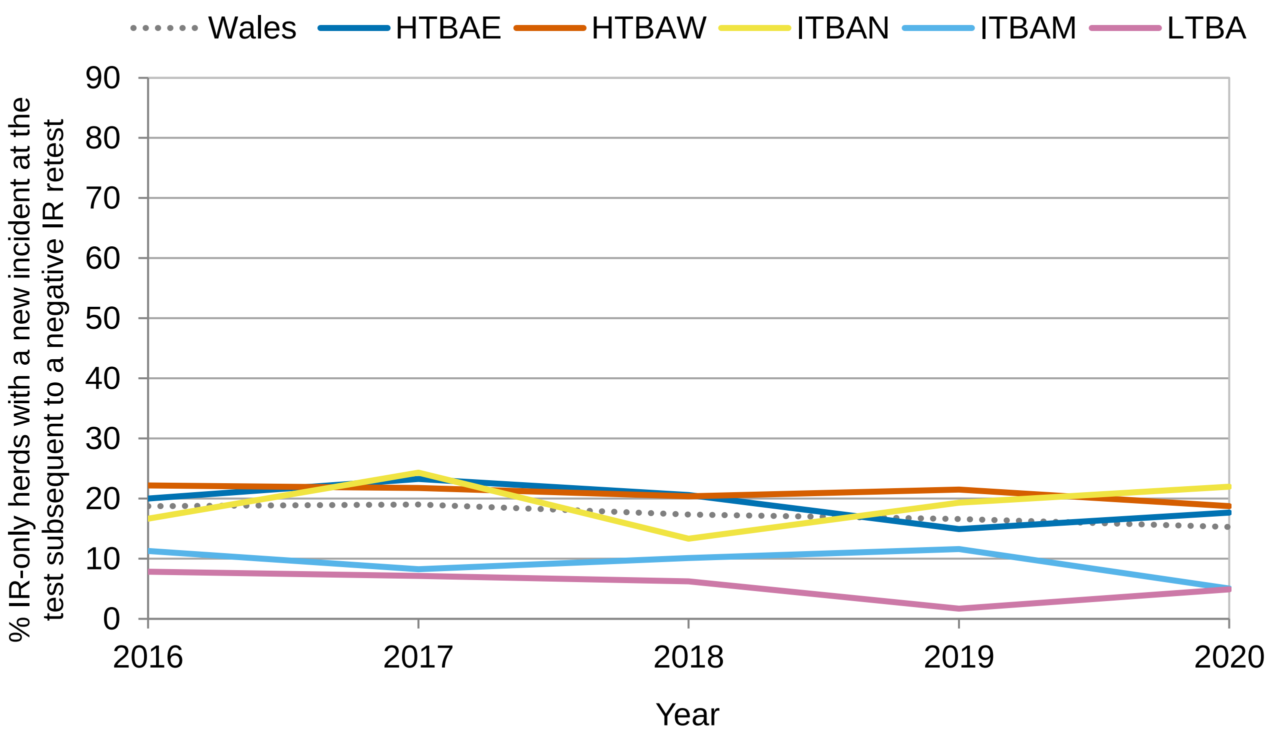

Figure 7.2.3c: IR-only herds with a new TB incident at the test subsequent to a negativeIR retest, within fifteen months, by TB Area (2016 to 2020)

The grey dotted line represents the trends in Wales overall

Figure 7.2.4 shows the number of animals slaughtered as IRs per 1,000 animals tested (total skin tests), by TB Area, while Figure 7.2.5 shows the density of IRs in 2020 (for herds with at least one IR per km^2). The number of IRs per 1,000 animal tests was highest in the HTBAW, where the density of IRs is highest, followed by the ITBAM and HTBAE. However, when considering the number of animals slaughtered as IRs per 1,000 animal tests at severe interpretation, the HTBAE and ITBAN is not far below the HTBAW (0.76 compared to 0.70 and 0.69 respectively; Table 7.2.1).

There are also areas of increased IR density in parts of the ITBAN and even the LTBA, although in areas of lower levels of infection, a 'hotspot' could be representative of just one OTF-W incident. The darkest blue colour on the map with the lowest density band (0-0.04 IRs per km^2) is more widespread in 2020 than in 2019 (Figure 7.2.5), however there are areas which had previously shown increased IR density in 2019 which have reduced in 2020, for example in parts of the HTBAE, HTBAW and LTBA.

There are areas within the HTBAE that had a higher density of IRs in 2019 which are now lower in 2020, as well as areas with increased IR density. One area to the north east of the HTBAE is showing a higher density, albeit in a smaller spatial area (density of IRs of 0.16-0.20 per km^2). There is a hotspot in the ITBAN which is an area known to have an increased level of TB infection and the density of IRs has also increased in 2020. Areas of increased TB infection in the LTBA or ITBAN (also with increased IR density) have inevitably resulted in a change of policy being implemented from June 2021[15].

Table 7.2.1: The number of reactors and IRs (and number confirmed), plus IR's per 1,000 animal tests, by interpretation and TB Area, 2020

TB Area	Interpretation	No. of reactors	No. of confirmed reactors	No. of IRs	No. of confirmed IRs	No. of IRs per 1,000 animal tests
HTBAE	Severe	1,360	510	64	2	0.703
HTBAE	Standard	24	1	10	0	0.033
HTBAW	Severe	2,919	411	208	11	0.756
HTBAW	Standard	195	8	36	1	0.065
ITBAM	Severe	280	61	8	2	0.506
ITBAM	Standard	11	1	6	0	0.031
ITBAN	Severe	379	92	28	2	0.678
ITBAN	Standard	22	3	9	2	0.064
LTBA	Severe	148	42	6	0	0.558
LTBA	Standard	13	0	7	1	0.027

[15] https://gov.wales/changes-how-we-manage-breakdowns-low-tb-area

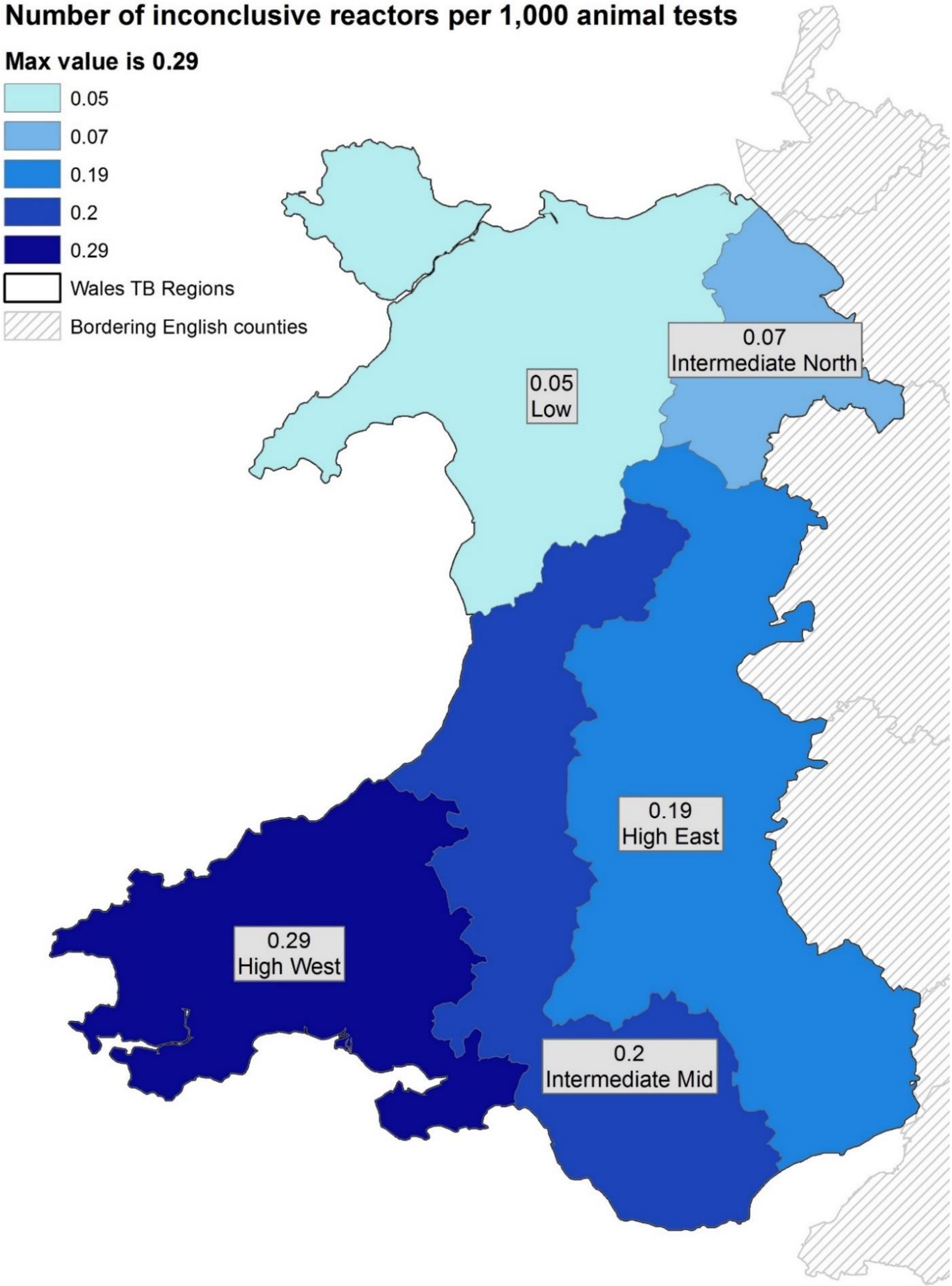

Figure 7.2.4: Number of animals slaughtered as IRs per 1,000 animals tested in 2020, by TB Area

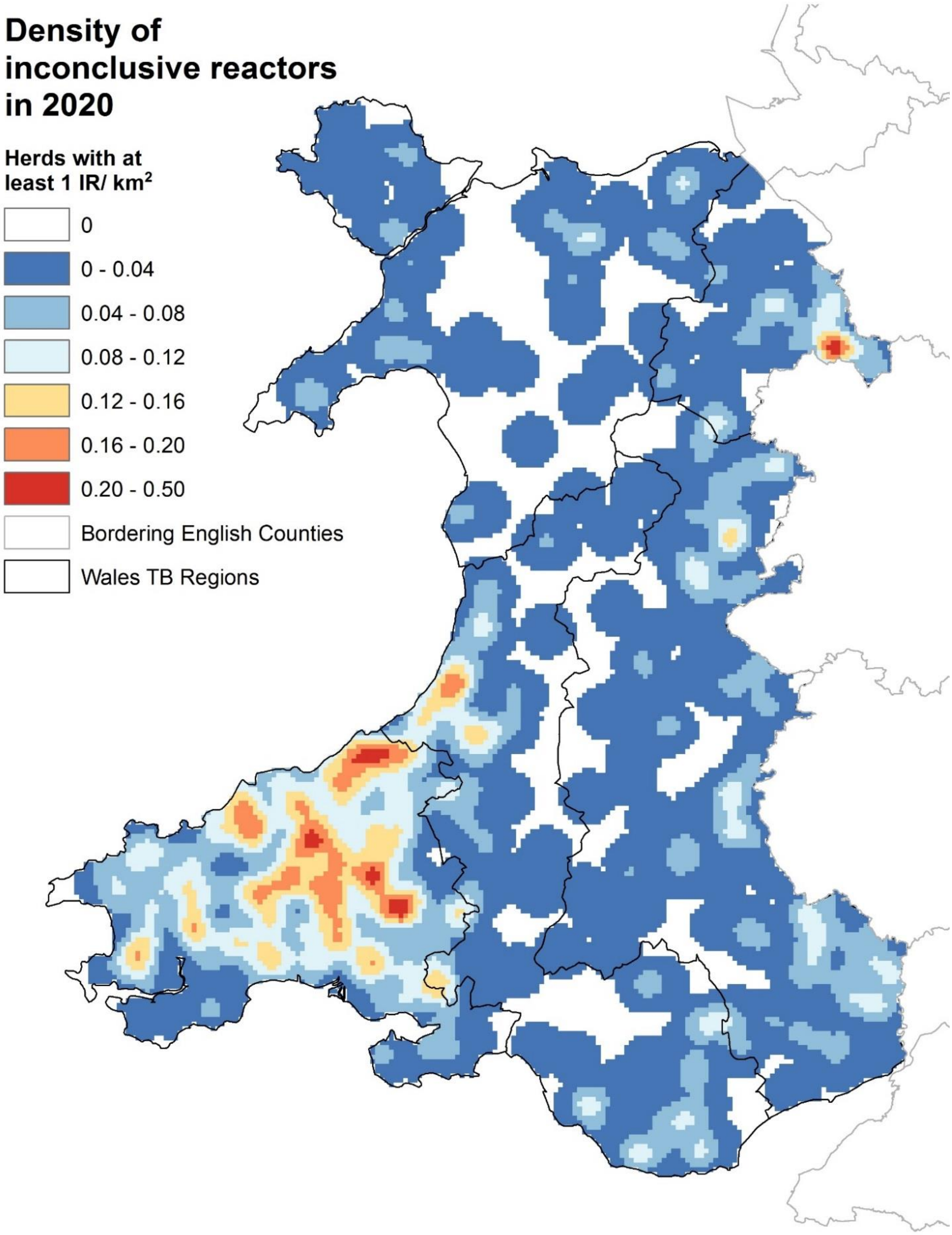

Figure 7.2.5: Density of inconclusive reactors per km², 2020

Figure 7.2.6 shows the geographical distribution of IR-only herds that had a new TB incident at either the IR retest, or at the test subsequent to a negative IR-retest in 2020. The data has been split by OTF-S and OTF-W. IR-only herds with no TB incident in 15 months are not shown on the map (621 herds).

IRs are tested either on their own or in a herd where reactors were identified, with the rest of the herd. It is important to identify IR-only herds that suffer from subsequent TB incidents, as the cattle in these herds may already have been infected at the IR-only test. Retests of IRs are carried out at least 60 days after the first test, with a subsequent test 12 months later (to allow for a 15-month follow-up period).

As expected, most were in the HTBAW and HTBAE, with the majority being OTF-W rather than OTF-S. OTF-S incidents disclosed either at the IR retest or the subsequent test (post re-test) were mostly distributed around the HTBAE and ITBAM.

Across Wales, 23 IR-only herds had an OTF-S incident at retest and 10 with an OTF-S incident at the subsequent test (post retest). A total of 103 IR-only herds had an OTF-W incident at the retest and 99 IR-only herds had an OTF-W incident at the subsequent test (post retest). This was slightly lower in comparison to 2019 (126 and 112, respectively). The decrease reported here and in previous figures would suggest that policy measures used for IRs are working.

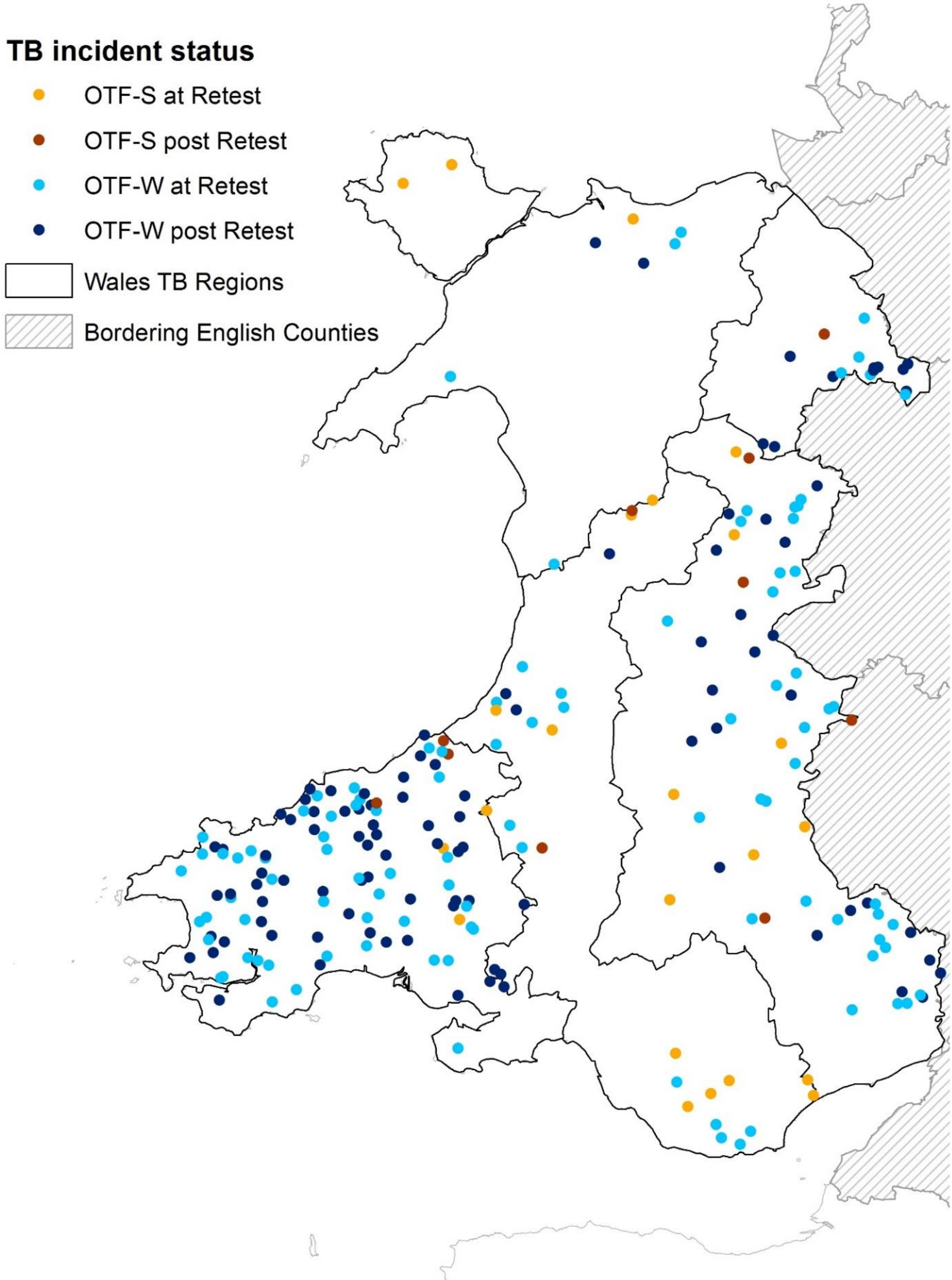

Figure 7.2.6: IR herds with a new OTF-W or OTF-S incident at the IR retest or at the test subsequent to a IR retest that was negative, within fifteen months (2020)

8. Slaughterhouse cases

Key points:

- In 2020, 63 (11.4%) of all new OTF-W incidents were disclosed through slaughterhouse surveillance (SHC).
- The geographic distribution of OTF-W incidents disclosed by slaughterhouse surveillance reflects the distribution of all new TB incidents disclosed in 2020. Most are in the HTBAE and HTBAW where the burden of disease is highest (16 and 28 SHC incidents disclosed in 2020, respectively).
- Compared to herd sizes of 300 or more animals (reference category), only herds with between 51 and 100 animals had significantly reduced odds ($P<0.05$) of an OTF-W incident being disclosed in the slaughterhouse, an effect which remained after adjusting for herd type and TB Area.
- There was no significant difference in the odds of dairy herds incurring an OTF-W incident through slaughterhouse surveillance, compared to beef herds. However, there is a greater risk of detection of infection in dairy herds (see chapter 4), which could suggest there is a disparity in the effectiveness of slaughterhouse surveillance in dairy herds compared to beef herds.
- After adjusting for herd size and type, herds in the ITBAM were three times more likely to have an OTF-W incident disclosed in the slaughterhouse compared to the HTBAW. There was no significant difference for all other TB Areas.

8.1 Incidents disclosed at slaughterhouse inspection

In 2020, there were 552 new OTF-W incidents disclosed in Wales, with 63 (11.4%) disclosed through slaughterhouse surveillance. This is a 19% increase compared to 2019 (9.6%). There were 45 negative results from SHC in 2020 where culture was performed. Slaughterhouse surveillance may detect infected cattle that may have otherwise been missed through active (live) surveillance testing.

The percentage disclosed varied by TB Area and reflects the variation in the background force of infection (Figure 8.1.1, 8.1.2). In TB Areas where the level of infection is generally lower, the percentage of OTF-W incidents disclosed by SHC may be higher. The number of incidents disclosed by SHC may also be linked to the surveillance effort within slaughterhouses. A training exercise in 2010 was associated with an increase in the number of incidents disclosed by SHC. Decreases in the percentage of incidents disclosed by SHC have been observed because of both the 2001 FMD outbreak when live animal testing resumed in 2003 and Health Check Wales in 2008 (changes observed in 2003 and 2009). These effects were more evident in the ITBAN, ITBAM and LTBA.

The ITBAM generally has the highest percentage of SHC-disclosed OTF-W incidents (25.7% in 2020) as well as the LTBA, although there has been a decline in the LTBA over the last two years (11.8% in 2020).

In the ITBAN, the percentage of SHC-disclosed OTF-W incidents increased to 11% in 2020 which was similar to the percentage observed in 2017.

Only the HTBAE observed a slight decrease in the percentage of OTF-W incidents disclosed by SHC in 2020 (8.5% in 2020, down from 8.6% in 2019), where all other areas observed an increase (in the HTBAW; 11.7%, up from 8.8% in 2019).

It is difficult to extract any trends in the percentage of SHC-disclosed OTF-W incidents by TB Area, as there is year-on-year variation, unless related to a specific event as mentioned above. Any variation for the last ten years cannot be explained by the frequency of testing as is the case in England since all herds have been annually tested in Wales since 2010. Changes to the number (or percentage) of new OTF-W incidents disclosed by SHC likely reflect changes in testing and control regimes, where infection is detected on the farm at an earlier stage as well as surveillance test performance.

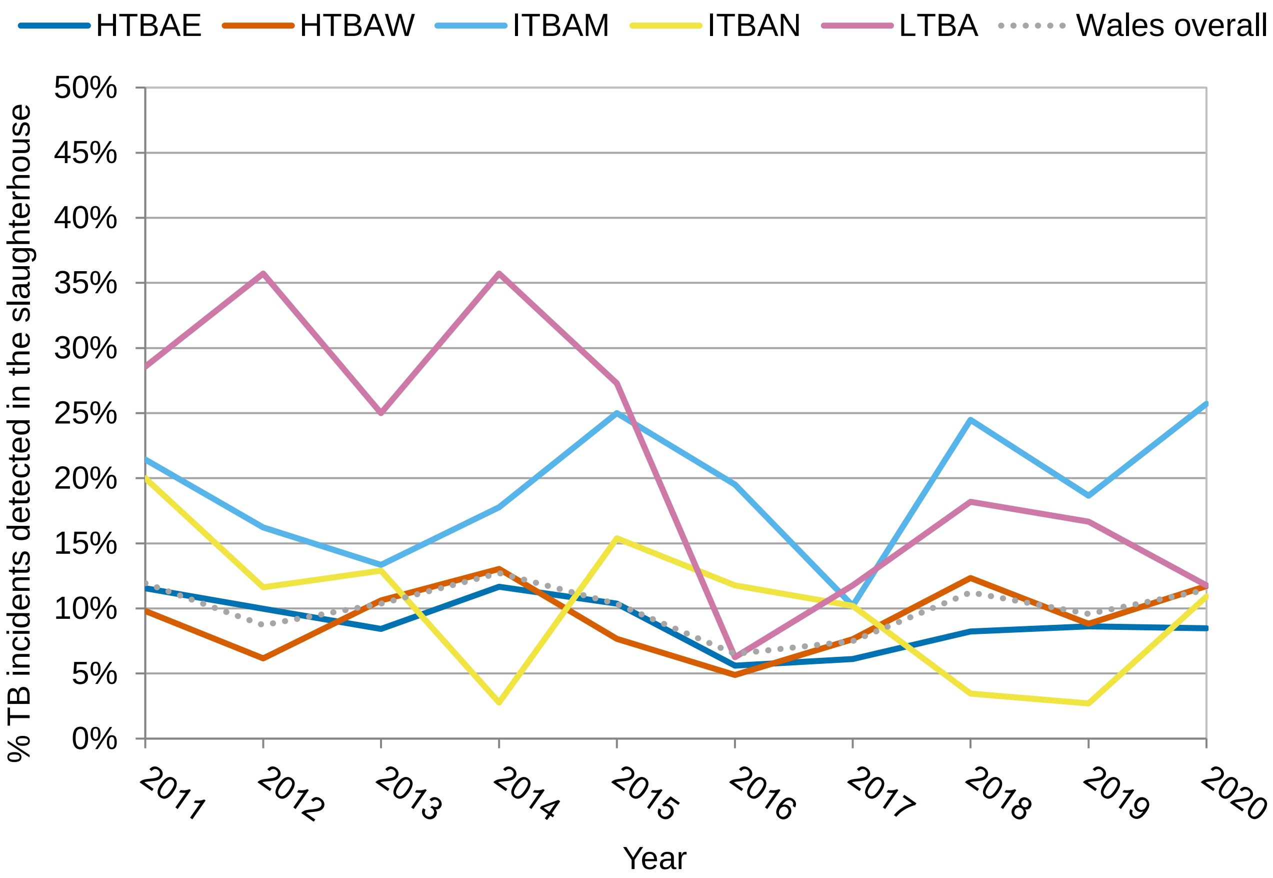

Figure 8.1.1: Percentage of OTF-W incidents disclosed in the slaughterhouse, by TB Area, 2011-2020

The geographic distribution of OTF-W incidents disclosed by SHC reflects the distribution of all new TB (and OTF-W) incidents disclosed in 2020 (i.e., those detected by live animal testing or slaughterhouse inspection; Figure 8.1.2). Most are located in the HTBAE and HTBAW where the burden of disease and background levels of infection are highest (16 and 28 incidents disclosed by SHC in 2020, respectively). The remaining TB Areas had fewer than ten OTF-W incidents disclosed by SHC (nine in the ITBAM, six in the ITBAN and four in the LTBA). In the ITBAM, these are mostly clustered around the mid-point bordering the HTBAW.

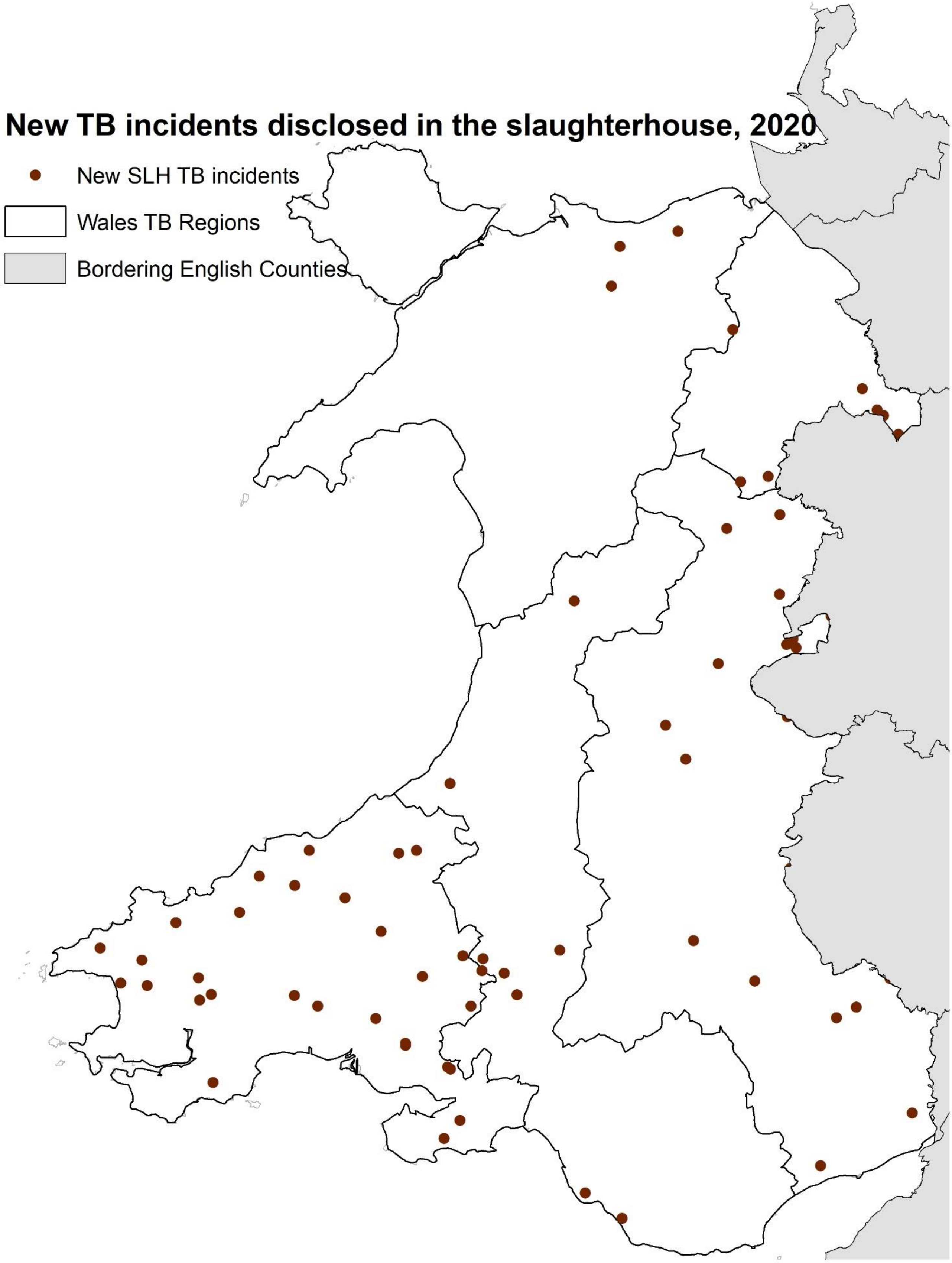

Figure 8.1.2: New TB incidents disclosed in the slaughterhouse (SLH), 2020

Table 8.1.1 shows the results of a logistic regression to look at several factors (herd size, herd type and TB Area) and how these affect the odds of a TB incident being disclosed by SHC. Where there are increased odds, this could be due to reduced sensitivity of active (live) skin testing in a specific area.

Compared to herd sizes of 300 or more animals (reference category), all other herds had reduced odds of having an OTF-W incident being disclosed by SHC, however only herds with between 51 and 100 animals had significantly reduced odds ($P<0.05$), an effect which remained after adjusting for herd type and TB Area.

There was no significant difference in the odds of either beef or dairy herds incurring an OTF-W incident by SHC. However, there is a disparity in the risk of detection of TB in the field (Table 4.5.1, dairy herds appear to have greater than three times the risk of detection in the field). Therefore, slaughterhouse surveillance may not be as effective for dairy herds (or likewise, field surveillance via routine testing may not be as effective in beef as it is in dairy herds).

Relative to the HTBAW (reference category), only the ITBAM had significantly increased odds of an OTF-W incident being disclosed by SHC, an effect which remained after adjusting the logistic regression for herd size and type. After adjusting for these factors, herds in the ITBAM were three times more likely to have an OTF-W incident disclosed by SHC. In 2019 the same result was observed, with potential factors being linked to either variation in the sensitivity of slaughterhouse surveillance (between TB Areas), or geographic clustering of official veterinarian (OV) surveillance test performance issues.

Table 8.1.1: Results of Logistic regression analyses of the associations between herd type, herd size and TB Area and the odds of an OTF-W incident being disclosed by slaughterhouse surveillance (SHC) in 2020

	Total OTF-W incidents	No. SHC incidents (%)	No. non-SHC incidents (%)	Unadjusted Odds ratio	Unadjusted 95% CI	Unadjusted 95% CI	Adjusted Odds ratio	Adjusted 95% CI	Adjusted 95% CI
Herd size									
1 – 10	9	0 (0)	9 (100)	-					
11 – 50	88	11 (12.5)	77 (87.5)	0.72^{ns}	0.33	1.58	0.71^{ns}	0.29	1.76
51 – 100	122	8 (6.6)	114 (93.4)	0.35*	0.15	0.83	0.36*	0.13	0.94
101 – 200	129	14 (10.9)	115 (89.2)	0.61^{ns}	0.30	1.27	0.58^{ns}	0.27	1.28
201 - 300	77	9 (11.7)	68 (88.3)	0.67^{ns}	0.29	1.54	0.60^{ns}	0.25	1.43
>300	127	21 (16.5)	106 (83.5)	*Ref*				*Ref*	
Herd type									
Beef	306	30 (9.8)	276 (90.2)	*Ref*				*Ref*	
Dairy	242	33 (13.6)	209 (86.4)	1.45^{ns}	0.86	2.46	1.04^{ns}	0.52	2.06
Other/mixed	4	0 (0)	4 (100)	-	-	-	-	-	-
TB Risk Area									
HTBAE	189	16 (8.5)	173 (91.5)	0.70^{ns}	0.37	1.33	0.82^{ns}	0.40	1.67
HTBAW	239	28 (11.7)	211 (88.3)	*Ref*	-	-	*Ref*	-	-
ITBAM	35	9 (25.7)	26 (74.3)	2.61*	1.11	6.13	3.02*	1.24	7.33
ITBAN	55	6 (10.9)	49 (89.1)	0.92^{ns}	0.36	2.35	0.90^{ns}	0.35	2.33
LTBA	34	4 (11.8)	30 (88.2)	1.00^{ns}	0.33	3.06	1.09^{ns}	0.35	3.43
Total	**552**	63 (11.4)	489 (88.6)						

*, **, *** and ns denote levels of statistical significance of p≤0.05, p≤0.01, p≤0.001, p>0.05 and not significant respectively.

[1] Unadjusted refers to the univariable logistic regression analyses, looking at the associations between herd size, herd type or TB risk area and the odds of an incident being detected in the slaughterhouse.

[2] The odds ratio is the odds of disease in the exposed categories relative to the odds of disease in the unexposed (reference [‘*Ref*’]) category.

[3] Adjusted refers to a multivariable logistic regression analyses where the associations between herd size, herd type or TB risk area and the odds of an incident being detected in the slaughterhouse were adjusted for the effects of each other