Animal & Plant Health Agency

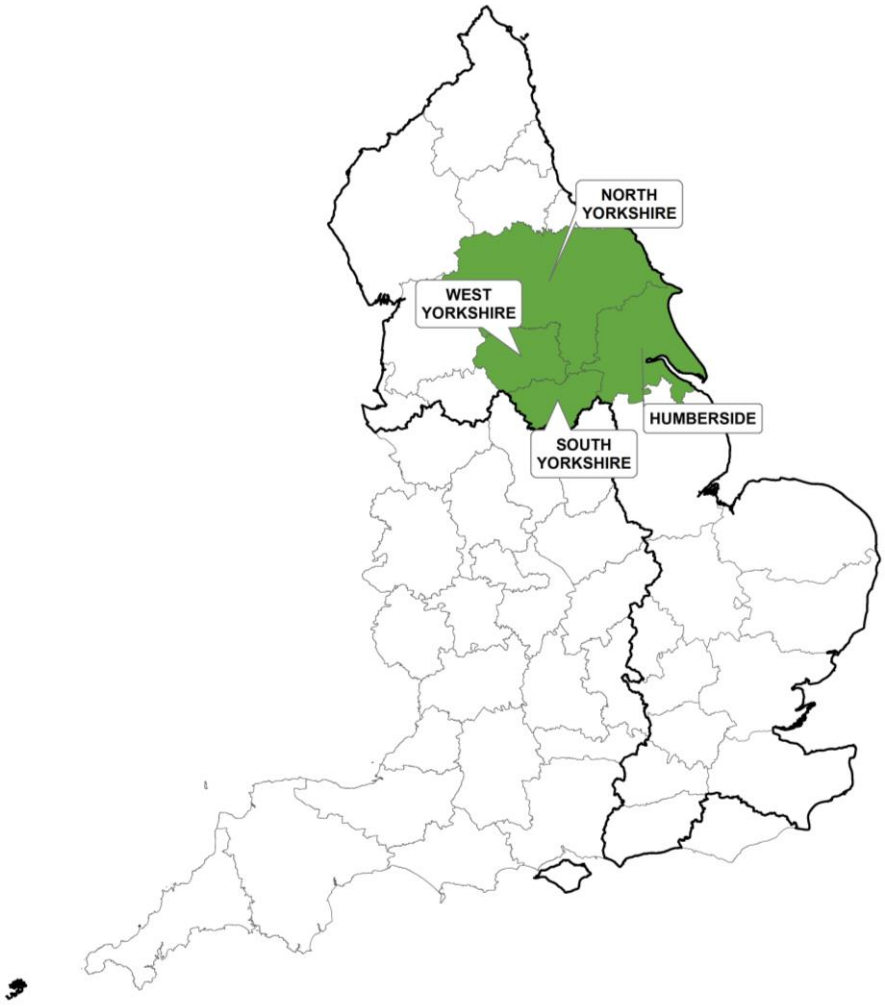
Year-end descriptive epidemiology report:

Bovine TB in the Low Risk Area of England

County coverage: Yorkshire and Humberside (including North Yorkshire, West Yorkshire, South Yorkshire and Humberside)

Year-end report for: 2019

TB Low Risk Area - YORKSHIRE AND HUMBERSIDE



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Executive summary

Reporting area

Yorkshire and Humberside (including the counties of North Yorkshire, West Yorkshire, South Yorkshire and Humberside) is part of the Low Risk Area (LRA) that was established in 2013. The following year, the bovine tuberculosis (TB) surveillance strategy for this area was incorporated into the Government's strategy to achieve Officially Tuberculosis Free (OTF) status for England by 2038. Overall the LRA has a very low and stable incidence of infected herds. This end of year report describes bovine TB in Yorkshire and Humberside.

Local cattle industry

The cattle industry in this region is large and diverse. The greatest proportion of herds and animals are located in North Yorkshire, where there is a split across different herd sizes. Across the rest of the region, smaller herds predominate. Nearly two thirds of the cattle reared in the region are beef animals. The different topographical characteristics of the region mean different farming enterprises are seen in different areas, developed to maximise the efficiency of productivity in these areas. Despite this, the split between beef, dairy and dual purpose breeds is relatively stable across the different counties. There are currently 23 licensed finishing units (LFUs) across the region, of which 17 are located in North Yorkshire, five in South Yorkshire and one in Humberside.

New incidents of TB

In 2019 there were 30 new TB herd incidents in Yorkshire and Humberside. Seven of them had one or more animals with visible TB lesions (VL) at post-mortem examination (PME) or a positive *M. bovis* culture result, leading to the withdrawal of OTF herd status (OTF-W). The remaining 23 incidents had their OTF status suspended (OTF-S) due to the lack of VL at PME and a negative *M. bovis* culture. This compares with the total of 23 TB incidents in 2018, of which eight were OTF-W and 15 OTF-S.

In North Yorkshire, there were four new OTF-W incidents and 12 new OTF-S incidents during 2019. This compares to six OTF-W and 11 OTF-S incidents seen in the county in 2018. This adds to the slight increasing trend in incident incidence seen since 2016, but remains considerably lower than what was seen in 2014/2015.

In South Yorkshire, there were two new OTF-W and eight new OTF-S incidents during 2019, which compares to two OTF-W and one OTF-S incident disclosed during 2018. This represents a large spike, and the highest recorded number of incidents recorded over the past five years. Five of these OTF-S incidents were part of a cluster of cases disclosed in the south-west of the region.

In West Yorkshire, there were no OTF-W and three OTF-S incidents disclosed during 2019 in comparison to no OTF-W and two OTF-S incidents in 2018. This shows a slight increase, however the numbers are very small and so it is difficult to confirm a trend in this county.

In Humberside, there was one OTF-W and no OTF-S incidents in 2019, compared to no OTF-W and two OTF-S incidents in 2018. This is a fall in the general number of cases seen in this region over the past five years.

Potential or confirmed TB hotspot areas

A new potential hotspot area (HS27) was established during 2019 in the south-west region of North Yorkshire and encroaching into East Lancashire. At the time of reporting, *M. bovis* infection had not been confirmed in any of the badger and wild deer carcases submitted to APHA.

Unusual TB incidents

One of the three OTF-S incidents detected in West Yorkshire in 2019 led to the removal of 42 animals as skin test reactors and/or interferon gamma (IFN-γ) test positive animals. These animals had all been bought in as one batch from a herd in Pembrokeshire, in the high risk area of Wales and initially disclosed at a post-movement test.

One OTF-W incident was disclosed in a commercial beef fattening enterprise with a co-located petting farm. Susceptible species in the petting farm were tested for TB with negative results and additional biosecurity was put in place to reduce the risk of disease transmission from the commercial enterprise into the petting farm.

Two pigs tested positive to the skin test on a holding where they co-habited with a herd of dairy cattle that had its OTF status withdrawn. Post-mortem examination revealed potential TB-like lesions in one of the pigs, however *M. bovis* was not isolated in bacteriological culture.

Suspected sources and risk pathways for TB infection

From the disease investigations carried out, the main risk pathways for herds in this region in 2019 were:

- Inward movement of cattle from areas of higher risk: this accounted for over 45% of the weighted risk pathway contributions (Table A4.1), and was concluded to be the most probable source of infection in four out of seven OTF-W incidents. Cattle movements from higher TB risk areas of GB were also a likely contributing factor in several OTF-S incidents, although the lack of genotype information from herds with

OTF-S incidents makes confirming the source of infection much more difficult in those cases.

- Lateral spread of infection from contaminated fomites and contiguous cattle and local cattle movement: the involvement of these pathways was considerably less significant than the inward movement of cattle (Table A4.1). However it was considered as a route of introduction in several OTF-S incidents. Sharing of equipment and personnel between holdings and grazing of neighbouring herds is reasonably common practice, but its potential involvement in the spread of TB highlights the importance of strict biosecurity practices.
- Undisclosed infection in wildlife populations: there has been no evidence to date of confirmed *M. bovis* infection in wildlife within the region. APHA set up a potential hotspot area (HS27) along the North Yorkshire-Lancashire border due to a cluster of cases involving predominantly homebred animals with no clear source of infection. However, to date, no positive *M. bovis* culture results have been obtained from submitted wildlife in this area. Despite the limited evidence in this region, we must continue to consider this as a potential route of introduction to allow us to detect potentially infected wildlife promptly if they were to arise.

Details of the methodology used to calculate the weighted contribution of the different suspected sources of *M. bovis* infection for all new incidents can be found in the main body of the report and in the Explanatory Supplement for England 2019.

Disclosing tests

The primary method of detection of TB-infected herds in the region was active surveillance by skin testing of herds. New TB incidents began through routine herd testing, radial surveillance testing, pre- and post-movement testing, whole herd testing, and through disclosure of tuberculous lesions during routine meat inspection of non-reactor animals at slaughterhouses (SLH). Routine Herd Testing, pre-movement testing and Slaughterhouse case detection led to the disclosure of OTF-W incidents. Radial testing and Routine Herd Testing played a key role in the detection of OTF-S incidents across North and South Yorkshire, highlighting the importance of these ongoing surveillance methods. Very few new incidents were detected though post-movement testing.

Reactor numbers

A total of 166,625 animals were tested, by means of the skin tests and IFN-γ blood test, across this region during 2019 (Table A3.2). Of these, 122 cattle (0.07%) were compulsorily slaughtered for TB control reasons, of which 82 were skin test reactors and 40 were detected through IFN-γ testing. In North Yorkshire, a total of 53 reactors were removed, 28 skin test reactors and 25 IFN-γ test positive cattle. In South Yorkshire, 23 reactors were removed in total, 16 of which were skin test reactors and seven IFN-γ test positive. In West Yorkshire, 46 reactors were removed, 38 skin test reactors and eight IFN-γ test positive. The number of reactors removed in West Yorkshire is a marked increase

compared to previous years, but the majority of these were from one OTF-S incident triggered by post-movement testing of a large batch of cattle originating from a recently de-restricted herd in Wales. No skin test reactors or IFN-γ test positive cattle were removed from Humberside in 2019, where the only OTF-W incident was disclosed by slaughterhouse surveillance.

Risks to the reporting area

The abundance of large commercial beef fattening enterprises across the region poses a risk through the introduction of animals purchased from higher risk areas of the UK. Large enterprises often have a rapid turnover of animals, regularly restocking. In such situations, animals are often sourced for convenience, rather than by TB history and location and of their herd of origin, thus increasing the risk of TB introduction.

The southern boundary of the region with Derbyshire and Nottinghamshire in the Edge Area poses a potential risk of TB introduction into Yorkshire and Humberside. At the moment, this does not appear to be within close proximity to the LRA boundary, however extra care needs to be taken to prevent introduction through this route.

The cluster of cases seen along the south west border of North Yorkshire with Lancashire, continues to be an area of focus. This cluster has been ongoing since 2017 and has now affected 10 holdings. Many of these incidents involved only homebred animals where a firm conclusion about the origin of infection could not be reached. Due to this, a potential hotspot area (HS27) has been established to allow for ongoing cattle surveillance alongside surveillance of the wildlife populations in this area. At the time of reporting, no positive TB results had been reported from any of the wildlife specimens submitted to APHA for culture.

Risks posed by the reporting area

The risk posed to surrounding areas from Yorkshire and Humberside is low. The border of south-west South Yorkshire with northern Derbyshire could potentially act as a pathway for the translocation of infection. It is reasonably common practice for herds in this region of South Yorkshire to send animals into Derbyshire (Edge Area) for summer grazing.

Forward look

The main focus going forward will be around the results of the potential hotspot area (HS27) established along the Lancashire border in south west North Yorkshire. This will help to demonstrate if there has been any spill over of infection into wildlife populations in this area, and if this requires further action.

Additionally this report highlights a cluster of cases in South Yorkshire close to the boundary of the LRA with the Edge Area. Going forward this will also be an area that will

be monitored closely. It may subsequently be necessary to implement a potential hotspot in this area as well, depending on the progression of the disease situation.

The ongoing routine and enhanced surveillance methods are also critical in enabling this region to become free from TB. Routine Herd Testing and radial testing remain prominent in the timely disclosure of cases. Farmer compliance with the post-movement testing rules to quickly detect any infected animals entering the region, and limiting their ability to transmit infection, also has a key role to play. The combination of these different testing regimes is vital in order to effectively control the introduction and spread of infection across the region.

This report has highlighted that the major risk factor to the introduction of infection into this region is through the purchase of cattle from higher TB risk areas of the country. This is something that needs continued publicity and education to the industry to ensure that everyone is equally aware of, and aims to minimise, the risk from purchasing animals. This, coupled with further education on good biosecurity practice, will help to maintain and reduce the low incidence of TB we currently enjoy in this region as a whole.

Introduction

This report describes the level of bovine tuberculosis in cattle herds in Yorkshire and Humberside (including the counties of North Yorkshire, West Yorkshire, South Yorkshire and Humberside) in 2019. Bovine TB is caused by the bacterium *Mycobacterium bovis* (*M. bovis*), and will subsequently be referred to as TB. This report explores the frequency and geographical distribution of TB in cattle herds. It examines what is likely to be driving TB in Yorkshire and Humberside, and the risks the disease in these counties may pose to neighbouring cattle. Although other sources may refer to TB 'breakdown(s)', this report will use the term 'incident(s)' throughout. This report is intended for individuals involved in the control of TB, both in the local area and nationally. This includes, but is not limited to: farmers, veterinarians, policy makers and the scientific community.

In 2014, the Government published its Strategy to achieve Officially TB Free (OTF) status for England by 2038. A key action was to recognise the different amount of TB in different parts of the country and to vary the approach to control accordingly. To this end, three management areas were established (Appendix 1). Yorkshire and Humberside forms part of the LRA. Overall, the LRA has a very low and stable incidence of infected herds. The current strategy seeks to rapidly control infection when it arises through high sensitivity testing of affected herds and temporarily enhanced local surveillance (radial and hotspot testing). Compulsory pre- and post-movement testing of cattle entering the LRA from higher risk areas of the UK is also performed to reduce the risk of TB introduction. The aim is to preserve the favourable disease status of this county so that it can be declared OTF as soon as possible.

Cattle industry

The cattle industry across Yorkshire and Humberside is large and diverse. Over 60% of the all of the registered cattle holdings in the region as a whole are found in North Yorkshire (see Table A2.1). Small holdings, with fewer than 50 cattle, are the predominant type of business across much of the region (Figure 1), with median herd sizes in Humberside, South Yorkshire and West Yorkshire all under 50 animals. In North Yorkshire a wider variety of herd structures exist, ranging from 1-50 animals to over 501 animals, this in turn results in a generally higher density of cattle compared with much of the rest of the region.

Across the region as a whole, there has been a decrease in the number of holdings, with approximately 200 fewer registered herds than in 2018. This appears to be a trend across all regions and has largely been seen as a fall in the number of small holdings (1-50 animals) and holdings of 351-500 animals. The remaining herd structures appeared to be relatively stable. This fall in holdings of 1-50 and 351-500 animals could represent the challenges that the farming industry as a whole faces in the modern day, with it becoming ever more challenging to be economically viable with smaller, and in some set ups,

medium numbers of animals. Despite this, the mean and median herd sizes remained relatively static.

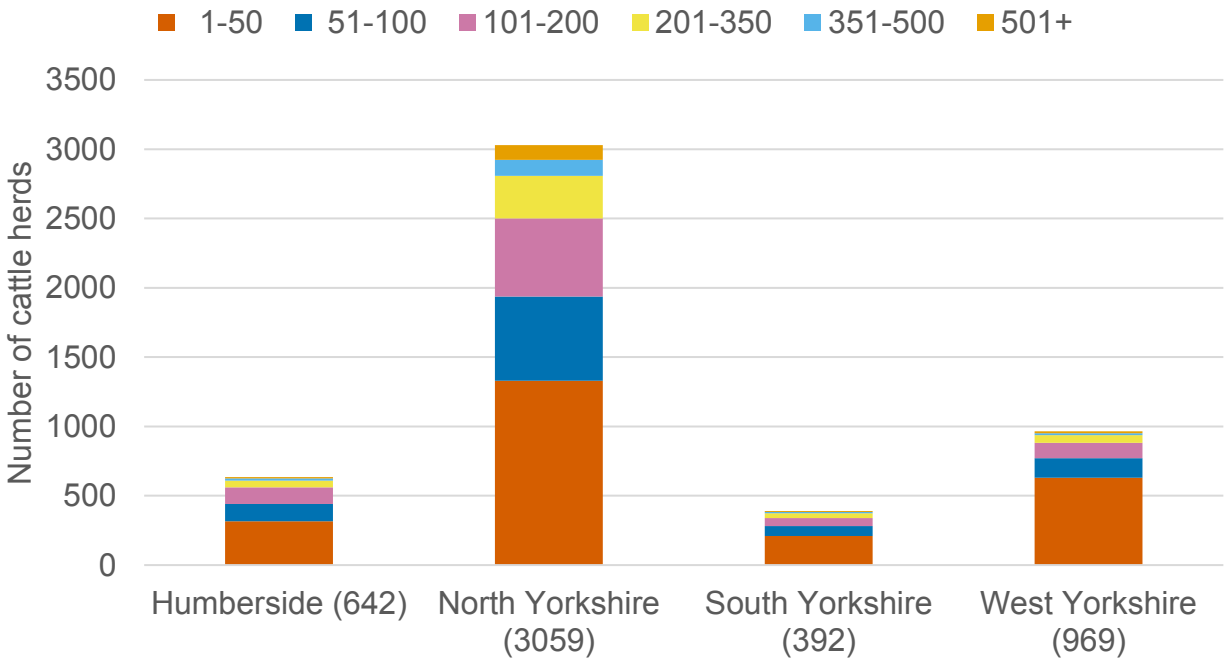


Figure 1: Number of cattle holdings in Yorkshire and Humberside, by herd size and county in 2019.

Across the region, 65% of the cattle are registered as beef animals with 31% being dairy-only animals. The remaining animals are recorded as dual breeds (Table A2.2). This is proportionally in line with what was seen in 2018. However, there appears to have been a general downwards trend in the total number of bovine animals in general in the region since 2018. Across North Yorkshire and Humberside the relative proportions of dairy and beef animals remained reasonably static, but across South Yorkshire and West Yorkshire there was a slight increase in the proportion of beef animals, and a fall in the number of dairy animals.

Grazing practices and common land

Traditional farming practice across the region is to house the cattle during the winter months and to turn them out to graze for the remainder of the year. This is highly dependent on annual weather conditions, but often results in management groups being mixed and re-arranged during housing. As we have seen, beef production makes up the majority of the cattle livestock in the region. This is often on large commercial set ups in regions where it allows them to take advantage of abundant by-products from the arable sector (e.g. straw). There are also pockets of common grazing that still exist mainly in the upland areas of the region. This can result in co-grazing of multiple herds and increased

risk of disease transmission. This makes up a very small proportion of the topographical area of the region as a whole, and has, to date, not been directly associated with any TB transmission.

Markets

There are 16 approved livestock markets across the region as a whole. Five of these currently hold an APHA licence for slaughter gatherings of TB restricted cattle, or for the regulated sale of animals that are exempt from a required pre-movement test. All of the TB licensed markets and 12 of the 16 markets are located in North Yorkshire, reflecting the overall commercial nature and movement of the cattle population in this area. Buyers appear to be generally well aware of the TB risk and attempt to source animals responsibly. Beef cattle buying tends to follows the general English pattern of West/South West England and Wales to East/North East England. To maintain throughput in these large beef production units however, market movements are often frequent. This is often facilitated by dealers who regularly source animals from multiple sources across different regions in the UK, including from the High Risk Area (HRA) where bovine TB incidence is considerably higher. Even when animals are responsibly sourced from holdings in the LRA, their premises of birth may be in the HRA and so the risk of them carrying residual, undetected infection into the LRA is higher. Throughout Yorkshire and Humberside, TB incidents were more commonly seen on beef enterprises. This is unsurprising, given the relative proportion of beef animals in the region. From this though, it would seem fair to conclude that due to the production cycles in many of these beef fattening enterprises, there is potential for infection to move through the markets.

Finishing units

Licensed finishing units (LFU) approved by APHA are permitted in the LRA. They are all non-grazing fattening units that operate under stringent biosecurity conditions, including strict wildlife proofing measures. They can only source animals from OTF premises, which must have undergone pre-movement testing with clear results if necessary and can only move from the LFU to slaughter. Providing these conditions are met and maintained, it has been concluded that they present a very low risk of TB spread in the area. Due to this cattle in LFUs are exempt from TB skin testing requirements.

One new LFU was approved in North Yorkshire during 2019, bringing the total number of LFUs in the region to 23, of which 17 are located in North Yorkshire, five in South Yorkshire and one in Humberside. This again reflects the volume and commercial nature of cattle farming across this region. There were no TB incidents on LFUs in 2019 in this region.

Descriptive epidemiology of TB

Temporal TB trends

Unless otherwise specified, this report includes all new TB incidents detected during the reporting period. This includes Officially Tuberculosis Free Status Withdrawn (OTF-W) incidents and Officially Tuberculosis Free Status Suspended (OTF-S) incidents. OTF-W incidents are those in which at least one animal was identified with typical lesions of TB at post mortem (PM), and/or positive for *M. bovis* on culture from tissue samples. OTF-S incidents are those with one or more reactors to the Single Intradermal Comparative Cervical Tuberculin (SICCT) skin test, but without full confirmation of *M. bovis* infection by PM or bacterial culture.

The largest number of TB incidents was again disclosed in North Yorkshire, where there were a total of four OTF-W and 12 OTF-S incidents during 2019 (Figure 2a). Whilst this is considerably lower than what was seen during 2014-2015, it is more than the total number of cases in 2016. Although more incidents are seen in North Yorkshire than in other counties in the region, it should be remembered that this is the area with the highest number and density of cattle, and so it might be expected that the numbers of incidents would be higher.

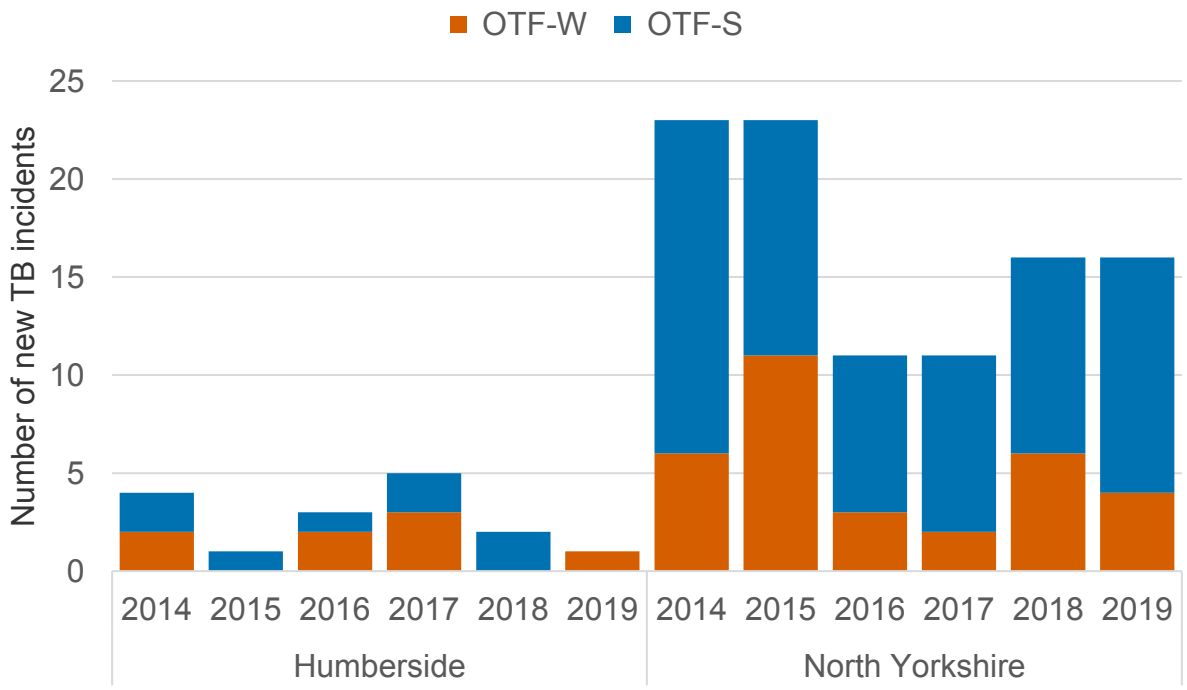


Figure 2a: Annual number of new TB incidents in Humberside and North Yorkshire from 2014 to 2019.

In South Yorkshire, there were two OTF-W and eight OTF-S incidents (Figure 2b). This was a marked increased from 2018, and the highest number of incidents recorded in this area over the past five years. The increase was most likely due to the detection of two OTF-W incidents disclosed in the second half of 2018 and the implementation of radial testing zones around those herds. This resulted in an increase in OTF-S incidents disclosed in 2019. Whilst this increase in incidents can be explained in part due to the greater number of herds that were tested per annum, compared to previous years, it also helps to demonstrate the importance of radial surveillance in detecting potential lateral spread of infection.

Humberside (Figure 2a) and West Yorkshire (Figure 2b) recorded very few incidents with just one OTF-W incident in Humberside and three OTF-S incidents in West Yorkshire. This represents a general downward trend in overall incidents in Humberside, whilst it follows a slight increasing trend in West Yorkshire. The very few cases in these regions, however, make it difficult to comment on any ongoing trends, but the continued low incidence is paramount.

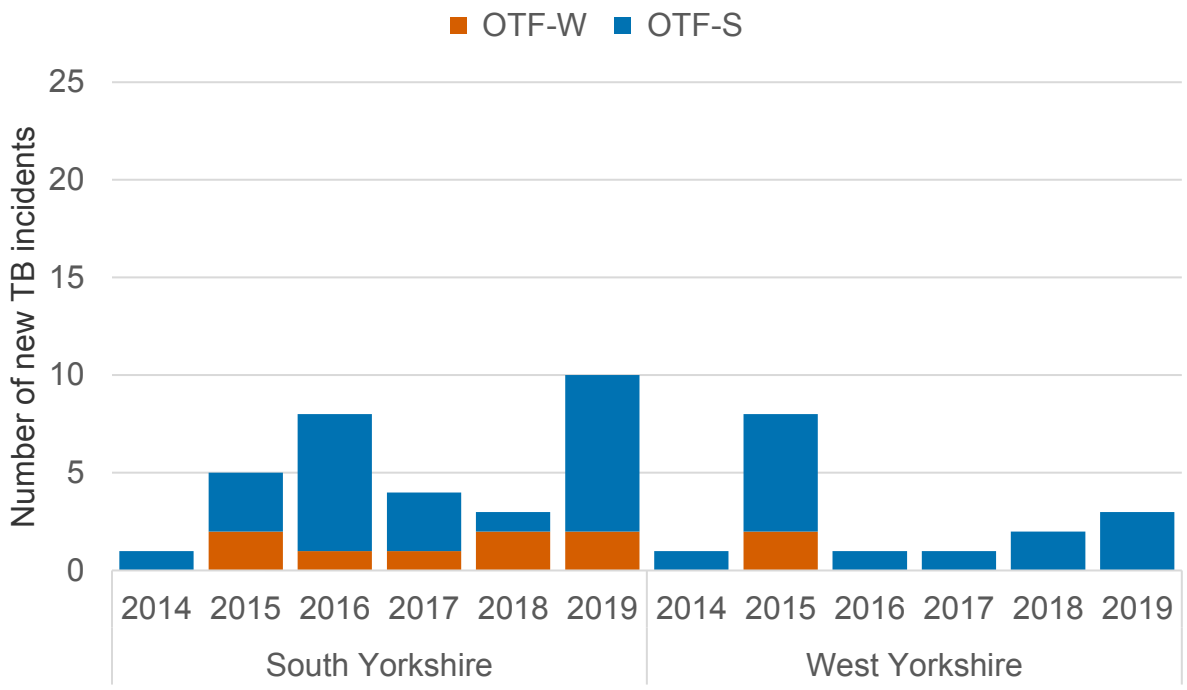


Figure 2b: Annual number of new TB incidents in South Yorkshire and West Yorkshire from 2014 to 2019.

Geographical distribution of TB incidents

The overall geographical distribution of cases in 2019 was similar to what was seen in 2018, with incidents mainly occurring in the north west of the region as a whole, mirroring the areas of moderate to high density of cattle (Figure 3).

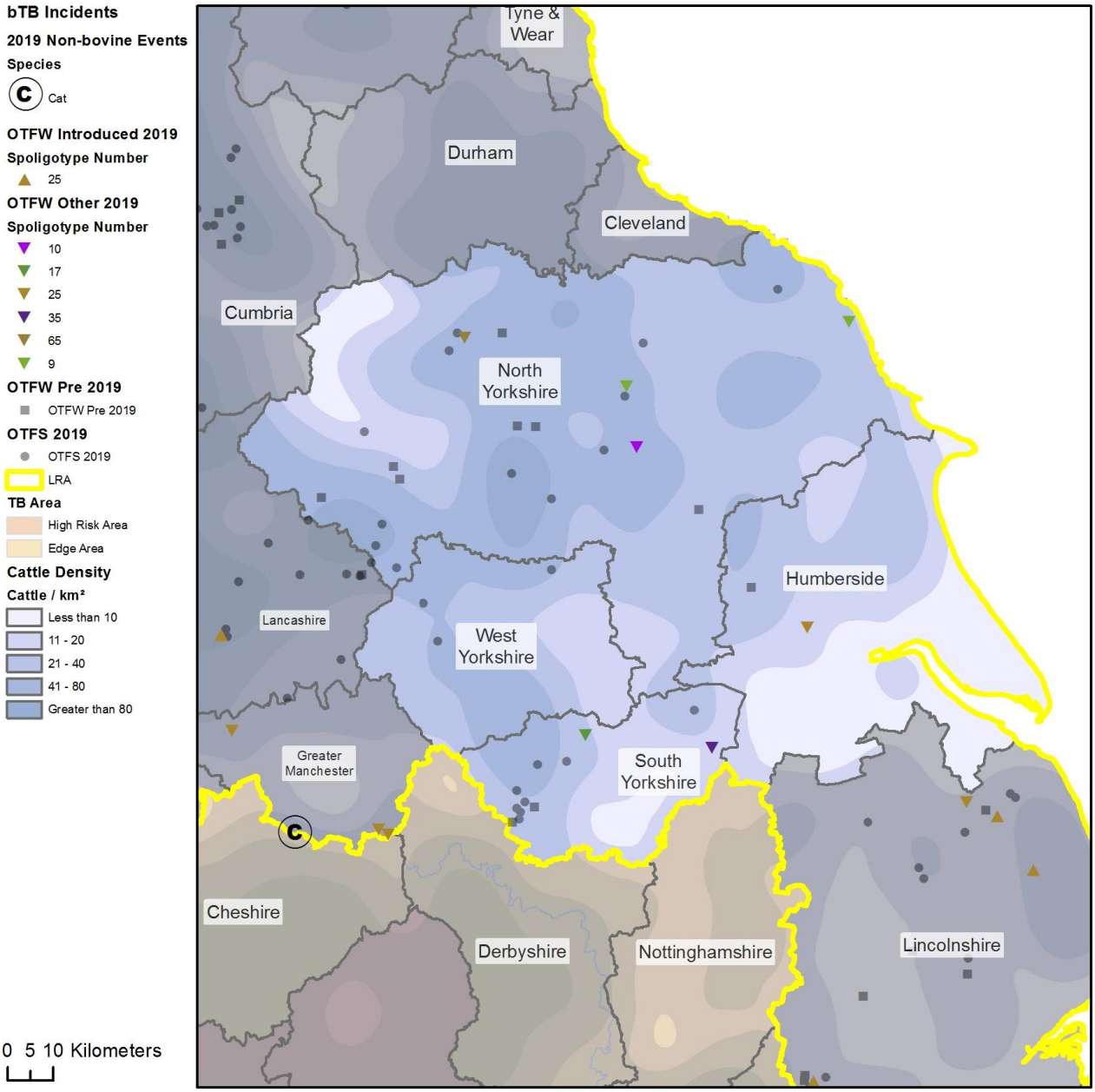


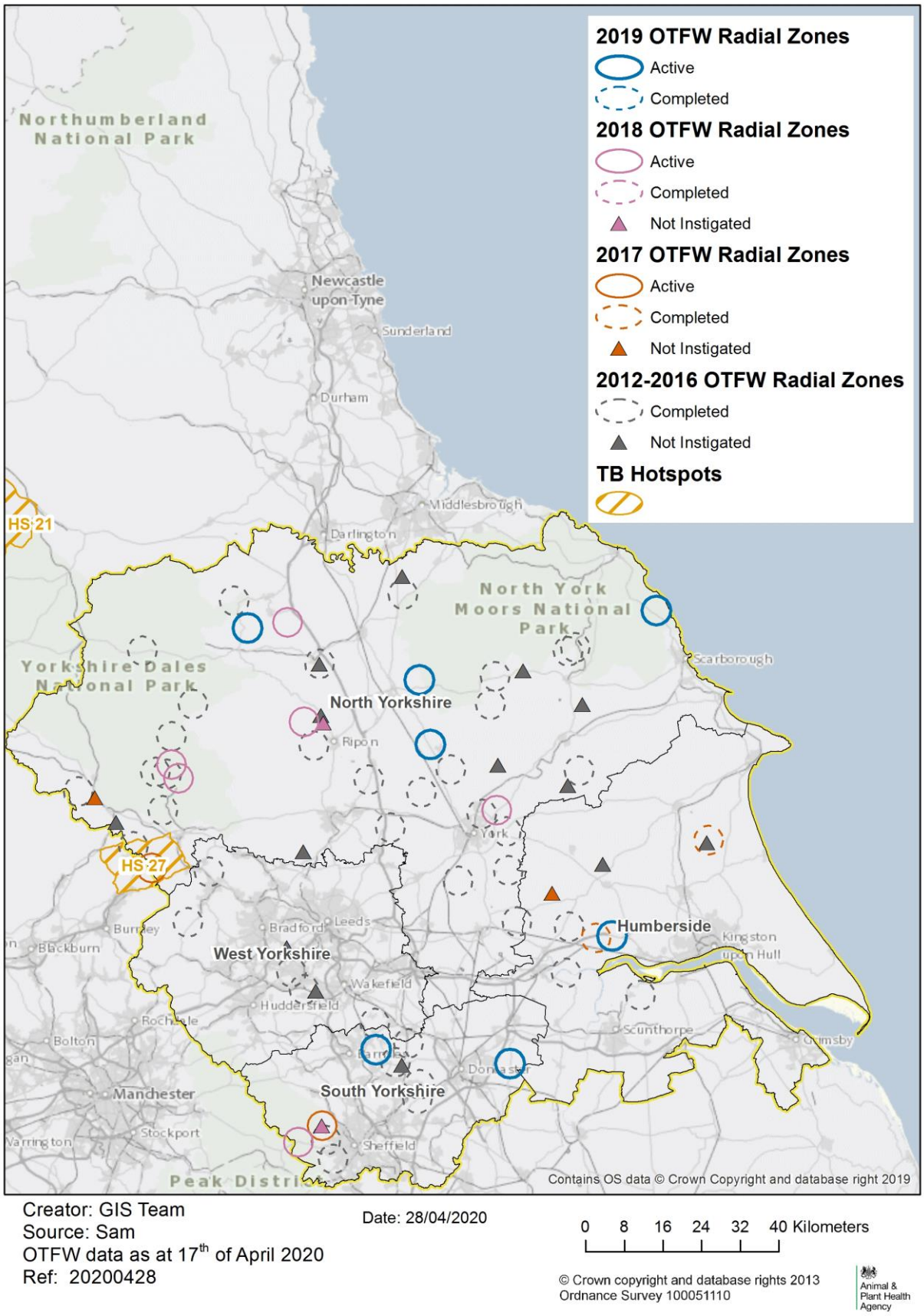
Figure 3: Location of cattle holdings in Yorkshire and Humberside with new TB incidents (OTFW and OTFS) in 2019, and cattle holdings with pre-2019 OTFW incidents that are still ongoing at the end of 2019, overlaid on a cattle density map.

A cluster of cases has also developed in the south west of South Yorkshire. This is in an area of generally lower cattle density, but is within close proximity to the border with Derbyshire (Edge Area) and potentially raises questions about the risk of spread of infection across the LRA-Edge Area border. Holdings on the other side of this boundary in Derbyshire are subjected to annual testing, however the incidence of herd incidents along the boundary appears to remain low (Appendix 6). Closer examination of herd incidence in the neighbouring county of Derbyshire does not highlight any incidents within close proximity to this cluster of cases. The cluster appears to have been triggered by two OTF-W incidents in 2018 (Figure 3). This has resulted in the disclosure of five OTF-S incidents within the radial surveillance zones during 2019. At the time of reporting, all the TB incidents in this cluster had been resolved and there were no grounds to suspect lateral spread of infection or infection in the wildlife populations.

There were two additional OTF-W incidents in South Yorkshire during 2019 (Figure 3). In the Doncaster area (east of the county) a reactor was found at a post-movement test, following a movement of cattle from the HRA. This triggered the initiation of a radial surveillance zone (Figure 4), and at the time of writing, there had been no further incidents disclosed within this zone. The radial testing regime remains ongoing. The incident in the north of South Yorkshire was on a holding that had been present in a radial zone between 2016 and 2018. The holding had however tested clear throughout the duration of this radial testing regime. The disease investigation for this incident concluded that the most likely route of infection introduction was through the movement of animals from the HRA. The likelihood of lateral spread or residual infection being present in this area is therefore considered to be low. The radial testing regime for this more recent incident remains in place, and at the time of writing had not disclosed any further incidents (Figure 4).

A new OTF-W incident was disclosed in the northern part of North Yorkshire, where cattle density is particularly high. This led to the initiation of a radial surveillance zone around this premises. Whilst there have been incidents and radial zones in this area in the past (Figure 4), this incident holding had not been included in a previous radial testing zone, indicating it was more than 3km away from the original incident herd and so the likelihood of lateral spread of infection being involved is therefore very low. At the time of writing two subsequent OTF-S incidents have been disclosed through the current radial testing in this area. Both of these cases have been investigated and now resolved, indicating a very low likelihood of lateral spread. Ongoing radial testing remains in place.

There were two new OTF-W incidents in the central part of North Yorkshire, within 14km of each other (Figure 3). No epidemiological links have been detected between these incidents. The origin of one was attributed to the import of an animal from Northern Ireland, disclosed as a SLH case. The other incident was in a herd with few movements, and the origin remains obscure. Radial testing remains underway around both of these incidents to identify any lateral spread of infection (Figure 4). To date no further incidents have been disclosed.



Creator: GIS Team
Source: Sam
OTFW data as at 17th of April 2020
Ref: 20200428

Date: 28/04/2020

0 8 16 24 32 40 Kilometers

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Figure 4: Potential hotspot areas and OTF-W radial surveillance zones that were active, completed or not instigated in Yorkshire and Humberside during 2019, by year of initiation.

An OTF-W incident was disclosed on the east coast of North Yorkshire, in an area with no previous incidents. This was triggered by two reactors disclosed through routine herd testing (RHT). One of these animals presented with visible lesions and was subsequently positive for *M. bovis* on culture. This animal was homebred and had never left the holding of origin. There was however a history of purchase of animals on the holding, including from the HRA of England. Epidemiological investigation suggested that the most likely route of introduction of infection was a lateral transfer of infection to the reactor animal from an animal bought in from the HRA. By the end of 2019, no subsequent incidents had been disclosed through radial testing. The radial testing regime does, however, remain in place.

There was a cluster of cases in the north-west of North Yorkshire (Figure 3) which has so far resulted in the initiation of two radial surveillance zones (Figure 4). This developed over an area where there had been incidents in the past. From March 2018 to the end of 2019, there have been a total of 10 incidents in this area of North Yorkshire. This included two OTF-W incidents, two OTF-S2 incidents that were contiguous to the OTF-W incidents, and six OTF-S incidents. Of these, three were newly disclosed OTF-S incidents in 2019 (Figure 3). At the time of writing, all of the incidents in this cluster had been resolved. There are concerns that there is a higher than normal number of cattle herd incidents in this part of North Yorkshire, where premises often have multiple parcels of land that often involve hill land suitable for grazing cattle. The likely source of infection has only been identified as due to cattle movements in two of the incidents, one of which involved the direct movement of an animal from an incident herd, resulting in a subsequent local incident. In many other cases, the test reactors were predominantly homebred animals, where the source of infection was not clear. Whilst there is limited knowledge of badger activity in the area, we cannot rule out wildlife involvement. *M. bovis* has, however, only been cultured from one of the incidents. The lack of *M. bovis* isolation means that whole genome sequencing of the organism cannot be performed, so confirmation of any potential epidemiological links is difficult.

There has also been an ongoing cluster of cases in the south-west of North Yorkshire, directly along and across the border with Lancashire (Figure 3). This cluster of cases has been ongoing since 2017 and spans the county boundary with Lancashire. Between 2017 and 2019 a total of 10 incidents (two OTF-Wand eight OTF-S) on different premises were disclosed. The initial disclosing incident was an OTF-W incident with several reactors on a dairy farm which had no history of purchasing animals since 2013. No *M. bovis* was cultured, so no genotype was identified from this herd. Radial testing revealed a further OTF-W incident in a homebred beef suckler herd. The source of infection for both of these incidents remains undetermined. Further OTF-S incidents have since been identified in the area, during radial and pre-movement testing, many involving homebred cattle. In some cases, the likely source of infection was the purchase of infected cattle, however the source of infection in the majority of cases remains undetermined. Due to this, the epidemiological investigation could not rule out the potential for wildlife involvement in this cluster of cases. A potential hotspot area (PHS27) was therefore set up and defined by distinct boundaries (Figure 4) in this area. The aim is to facilitate further cattle surveillance, but to also introduce TB surveillance in badgers and wild deer populations in the area. This

includes the identification and collection of carcases reported by the public, allowing for examination and sampling where appropriate. The result is a more in depth understanding of the overall situation of TB in this region. At the time of reporting no *M. bovis* positive culture results from badger and deer carcases sampled as part of this potential hotspot had been identified. This area remains a primary focus for TB control in the region.

A new OTF-W incident was also disclosed in Humberside. Whilst this is generally an area of low herd incidence (Figure 4), a previous radial surveillance zone had been active in this area in 2017. The new incident premises was however not included in the 2017 radial testing regime, making the likelihood of lateral spread of infection from the original incident premises in 2017 low. There is a history of movement of cattle from the HRA and LRA onto the 2019 incident premises. This was considered to be involved in the introduction of infection, however the potential for lateral spread cannot be ruled out so a radial testing regime was implemented. At the time of writing, no subsequent incidents had been disclosed in this radial zone.

Apart from the clusters of cases in the south-west region of South Yorkshire and south-west of North Yorkshire, there appears to be little clustering of new cases around new or pre-2019 OTF-W incidents. This is significant as it helps to demonstrate a general lack of lateral spread of infection from OTF-W incident herds in the region. As has been demonstrated in the instances of these clusters, the continuation of the radial testing regime to help detect or rule out local spread infection is paramount.

Other characteristics of TB incidents

Duration of incidents

The shortest duration of an incident is when there is no evidence of spread of infection within the herd, and so no further reactors are disclosed at Check Tests or Short Interval Tests (SITs). The disclosure of additional reactors, or inconclusive reactors, requires subsequent testing of the herd, to be carried out at minimum intervals of 60 days after the slaughter of all the test reactors, to confirm freedom from infection. The more complex incidents therefore usually take longer to resolve.

OTF-W incidents generally take longer to resolve than OTF-S incidents, as a minimum of two SITs at severe interpretation and a supplementary IFN-γ test are required to restore the OTF status of the affected herd. By contrast most herds with OTF-S incidents in the LRA only need one SIT with negative results to regain OTF status. The overall duration of an incident is extended each time an additional reactor is disclosed. The difference in duration of incidents therefore demonstrates the more stringent testing regime for OTF-W incident herds compared to OTF-S incident herds in the LRA, and the higher levels of transmission leading to larger numbers of test reactors within certain herds.

During 2019, in North Yorkshire, the average time to resolution of an OTF-S incident was 160 days, with OTF-W incidents taking an average time to resolution of 282 days (Figure 5a). In South Yorkshire, the average time to resolution of an OTF-S incident was 137 days (Figure 5b), with the majority of incidents resolving quickly in under 100 days or taking

151-240 days. In this region, the median time to resolution of OTF-W incidents was 177 days. This is most likely because there were more additional reactors disclosed on both OTF-S and OTF-W incidents in North Yorkshire than in South Yorkshire.

In West Yorkshire the mean length of an OTF-S incident was 127 days (Figure 5b). This is shorter than in other counties of the region. The majority of incidents in this region were disclosed as reactors to the skin test, which were found to have no visible lesions and were negative for *M. bovis* culture. This required them to have only one subsequent SIT, which lead to resolution of the incident as no further reactors were disclosed.

Importantly, across the region there were no persistent incidents (i.e. those lasting 551+ days), indicating that normal incident control policy is effective and the likelihood of residual herd infection in the region is very low.

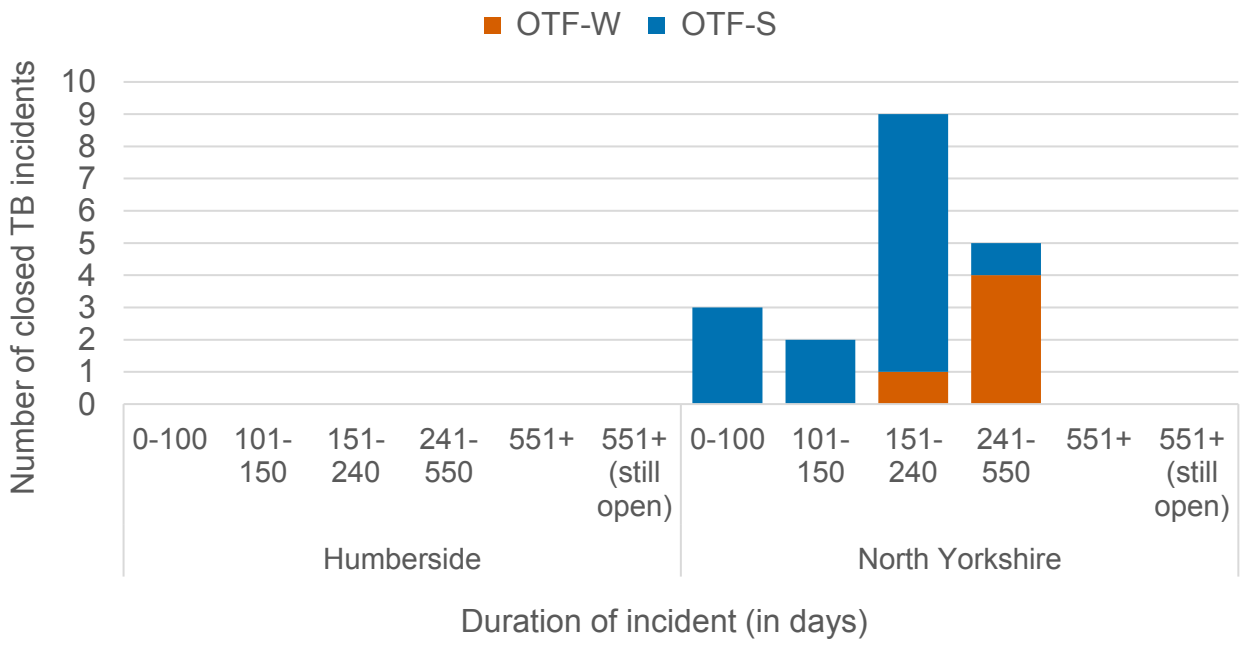

Figure 5a: Duration of all TB incidents (OTF-W and OTF-S) that ended in 2019, and the number of persistent TB incidents (551+ days) that were unresolved at the end of 2019 in Humberside and North Yorkshire. There are no data displayed for Humberside as no incidents ended in 2019 and ongoing incidents are less than 551 days. Note that Licensed Finishing Units (LFUs) have been excluded.

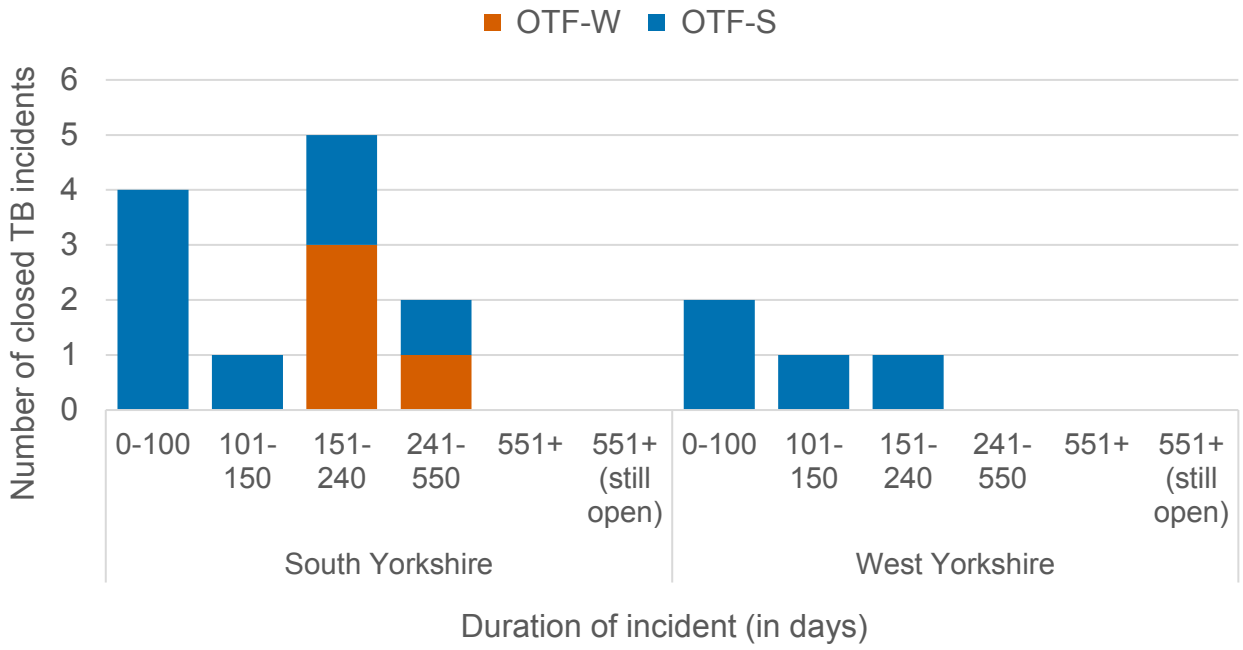

Figure 5b: Duration of all TB incidents (OTF-W and OTF-S) that ended in 2019, and the number of persistent TB incidents (551+ days) that were unresolved at the end of 2019 in South Yorkshire and West Yorkshire. Note that finishing units have been excluded.

Unusual incidents

Across North Yorkshire and South Yorkshire an average of two to three reactors were disclosed over the course of each incident during 2019 (Table A3.2). In West Yorkshire however, this number increased significantly from 1.5 in 2018, to 15.3 in 2019. This is due to one exceptional OTF-S incident in this area, with 34 reactors and an additional 17 inconclusive reactors (IRs) disclosed at a post-movement test. All of the reactors and IRs had moved onto the holding as part of a group of 60 animals from Wales. The origin herd in Wales had been under TB restrictions following an OTF-W incident and the final short interval test had been used as the qualifying pre-movement test for these animals. Of the 17 IRs, eight subsequently tested positive to an ad-hoc IFN-γ test. The remaining nine IRs were re-tested at severe interpretation with negative results. A total of 42 animals were therefore removed for TB control. None of them had visible lesions of TB and they were all negative for *M. bovis* on bacteriological cultures. The origin herd was subsequently re-tested, disclosing further reactors and put back under restrictions. The short interval test (SIT) on the West Yorkshire herd was clear, demonstrating no evidence of spread from the introduced animals to the resident cattle herd. The incident was resolved after four months and attributed to the movement of animals from the High TB area of Wales.

One of the OTF-W incidents in South Yorkshire disclosed during 2019 originated from a holding that ran a petting farm alongside their commercial fattening cattle enterprise. The holding was already under annual testing requirements due to the presence of the petting farm. The initial TB reactor animal was found in the commercial fattening herd and the likely origin of infection was purchase of cattle from the HRA. Whilst the commercial

fattening unit was run separately from the petting farm, there was indirect contact through staff members. To complete the disease investigation, the alpacas, goats and cattle present on the petting farm were therefore tested as part of the incident control procedure, all with negative results. An additional biosecurity point was also put in place to reduce the risk of transmission from the commercial enterprise into the petting farm.

Genotypes of *M. bovis* isolated

When *M. bovis* is isolated from tissue samples in laboratory cultures, APHA undertakes DNA typing analyses to determine the specific genotype of the bacterium. This supports epidemiological investigations into the origin of infection.

In North Yorkshire four different genotypes of *M. bovis* were isolated from herds sustaining new incidents in 2019 (Figure 6). One of these was associated with the assumed purchase of cattle with undisclosed infection (9:c). This incident was triggered by a homebred reactor disclosed at a routine herd test (RHT). There was however a history of purchased animals from the HRA of England and so this was considered the most likely source of the infection. Genotype 9:d was isolated from another herd and was associated with an animal imported from Northern Ireland. Genotype 9:d is common in parts of the UK, with a home range around Wiltshire and southern Gloucestershire. There are however known distinct strains circulating around Cumbria and southern Scotland, thought to have been introduced via routes from the Republic of Ireland and Northern Ireland. Further work is underway to confirm the phylogeny of this genotype, and to potentially highlight the route of introduction of this strain into North Yorkshire. Understanding this will allow us to monitor these pathways and to better understand, and hopefully reduce, further TB incursion into the region.

A further incident in North Yorkshire was associated with genotype 10:a of *M. bovis*. This genotype is very common in parts of the UK, with a defined home range around Gloucestershire, Oxfordshire, Warwickshire, West Berkshire and Wiltshire, it is however very rarely seen in North Yorkshire. There appears to be very limited movement of cattle onto this holding and no direct links to the homerange of this genotype or holdings with historic incidents involving this genotype. Further epidemiological investigations are underway to try and determine the origin of infection.

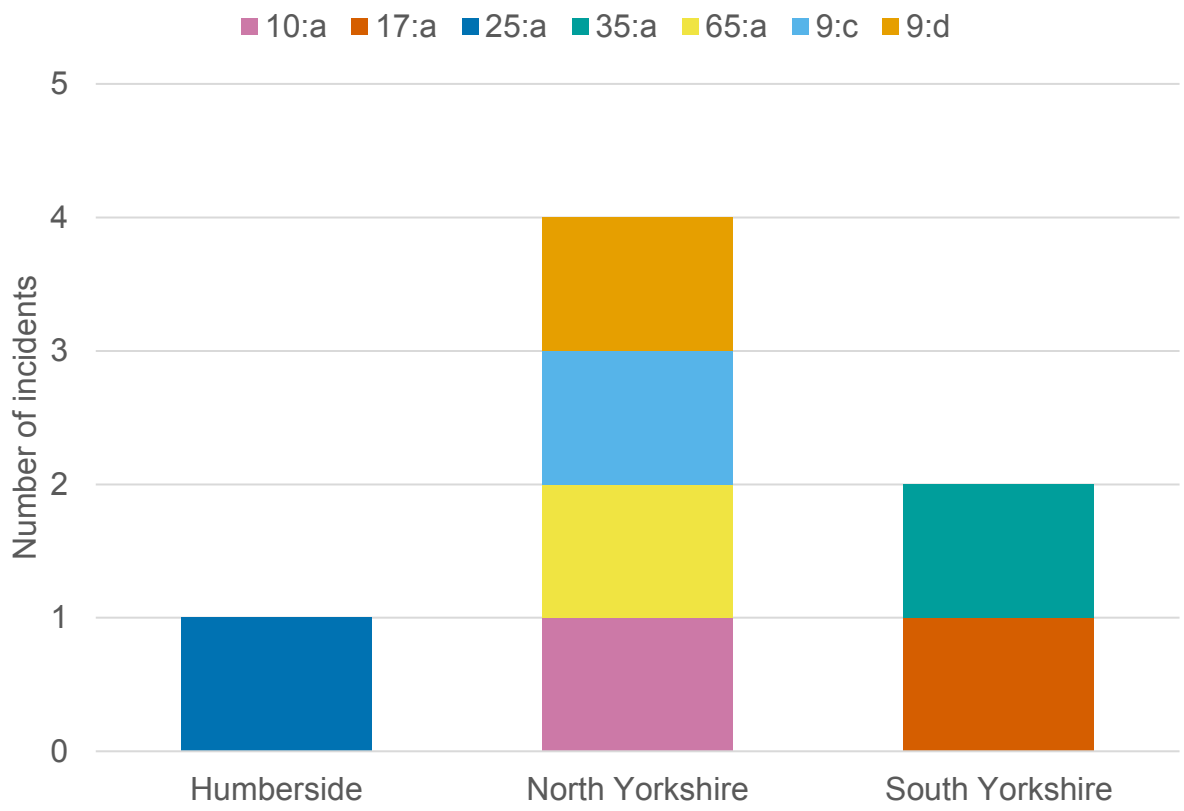

Figure 6: Genotypes of *M. bovis* identified in herds with OTF-W incidents in Yorkshire and Humberside in 2019, by county. Note that West Yorkshire is not represented due to no OTF-W incidents in the report period.

Genotype 65:a was isolated from an incident herd in North Yorkshire. This is a very uncommon genotype and the origin of infection was difficult to determine. The holding also had a group of pet pigs, two of which were reactors to the skin test and one of them presented with visible lesions (VL) at PM examination. Although *M. bovis* was not cultured from the pig samples, this source of infection cannot be fully dismissed.

The two OTF-W incidents disclosed in South Yorkshire were associated with genotypes 17:a and 35:a. Genotype 17:a is highly prevalent across much of the West of England and parts of Wales, with a homerange centred around Hereford/Worcester, Shropshire, Powys, Gloucestershire and Wiltshire. The disclosing animal was purchased from the HRA, and so it was concluded that the most likely route of infection introduction was through the movement of animals from the HRA. Genotype 35:a was isolated from an animal whose previous holding of residence was in the HRA and had suffered OTF-W TB incidents associated with the same genotype.

A cluster of TB incidents in the south west of South Yorkshire has emerged through 2018 and continued through 2019. Genotype 17:a was isolated from one of the original incidents in this cluster in 2018. *M. bovis* has not been isolated from any further incidents in 2019 to demonstrate any further epidemiological links. Genotype 17:a was however isolated from one of the OTF-W incidents in 2019 in South Yorkshire, not involved in this cluster. A

thorough disease investigation has also determined the most likely route of introduction is through the purchase of animals from the HRA. Despite this, the potential for infection to have spread into the wildlife populations should not be ignored, and so ongoing incidents around this area will continue to be closely monitored.

In 2019, Humberside disclosed its first OTF-W incident since 2017. This was found to be associated with genotype 25:a, which is highly prevalent in Staffordshire, Cheshire and Derbyshire. The reactor animal presented with typical lesions of TB at routine slaughterhouse surveillance with a subsequent positive *M. bovis* culture. Although not homebred, the animal was born in the LRA and had no direct epidemiological links with the homerange of this genotype. The holding did however report 50 movements of cattle during 2018-2019 from holdings that had had a TB incident within the previous three years, of which 37 had originated from the homerange of this genotype. It was therefore concluded that the most likely route of introduction of infection was through contact with an infected animal which had come from Staffordshire, Cheshire, or Derbyshire, indicating subsequent spread within the herd. Subsequent testing has however not disclosed any further reactors, and so alternative routes of introduction should not be overlooked.

During 2019, there were no genotypes of *M. bovis* attributable with high certainty to a wildlife source in Yorkshire and Humberside. As in previous years, purchase of undisclosed infected cattle remains the most common source of TB incidents in the area.

Suspected sources, risk pathways and key drivers for TB infection

The key drivers for the sporadic presence of TB within Yorkshire and Humberside were as follows:

- Inward movement of undetected TB-infected cattle from areas of higher risk
- Spread of infection through contaminated fomites and contact between contiguous cattle herds

It can be challenging to retrospectively establish the route of infection for a TB incident herd. The Animal and Plant Health Agency (APHA) aims to complete an epidemiological assessment for all TB incidents in the LRA (both OTF-W and OTF-S). This includes a thorough on-farm investigation and scrutiny of routinely collected data; such as cattle movement records, and the results of molecular analyses where available.

During the assessment up to three risk pathways of infection are selected for each herd. Each risk pathway is given a score that reflects the likelihood of that pathway bringing TB into the herd. The score assigned has been updated this year to reflect developing understanding of how likelihood is being assessed in practice. It is recorded as either definite (score 8), most likely (score 6), likely (score 4) or possible (score 1). The source(s) for each incident are weighted by the certainty ascribed. Any combination of definite, most likely, likely or possible can contribute towards the overall picture for possible routes of introduction in to a herd. If the overall score for a herd is less than six, then the score is made up to six using the ‘Other/Unknown Source’ option. Buffering up to six in this way

helps to reflect the uncertainty in assessments where only ‘likely’ or ‘possible’ sources are identified.

The weight of infection outputs in Appendix 4 are produced by combining the data from multiple herds and providing the proportion of pathways in which each source was identified, weighted by certainty that each source caused the introduction of TB. The outputs do not show the proportion of herds where each pathway was identified (this is skewed by the certainty calculation). Genotyping of *M. bovis* isolates can be a powerful tool in identifying a likely source of infection, however genotypes are not determined for OTF-S herds. The inclusion of OTF-S herds in these calculations increase the uncertainty in the outputs. As a result, the relative proportions of each risk pathway is very approximate and only broad generalisations should be made from these data. A more detailed description of this methodology is provided in the Explanatory Supplement to the 2019 bovine TB epidemiology report for England (https://www.gov.uk/government/publications/bovine-tb-epidemiology-and-surveillance-in-great-britain-2019).

The movement of infected cattle from areas of higher risk was the most common risk pathway for OTF-W and OTF-S incidents in the region during 2019 (Table A4.1 and Figure 7). This demonstrates the significant risk of TB introduction from the inward movement of cattle into the Yorkshire and Humberside area. Although by no means as significant, the potential involvement of contaminated fomites (e.g. tractors, muck spreaders, other vehicles, farm personnel and contractors) and the contiguous transmission from neighbouring cattle was also a potential route of infection for several incidents. The role of wildlife was also considered possible in a few incidents in the region.

All of the seven herds with OTF-W incidents in 2019 had no previous history of TB infection. This confirms that recurrent incidents arising from residual herd infection are very unlikely. All of these incidents also have information on the genotype involved available. This is extremely useful in determining and degree of genetic relatedness between different incidents, and their potential source. As outlined earlier in this report, in four of the seven incidents, epidemiological links to areas of higher TB risk could be demonstrated through the genotypes of *M. bovis* identified in the infected cattle. This indicates that the most likely source of infection in these incidents was from the introduction of animals from outside the region (Figure 7). In cases where no clear epidemiological connections can be made, further investigatory work is carried out to try and ascertain the true origin of infection. This is however not always possible and hence the importance of the LRA’s radial testing policy in ruling out the presence of infection in a geographical area.

What is of particular note with regards to the situation in this region as a whole, is that for the reporting period of this report, there were minimal epidemiological links between incidents in the region. One incident in North Yorkshire was concluded to be due to the direct movement of an animal from an incident herd in the local area. This limited evidence of direct epidemiological links demonstrates that there is minimal lateral spread of infection across the region. This further endorses the significance of the purchase of infected animals.

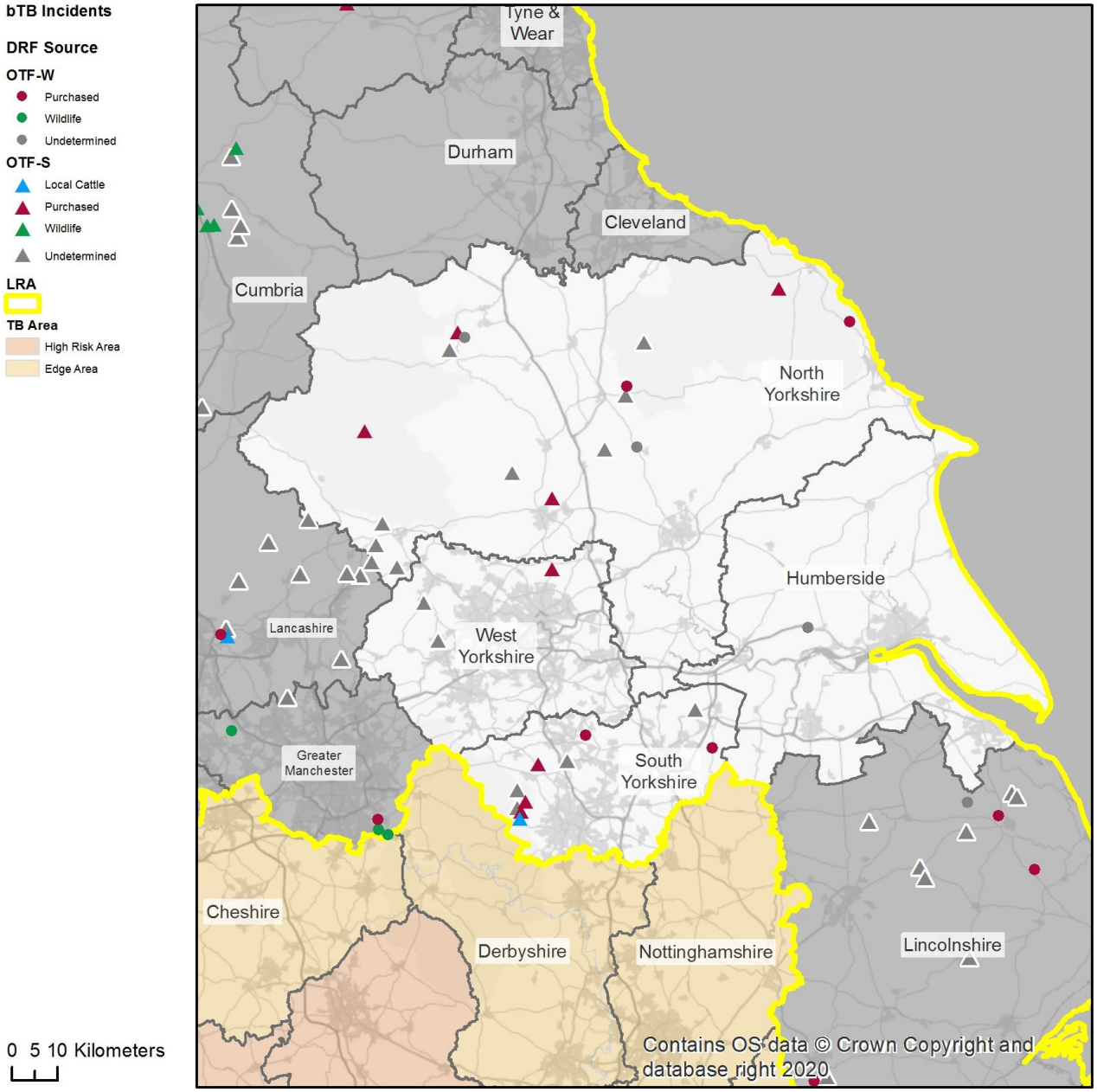

Figure 7: Map of the source of infection pathway recorded with the highest level of certainty for all TB incidents (OTF-W and OTF-S) in Yorkshire and Humberside, which started in 2019.

In cases where OTF status is suspended, it is considerably more difficult to draw firm conclusions about the origin of infection as no genotype information is available, due to the lack of *M. bovis* culture. In some cases, it is possible to confirm a link due to the involvement of a particular cohort of animals, or the infection status on a previous herd of residence. In the majority of cases however, such a clear link is often not present and so alternative sources of introduction, such as the involvement of wildlife, contaminated fomites or movement of contiguous cattle, must be considered. In this region at present there is only one potential hotspot area (HS27) where TB surveillance in wildlife is taking place. For the region as a whole it can therefore be difficult to completely rule out any

influence from a wildlife population. Many farmers report observations of badger or wild deer activity on or around the farm and surrounding land. Unlike in many areas of the country, at the moment we have no reason to suspect wildlife as being responsible for the introduction or spread of TB in Yorkshire and Humberside. As a result of this, many OTF-S incidents are concluded to have potential involvement of multiple different sources of infection. As such, they are then represented here as having an undetermined source. While on an individual case basis this can be frustrating, it is vital to capture this information and consider all potential routes of infection to allow any subsequent epidemiological links to be made with future incidents.

Across Yorkshire and Humberside, at the time of reporting, no laboratory-confirmed isolation of *M. bovis* in badgers or other wild animals have been identified, including samples submitted from the potential hotspot area (HS27) and no BCG badger vaccination had been undertaken.

TB in other species

Of the seven cattle farms with a new OTF-W incident in 2019, five had camelids, deer, pigs, goats or sheep. Routinely, APHA will check test any camelids, deer or goats co-located with an OTF-W cattle herd to determine their infection status. This resulted in 17 goats and two camelids being tested during 2019, none of which showed any positive reactions.

Co-habited sheep and pigs will only be tested following a local veterinary risk assessment (VRA) to determine the likelihood of infection transmission between the cattle unit and co-habited species. In one of the OTF-W cases in 2019, the VRA determined the risk of infection transmission with co-habited pigs to be significant and so the pigs on the holding were tested using the tuberculin skin test. Both pigs showed a positive reaction to the skin test and were removed. One of these subsequently presented with a typical lesion of TB at PM examination. However, the tissue samples were negative for *M. bovis* at laboratory culture.

There were no laboratory-confirmed incidents of *M. bovis* in any other domestic non-bovine farm animals (including; camelids, goats, sheep and pigs), pets, zoo animal collections, captive (farmed/park) deer holdings and captive wild boar farms in 2019 within this reporting region.

Detection of incidents

As shown in Figure 8, TB herd incidents (OTF-W and OTF-S) were disclosed across Yorkshire and Humberside through routine herd testing (RHT), routine post-mortem meat inspection at commercial slaughter (SLH cases), radial surveillance testing (RAD), pre-movement (PRMT) and post-movement testing (POSTMT). RHT resulted in the detection of 50% of all the incidents in North Yorkshire, and 30% in South Yorkshire. It also resulted in the detection of two out of four OTF-W incidents in North Yorkshire. This demonstrates

the ongoing importance of these routinely scheduled tests throughout the region in detecting infection.

Radial testing is undertaken in herds within a 3km radius of an OTF-W case. This allows for timely detection of any residual, recently or re-introduced infection in the locality and allows rapid detection of any lateral spread. During 2019, radial testing led to the detection of 40% of all of the incidents in South Yorkshire, and 30% of incidents in North Yorkshire. Given the previously described distribution of OTF-W incidents and clusters of cases seen in the south-west of North Yorkshire and South Yorkshire, this is largely what would be expected. It does, however, help to provide reassurance of the efficacy of this additional method of targeted TB surveillance in the LRA.

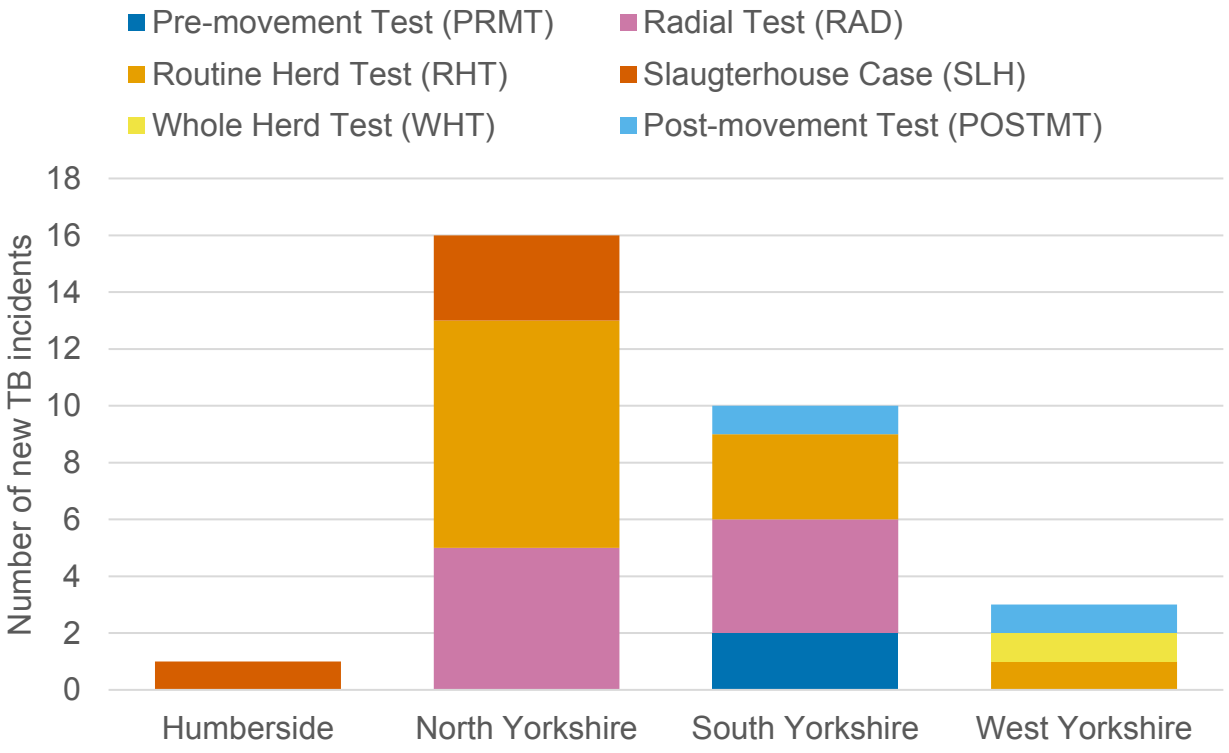

Figure 8: Number of TB incidents (OTF-W and OTF-S) in Yorkshire and Humberside in 2019, disclosed by different surveillance methods, by county.

Pre-movement testing led to the detection of two OTF-W incidents in South Yorkshire. Pre-movement testing is not a standard requirement for herds in the region and is usually only required for herds under additional surveillance (e.g. those in radial testing regimes). In both of these cases, there was strong evidence to suggest that the infection had been brought onto the holding in infected cattle purchased from the HRA. This raises questions about whether these cases would have been detected on herds that were not required to pre-movement test. This could have potentially led to the animal remaining on the holding

and the risk of lateral spread of infection or could have led to the further movement of animals with undisclosed infection.

Passive surveillance through detection of SLH cases is carried out by the Food Standards Agency (FSA) via post-mortem meat inspection of all cattle slaughtered for human consumption. SLH cases are privately slaughtered, non-reactor animals in which visible lesions (VLs) suspicious of TB have been detected at the abattoir. There are many conditions that can result in TB-like lesions detected at post-mortem, and so SLH cases are only considered positive if they result in a subsequent positive *M. bovis* culture. Three out of the seven OTF-W incidents in 2019 were established through detection of positive SLH cases. This potentially suggests that infection is only being detected once VL have developed or is not being picked up through the skin test. Two of these three animals had however never undergone a skin test prior to slaughter, potentially highlighting the risk of disease remaining undetected and the risk of lateral spread of infection within herds, and the area. This is of particular significance in Yorkshire and Humberside where the routine herd testing interval is 48 months, and only applies to breeding animals and their potential replacements. This means that animals kept only for fattening are not normally included in these routine herd tests. This therefore highlights the importance of ongoing passive surveillance at slaughter.

Post-movement testing led to the detection of two OTF-S incidents across the region. This is a relatively new testing requirement introduced in 2016 and designed to augment the pre-movement testing requirement for cattle moving from higher risk areas into the LRA. It is used to rapidly detect, usually recently acquired, infection missed at the pre-movement test. During 2019, over 15,000 post movement tests were carried out across the region. This equates to 9.5% of all testing carried out in the region during 2019. The low numbers of cases disclosed through this testing regime appears to show the effectiveness of pre-movement testing. One of the two incidents detected through this surveillance method did however lead to the detection of a very large number of reactors, with a clear epidemiological link to an incident herd in Pembrokeshire in the high risk area of Wales. The detection of cases such as this highlights the importance of post-movement testing. It allows early, targeted testing of potentially high risk animals entering the region. This therefore allows for rapid detection of infected cattle and minimises the risk of further spread of infection from these cases into the area.

The contribution of surveillance methods other than RHT in the detection of disease in this region is potentially greater than in other areas of the country. This can possibly be explained in part by the difference in the testing frequency in different areas of the UK. Yorkshire and Humberside belongs to the LRA, with all counties subject to four yearly routine testing regimes and allowing exemption of cattle not used for breeding. The proportion of cattle tested every year in this region, relative to other parts of the country, is therefore lower. This makes the relative proportions of animals detected through SLH cases or radial testing higher.

None of the seven OTF-W incidents disclosed in the region during 2019 had experienced a TB incident in the past. Only one of the OTF-S incidents had a previous incident in the previous 10 years. This was on a holding with a known high throughput of stock and a

history of purchases from high risk areas. Recurrent TB incidents can be due to either residual cattle infection missed by the skin test (and where applicable IFN-γ testing), or reintroduction of new infection in the period between two incidents. The fact that none of the herds sustaining OTF-W incidents in 2019 in this region had a previous TB history, indicates that the level of residual infection is low.

Skin test reactors and interferon gamma test positive animals removed

A total of 166,625 animals were tested, by means of the skin tests and IFN-γ blood test, across Yorkshire and Humberside during 2019 (Table A3.2). Out of these, 122 cattle (0.07%) were removed for compulsory slaughter for TB control, of which 82 were reactors to the skin test and 40 were detected through IFN-γ testing. This is higher than the 95 reactors that were removed during 2018. The rate of detection (per 1000 animals tested), however, remained relatively static across all counties, apart from West Yorkshire. This indicates that the rate of TB detection has remained relatively stable over the past year across these counties.

As displayed in Figure 9a, there were no reactors removed due to a positive reaction to the skin test or due to a positive IFN-γ test result in Humberside. There was however a confirmed OTF-W incident in this region, which was initiated through a confirmed SLH case. The incident was also disclosed towards the end of 2019, and as such any subsequent testing on this holding was still underway at the time of writing this report and so is not represented in Figure 9a.

In West Yorkshire, the rate of reactor detection markedly increased, with the number of reactors detected increasing over 15 times, from three in 2018 to 46 in 2019 (Figure 9b). As described earlier in this report, this is due to one OTF-S incident. This led to a total of 42 animals being removed as reactors, with 34 skin test reactors and eight IFN-γ test positive animals. This is a substantial increase to what has been seen in this region in the past. When the animals from this incident are excluded from the overall analysis for West Yorkshire, the number of animals removed as reactors was in line with the previous years.

In North Yorkshire, the total number of reactors removed fell from 58 in 2018, to 53 in 2019 (Figure 9a). The number of skin test rectors remained the same as in 2018, but fewer IFN-γ test positive animals were removed. This potentially represents a reduction in the lateral spread of infection within herds and earlier detection and removal of reactors.

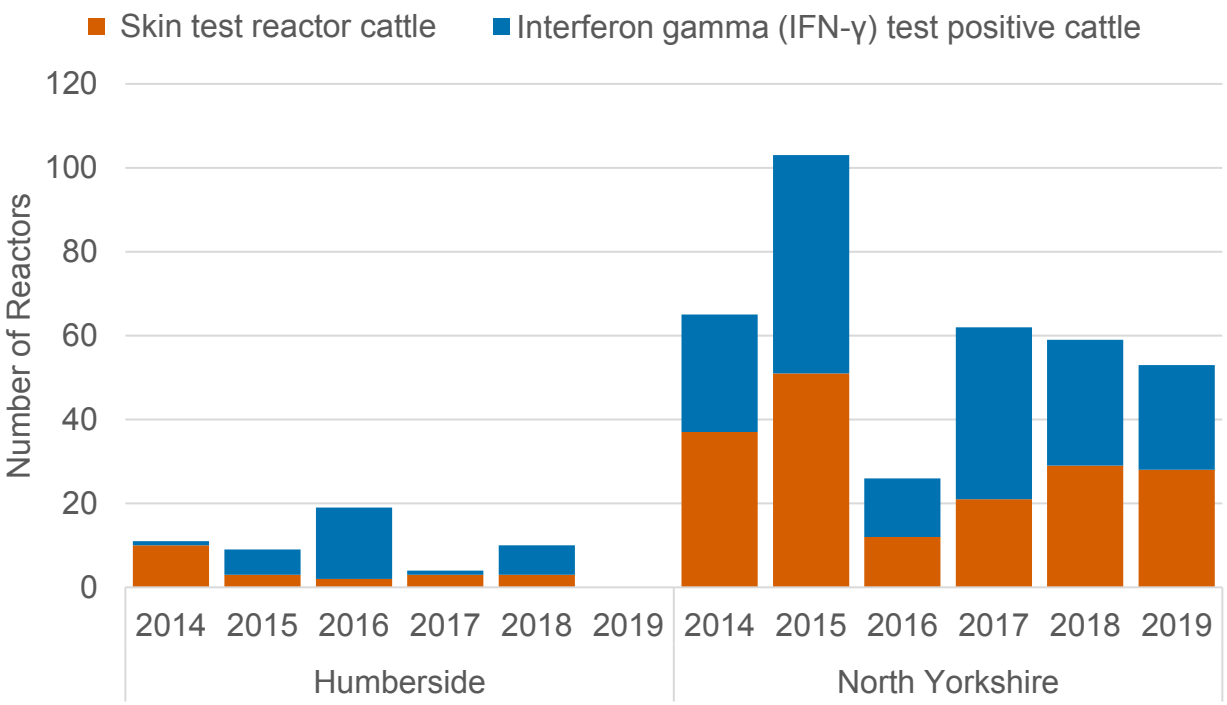

Figure 9a: Number of Skin test reactors and Interferon gamma (IFN-γ) test positive cattle removed by APHA for TB control reasons, in Humberside and North Yorkshire, 2014 to 2019.

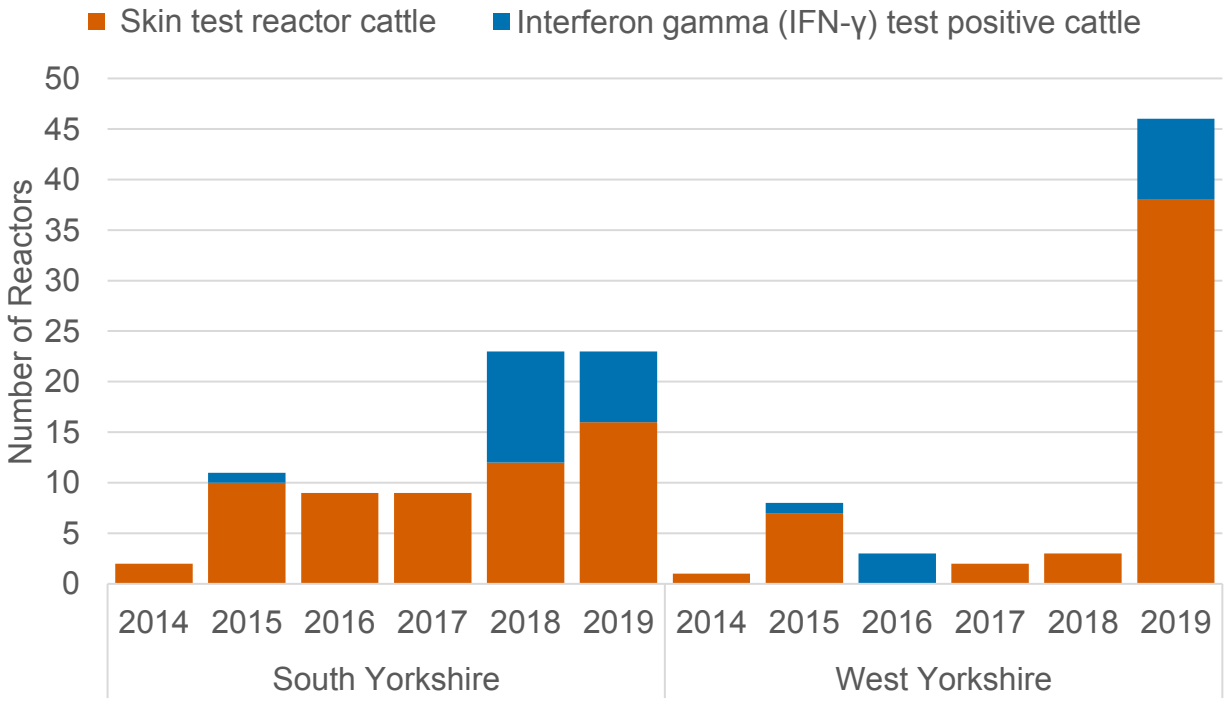

Figure 9b: Number of Skin test reactors and Interferon gamma (IFN-γ) test positive cattle removed by APHA for TB control reasons, in South Yorkshire and West Yorkshire, 2014 to 2019.

Despite an increase in the number of incidents in South Yorkshire, the number of reactors removed did not increase by the same proportions (Figure 9b). The number of skin test reactors removed increased slightly, but the number of IFN-γ test positive animals fell. This is likely because one of the OTF-W incidents in 2018 resulted in a much higher than average number of skin reactors being disclosed, with very few IFN-γ positive animals. Hence the relative numbers of reactors removed during 2018 and 2019 are difficult to interpret. Despite this, the overall number of reactors removed per incident in 2019 remained relatively stable across North Yorkshire and South Yorkshire (Table A3.2), indicating that the general structure of incidents remained much the same from previous years, with limited within-herd transmission and the associated success of the testing regimes in place in this area. The number and duration of incidents as well as the subsequent reactor removal provides a proxy for the economic impacts of TB in different regions to the tax payer and farmer.

As previously described, the largest number of OTF-S and OTF-W incidents were seen in North Yorkshire, with South Yorkshire also having a significant number of OTF-S incidents. The average duration of OTF-W incidents was 89 days longer in North Yorkshire than South Yorkshire in 2019. Across the region, OTF-S incidents lasted an average of 100 days in South Yorkshire, 107 days in West Yorkshire and 159 days in North Yorkshire. The higher number of incidents in North Yorkshire and South Yorkshire will be associated with greater costs to the tax payer in these regions. Whilst the longer durations seen will have higher economic and management implications to the farmers in these areas.

Summary of risks to Yorkshire and Humberside

The Yorkshire and Humberside region has a relatively low incidence of TB incidents in comparison to other regions of Great Britain (Appendix 6). Removal of infection from these incident herds has so far been relatively easily achieved, through application of the standard testing regimes, limiting the overall duration of incidents.

One of the potential risks to this region of the LRA is the border of South Yorkshire with the Edge Area counties of Derbyshire and Nottinghamshire. The density of cattle and herd incident incidence on each side of these boundaries presently appears to be relatively low, and so the associated risk should remain low, providing appropriate testing regimes are maintained. The proximity to parts of the Edge Area, where the overall herd incidence is considerably higher, is however of concern. There is always the possibility of translocation of infection across the boundary either through the introduction of infection into the wildlife population or through the movement of cattle between regions. To date, there is no indication of any wildlife involvement, however movement of animals for grazing purposes remains a concern. We have mentioned previously in this report about a clustering of cases seen in the south-west of South Yorkshire. Whilst this is of concern, there have been no closely related incidents along the LRA boundary, either geographically or

through genomic analysis of *M. bovis* isolates. The enhanced testing regimes present in the Edge Area aim to help mitigate the risk, however this potential route of introduction is an area that we continue to monitor.

The cluster of cases seen in the south-west of North Yorkshire is also an area of concern. There have been 10 incidents to date in this cluster, many of which involve homebred animals with limited evidence of movements potentially responsible for the introduction of infection. Targeted active surveillance for TB infection in wildlife remains a valuable tool, so the initiation of a potential hotspot (HS27) in this region will allow ongoing monitoring of the presence or absence of a wildlife reservoir. This will complement the enhanced TB surveillance measures in place for cattle herds and hopefully allow further understanding of the origin of infection in the area. At the time of reporting, no wildlife animals collected had tested positive for *M. bovis*.

As discussed previously, the structure of the cattle industry in this region involves large numbers of commercial fattening enterprises. These units rely on the rapid turnover of animals. Whilst there is a general good understanding of responsible sourcing, the involvement of cattle dealers often results in animals being brought into the region from areas of higher risk. One of the OTF-W incidents disclosed during 2019 originated in an animal imported from Northern Ireland due to the relative cattle pricing. Neighbouring regions have reported circulating TB infection with the same genotype responsible for this incident. Work is therefore ongoing to determine any links between this incident and the route of introduction. This could therefore highlight a route of infection into the region we need to be more aware of and monitor more closely.

Summary of risks from Yorkshire and Humberside to the surrounding areas

The border of the LRA with Nottinghamshire and North Derbyshire represents a potential route for infection translocation. Although these areas are in the Edge Area, the prevalence of incidents along the LRA boundary appears to be relatively low. Traditional husbandry practices in this part of South Yorkshire often involve sending cattle for summer grazing in areas of Derbyshire, potentially facilitating this. Whilst the risk of animals picking up infection whilst grazing is higher, we should not forget about the potential for an undisclosed infected animal to be sent away to graze and subsequently infect the wildlife in that region. However, the lower incidence of South Yorkshire than the Edge Area counties means that this presents less risk than potentially infected cattle returning to South Yorkshire.

The cluster of cases in south west North Yorkshire also offers potential risk into neighbouring Lancashire. Whilst Lancashire is also in the LRA, this cluster of cases is very much along and across the boundary, so the risk is shared between North Yorkshire and Lancashire. As previously discussed, it is unclear where the origin of infection in many of

these incidents has come from. Many of the incidents have involved homebred animals with a history of minimal purchases, leading to an unknown or obscure origin of infection. This has resulted in the implementation of the potential hotspot area (HS27) to allow for ongoing surveillance of cattle and wildlife populations. The boundaries of this potential hotspot area span the North Yorkshire-Lancashire border and so allows these additional surveillance measures to be applied across both counties.

Assessment of effectiveness of controls and forward look

Throughout this review we have assessed TB across Yorkshire and Humberside during 2019. We have shown that the rate of reactor identification, relative to the number of animals tested and the number of reactors disclosed per incident, has remained relatively stable across the different counties. In the situations where there has been an increase in reactor identification, such as the OTF-S incident in West Yorkshire, this was due to an exceptional incident caused by the purchase of a large batch of already infected animals from a high TB risk area of Wales. This, combined with the lack of recurrent herd incidents, and the often relatively short duration of incidents in Yorkshire and Humberside, indicates that the current control measures in place are largely effective at controlling TB in the region.

We have highlighted that many of the OTF-W incidents in the region are due to the purchase of animals from an area of higher risk, which remains the key area of focus to TB control in the region. These incidents have resulted in the instigation of radial testing zones around these premises to aid the detection of any undisclosed infection. It also allows investigation of potential transmission between local cattle herds and further investigation of any potential wildlife involvement or unexplained sources of infection. We have demonstrated that radial testing is vital in the detection of incidents, leading to the detection of several OTF-S incidents during 2019. These radial testing zones for the OTF-W incidents disclosed during 2019 will remain in place to allow further confirmation of this.

The effectiveness of post-movement testing has also been demonstrated in this region. The rapid detection of a large number of reactors, moved directly from a recently resolved incident herd in a high risk area of Wales, prevented the establishment of infection in a herd in West Yorkshire. The continuation of post-movement testing will be vital in allowing us to rapidly detect any purchased infection and prevent any further spread. Routine herd testing (RHT) remains the backbone of TB surveillance for cattle in this region and allows us to monitor TB incidence in the area. The requirements around RHT in this area mean that fattening animals are not normally tested. The importance of ongoing passive surveillance at slaughter is therefore key to allow us to detect these animals that may not have been skin tested.

We have also demonstrated the ability to implement additional surveillance when required in the region to allow further investigation of TB in specific areas. The ongoing cluster of cases in the south west of North Yorkshire, along the county boundary with Lancashire, has resulted in an ongoing situation of multiple incidents with unknown origins. This has led to the establishment of a potential hotspot area (HS27) to allow enhanced surveillance of cattle and wildlife populations. This will attempt to establish any further epidemiological links to TB infection in the area.

Despite the availability of advice on safer purchasing practices (e.g. TB Hub www.tbhub.co.uk and ibTB www.ibtb.co.uk), there is continued introduction of TB into the county through the purchase of cattle with undisclosed TB infection. The structure of the cattle industry, in particular the beef sector, in this region, results in a relatively high turnover of cattle. Whilst effort is made by many to source animals responsibly, some continue to purchase simply on price. There are also instances where high risk cattle are purchased without ascertaining their premises of birth, and therefore without knowing their true TB risk status.

The ongoing need for increased education about the importance of biosecurity, both on and off farm, and responsible sourcing practices to support the ongoing testing and surveillance control measures is paramount. Communication between farmers and their private veterinary care providers, the National Farmers' Union, other industry bodies and APHA is needed to instil these practices and the importance of ongoing TB control in this region. The combination of these strategies provide the best possible chance of success in reducing the overall incidence of TB in the region.

Appendices

Appendix 1: overview of risk and surveillance areas of England and Low Risk Area objectives and controls

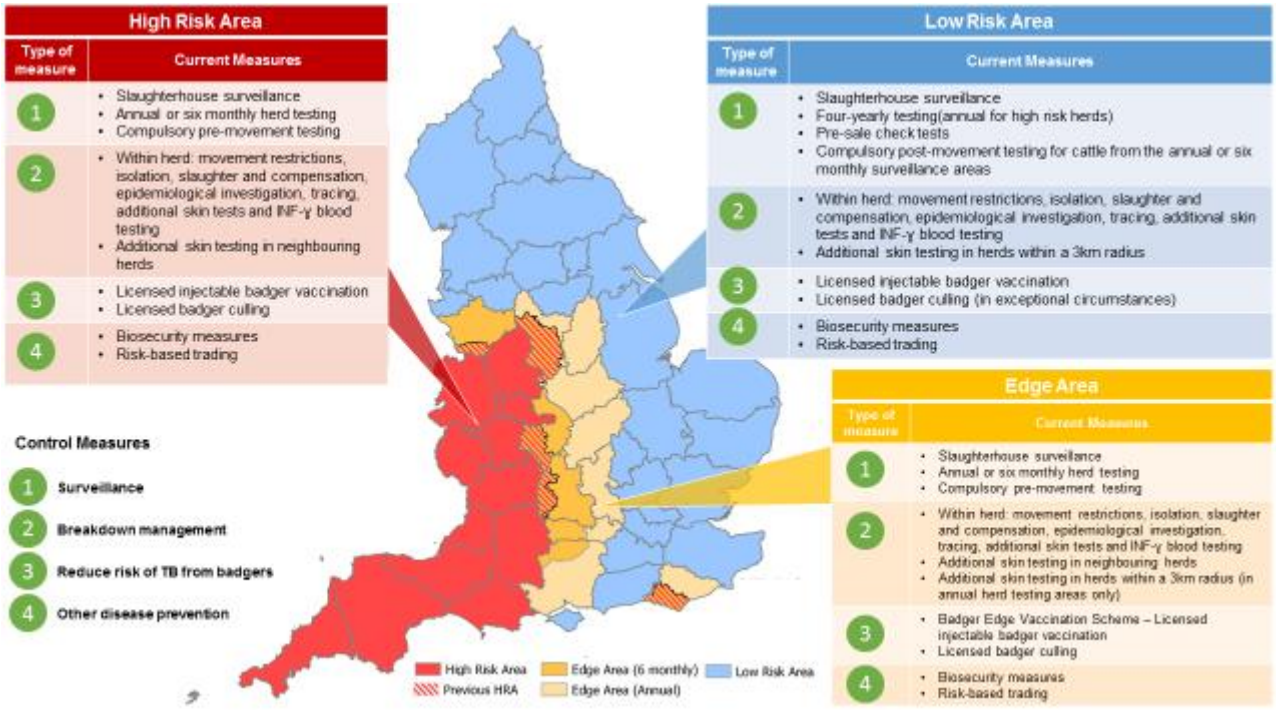

Figure A1: TB risk and surveillance areas of England effective since January 2018, as set out in the Government's Strategy for Achieving Officially Tuberculosis-Free Status for England. Map based on information published on www.tbhub.co.uk.

Policy objectives for the Low Risk Area

Progressive attainment of OTF status for individual counties (or groups of counties) within the current LRA, with the declaration of OTF status for all LRA counties by 2025. For more information about the government's strategy for achieving Officially Bovine Tuberculosis Free status for England, published in 2014 and independently reviewed in 2018, see:

https://www.gov.uk/government/publications/a-strategy-for-achieving-officially-bovine-tuberculosis-free-status-for-england

https://www.gov.uk/government/news/government-sets-out-next-phase-of-strategy-to-combat-bovine-tuberculosis

Key control measures in the Low Risk Area

Surveillance:

- default four-yearly routine surveillance (skin) testing of cattle herds, with annual testing for a small proportion of high risk herds

- voluntary pre-sale skin check tests
- compulsory pre and post-movement testing for cattle entering farms in the LRA (to live) from the annual or six monthly surveillance areas of England and Wales
- additional targeted surveillance (radial testing) of cattle herds located within a 3km radius of new incident herds with OTF status withdrawn (OTF-W) following the detection of lesion-positive test reactors and/or culture-positive animals
- slaughterhouse (SLH) surveillance (through PM meat inspection) of all cattle slaughtered for human consumption

Management of incidents:

- herd movement restrictions, isolation and rapid slaughter of TB test reactors and any direct contacts with statutory compensation payments to farmers, epidemiological investigation, tracing tests (at severe interpretation), and short interval skin testing supplemented in all herds affected by OTF-W incidents with mandatory interferon gamma (IFN-γ) blood testing

TB controls in the wildlife reservoir (badgers):

- licensed injectable badger vaccination
- licensed badger culling in exceptional circumstances, where *M. bovis* infection has been confirmed in badgers and it has a clear epidemiologically link with a local cluster of TB in cattle (e.g. East Cumbria TB hotspot)

Other measures:

- biosecurity measures
- promotion of responsible sourcing of cattle (e.g. through the use of the ibTB online (www.ibtb.co.uk) mapping application)

Summary of enhanced TB control measures in Yorkshire and Humberside

1. Low Risk Area Testing Policy

- Radial testing of herds in a 3km radius around an OTF-W incident holding continues.
- OTF-S incidents in Yorkshire and Humberside require just one short interval tests with negative results before OTF status is regained. OTF-W incidents in Yorkshire and Humberside require two consecutive short interval tests and an IFN-γ test, all with negative results before OTF status can be regained.
- Restrictions of resolved IRs for life to the farm had been applied.
- Once in an incident situation any further testing is done at least 60 days post reactor removal rather than 60 days post reactor isolation. This measure ensures that, in cases where there may have been ineffective isolation of reactors, any animals which may have been exposed to disease while the reactor was awaiting removal will be allowed sufficient time to mount a detectable immune response to the tuberculin skin test.

2. Unusual TB incidents
    - No known cases of human zoonotic TB reported in 2019.
    - No cases of fraudulent skin test reactors reported.
    - There were no incidents involving producer-retailers of unpasteurised milk products in 2019.

3. Other Testing Measures

    - One Flexible Extended IFN-γ Blood Test applied in a farm where the presence of Johne's disease in the herd had been confirmed. This test provides additional sensitivity in herds with *Mycobacterium avium* subspecies *paratuberculosis* infection and/or recent vaccination against this disease.

4. Other Control Measures

- Official Veterinarian TB skin testing quality control audits continue to be carried out by APHA. The aim is to ensure that the TB skin test is consistently performed to the required standards.
- Local Authority liaison is maintained as necessary, especially regarding the enforcement of overdue TB tests, illegal movements, fraudulent skin test reactors, and with Public Health colleagues regarding open TB cases or the consumption of unpasteurised milk.
- APHA provided representation at regional meetings with farmers, Official Veterinarians and NFU when requested.

Appendix 2: cattle industry in Yorkshire and Humberside

Table A2.1: Number of cattle premises by size band in each county at 1 January 2019. (RADAR data)

Size of Herds	Un*	1-50	51-100	101-200	201-350	351-500	501 +	Total Number of Herds	Mean Herd Size	Median Herd Size
Number of Herds in Humberside	8	315	127	118	50	16	8	642	88	49
Number of Herds in North Yorkshire	29	1329	609	564	307	114	107	3059	118	60
Number of Herds in South Yorkshire	2	211	71	58	35	9	6	392	86	44
Number of Herds in West Yorkshire	5	630	142	109	57	14	12	969	67	25

*The number of herds with an undetermined size.

Table A2.2: Number of animals by breed purpose in each county at 1 January 2019.

Breed Purpose	Beef	Dairy	Dual purpose	Unknown	Total
Number of Cattle in Humberside	45,096 (79%)	9668 (17%)	1634 (2%)	3 (<0.01%)	56401
Number of Cattle in North Yorkshire	226,094 (62%)	125,956 (34%)	9734 (2%)	29 (<0.01%)	361,813
Number of Cattle in South Yorkshire	24,110 (71%)	8462 (24%)	1283 (3%)	1 (<0.01%)	33,856
Number of Cattle in West Yorkshire	43,600 (66%)	18,877 (28%)	2788 (4%)	10 (<0.01%)	65,275

Appendix 3: summary of headline cattle TB statistics

Table A3.1: Herd-level summary statistics for TB in cattle in Yorkshire and Humberside in 2019.

Herd-level statistics	Humberside	North Yorkshire	South Yorkshire	West Yorkshire
(a) Total number of cattle herds live on Sam at the end of the reporting period	827	3698	489	1199
(b) Total number of cattle herds subject to annual TB testing (or more frequent) at the end of the reporting period (any reason)	24	242	93	30
(c) Total number of whole herd skin tests carried out at any time in the period	175	929	204	270
(d) Total number of OTF cattle herds having TB whole herd tests during the period for any reason	173	836	155	263
(e) Total number of OTF cattle herds at the end of the report period (i.e. herds not under any type of TB2 restrictions)	820	3656	472	1180
(f) Total number of cattle herds that were not under restrictions due to an ongoing TB incident at the end of the report period.	825	3692	488	1199
(g) Total number of new TB incidents detected in cattle herds during the report period	1	16	10	3
• OTF status suspended (OTF-S)	0	12	8	3
• OTF status withdrawn (OTF-W)	1	4	2	0
(h) Of the new OTF-W herd incidents, how many:				
• occurred in a holding affected by another OTF-W incident in the previous three years?	0	0	0	0

Herd-level statistics	Humberside	North Yorkshire	South Yorkshire	West Yorkshire
• could be considered secondary to a primary incident based on current evidence?	0	0	0	0
• were triggered by skin test reactors or 2xIRs at routine herd tests?	0	2	0	0
• were triggered by skin test reactors or 2xIRs at other TB test types (forward and back-tracings, contiguous, check tests, post-movement, etc.)?	0	0	2	0
• were first detected through routine slaughterhouse TB surveillance?	1	2	0	0
(i) Number of new incidents revealed by enhanced TB surveillance (radial testing) conducted around those OTF-W herds				
• OTF-S	0	5	4	0
• OTF-W	0	0	0	0
(j) Number of OTF-W herds still open at the end of the period (including any ongoing OTF-W incidents that began in a previous reporting period)	2	4	0	0
(k) New confirmed (positive *M. bovis* culture) incidents in non-bovine species detected during the report period (indicate host species involved)	0	0	0	0

Table A3.2: Animal-level summary statistics for TB in cattle in 2019.

Animal-level statistics (cattle)	Humberside	North Yorkshire	South Yorkshire	West Yorkshire
(a) Total number of cattle tested in the period (animal tests, blood and skin)	16,538	118,412	17,835	13,840
(b) Reactors detected in tests during the year:				
• tuberculin skin test	0	28	16	38
• additional IFN-γ blood test reactors (skin-test negative or IR animals)	0	25	7	8
(c) Reactors detected during year per incidents disclosed during year *	0.00	3.31	2.30	15.33
(d) Reactors per 1000 animal tests	0.00	0.46	1.29	3.32
(e) Additional animals identified for slaughter for TB control reasons (DCs, including any first-time IRs)				
• DCs, including any first-time IRs	0	4	3	0
• Private slaughters	0	3	3	3
(f) SLH cases (tuberculous carcases) reported by the Food Standards Agency (FSA) during routine meat inspection.	1	15	0	2
(g) SLH cases confirmed by culture of *M. bovis***	1	2	0	0

* Note: reactors may be from incidents disclosed in earlier years, as any found through testing during the report year count here.

** Note: not all cases reported are submitted for culture analysis. All cases reported are from any period prior to or during restrictions.

Appendix 4: suspected sources of *M. bovis* infection for all of the new OTF-W and OTF-S incidents identified in the report period

Table A4.1: Suspected sources of *M. bovis* infection for all of the new OTF-W and OTF-S incidents identified in Yorkshire and Humberside, in 2019.

Source of infection	Possible (1)	Likely (4)	Most likely (6)	Definite (8)	Weighted contribution
Badgers	12				5.8%
Cattle Movements	13	3	9	2	45.6%
Contiguous	2	1	1		5.0%
Residual Infection	1				0.6%
Domestic Animals					0.0%
Non-specific Reactor	5				2.7%
Fomites	4	1	1		5.3%
Other Wildlife	2				1.1%
Other or Unknown Source	5	1			33.9%

Please note that each TB incident could have up to three potential pathways so totals may not equate to the number of actual incidents that have occurred. Details of the methodology used to calculate the weighted contribution of the different suspected sources of *M. bovis* infection for all new incidents can be found in the main body of the report and in the Explanatory Supplement for England 2019 (https://www.gov.uk/government/publications/bovine-tb-epidemiology-and-surveillance-in-great-britain-2019).

Appendix 5: assessment of the origin of (and potential for spread of infection from) all of the new OTF-W incidents identified in the report period

A risk matrix was used to identify isolated incidents that were likely to have been introduced to the LRA by cattle movements, while not causing any onward local spread. The following two questions were considered for each incident, and a score attributed. TB incidents with a score of 1A, 1B or 2A may be removed from the county TB incidence calculations during an application for OTF status (but remain in the incidence calculations in this report).

What is the probability of *M. bovis* infection being introduced to the LRA via infected cattle movements?

1. Definite - for example, traced reactors found in the LRA OTF-W incident herd in question as a result of spread tracings from another TB incident herd, genotype/WGS linked.

2. Likely - for example, a Reactor or IR originated from a previous incident herd (and the genotype does not suggest otherwise), other cattle were moved into the herd from previous incident herd (but were subsequently slaughtered without testing), or the trading practice of herd provides likely evidence (purchasing large numbers of cattle from High Risk Area (HRA), or Edge Area, High and Intermediate TB areas of Wales, or from the island of Ireland).

3. Possible - not a closed herd, but cattle are purchased from the LRA, Scotland and/or EU Member States.

4. Not likely - indigenous infection is known in the locality, closed herd, genotype/WGS has been identified in local wildlife.

What is the probability of this being an isolated, sporadic ('one-off') incident, without secondary local spread from the index case?

A. Likely - no secondary incidents have been detected. There are **no** further incidents as a result of spread tracings anywhere and **no** genotype/WGS linked OTF-W incidents within 3km radial zone around the LRA OTF-W incident herd in question (or the 3km radial surveillance zone was not triggered).

B. Possible - no secondary incidents have been detected, but the dataset is incomplete. For example, incidents have occurred in the 3km radial zone, but only OTF-S ones, or, if OTF-W, they were of an unknown/different genotype.

C. Not likely - secondary spread from the index case, or exposure to a common wildlife source has occurred. For example, OTF-W incidents have occurred in the 3km zone linked by genotype or WGS, or there is known wildlife infection in the area with this genotype/close WGS.

Table A5.1: Risk matrix of the veterinary assessment of the origin of, and potential for spread of infection from, all the new OTF-W incidents identified in 2019.

	Probability of isolated, sporadic ('one-off') incident, without secondary local spread from the index case (A, B, C)		
Probability of *M. bovis* infection introduced through cattle movements (1, 2, 3, 4)	A. Likely	B. Possible	C. Not likely
1. Definite	1	0	0
2. Likely	1	2	0
3. Possible	0	3	0
4. Not likely	0	0	0

Appendix 6: herd incidence of TB in England

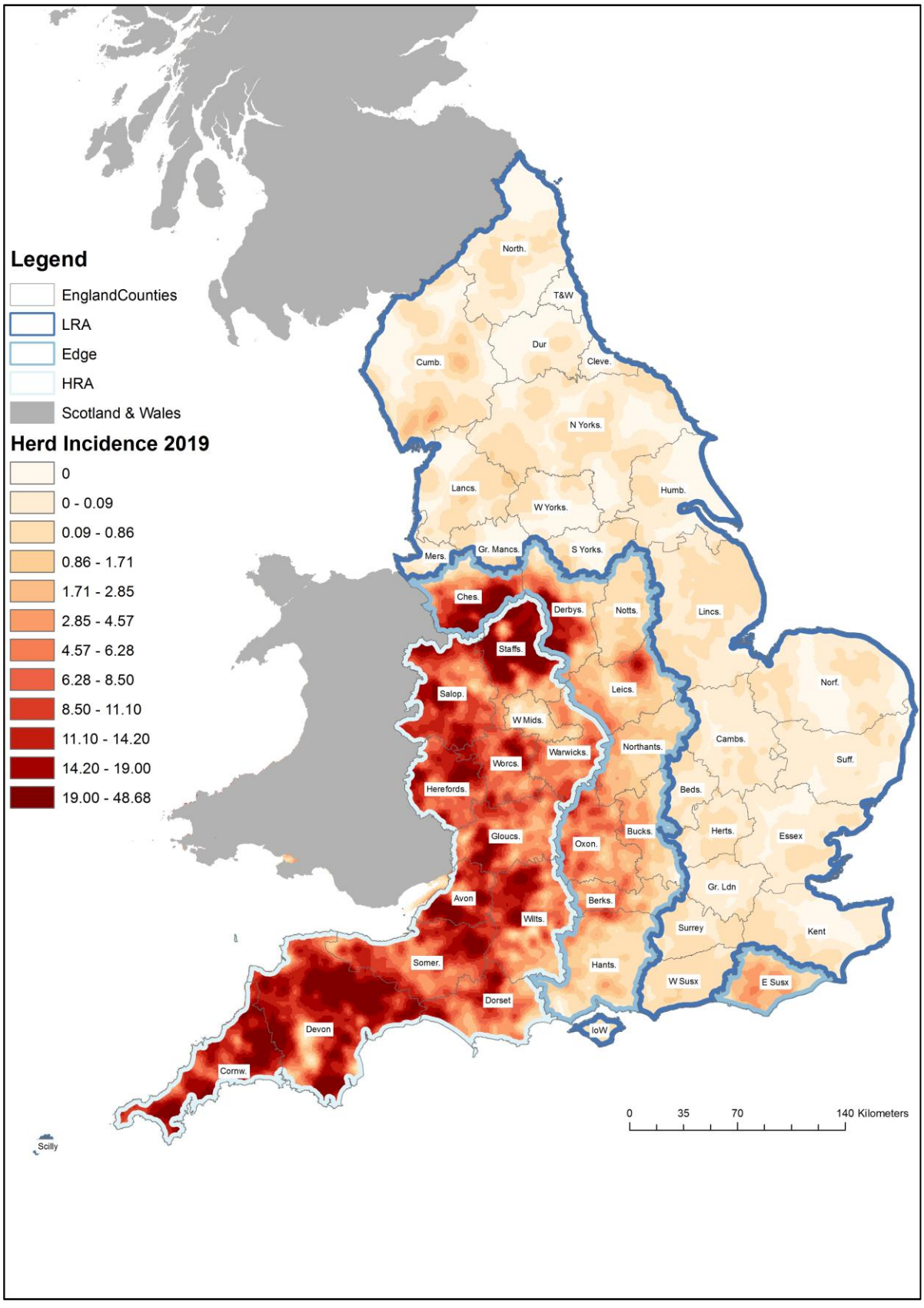

Figure A6.1: Herd incidence of TB in 2019 (incidents per 100 Herd Years at Risk), represented as a spatial kernel of the 100 closest herds per km^2.

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