Headline statistic on herd incidence: incidents per 100 herd-years at risk

The new TB herd incidence rate is calculated as the number of new herd incidents (breakdowns) detected during the reporting period, divided by the total time that herds under surveillance[1] during that period were at risk of infection.

What is a new herd incident? (numerator)

A new herd incident is a case of bovine TB[2] occurring as a result of a herd or individual animal test performed in an officially TB-free (OTF) herd during the twelve month period in question. Examples of animal tests are pre- or post-movement tests, tracing tests or post-mortem inspection at routine slaughter. The incidence rate in the National Statistics is presented both for <u>all</u> new herd incidents and new herd incidents where OTF status has been withdrawn (OTFW)[3].

What is time at risk of infection? (denominator)

This incidence rate uses the amount of time herds have been at risk of infection as the denominator. This is the sum of the time (in years) that all herds under surveillance in the twelve month period in question were at risk of infection. The 'risk of infection' comes from the herd being unrestricted following its previous negative test, after which it could contract the disease and remain undetected until the next time it is tested.

Time at risk is the amount of time between:

- Two negative herd tests
- A negative herd test and a test disclosing a breakdown
- The end of breakdown-related movement restrictions and the next herd test.
- A negative test or end of breakdown-related movement restrictions and the detection of an infected animal at meat inspection in a slaughterhouse.

This means that for any twelve month period, the calculation takes any herd which had a test during that period – whether the test resulted in a breakdown or not – and adds up the amount of time each herd had spent since its last negative TB test.
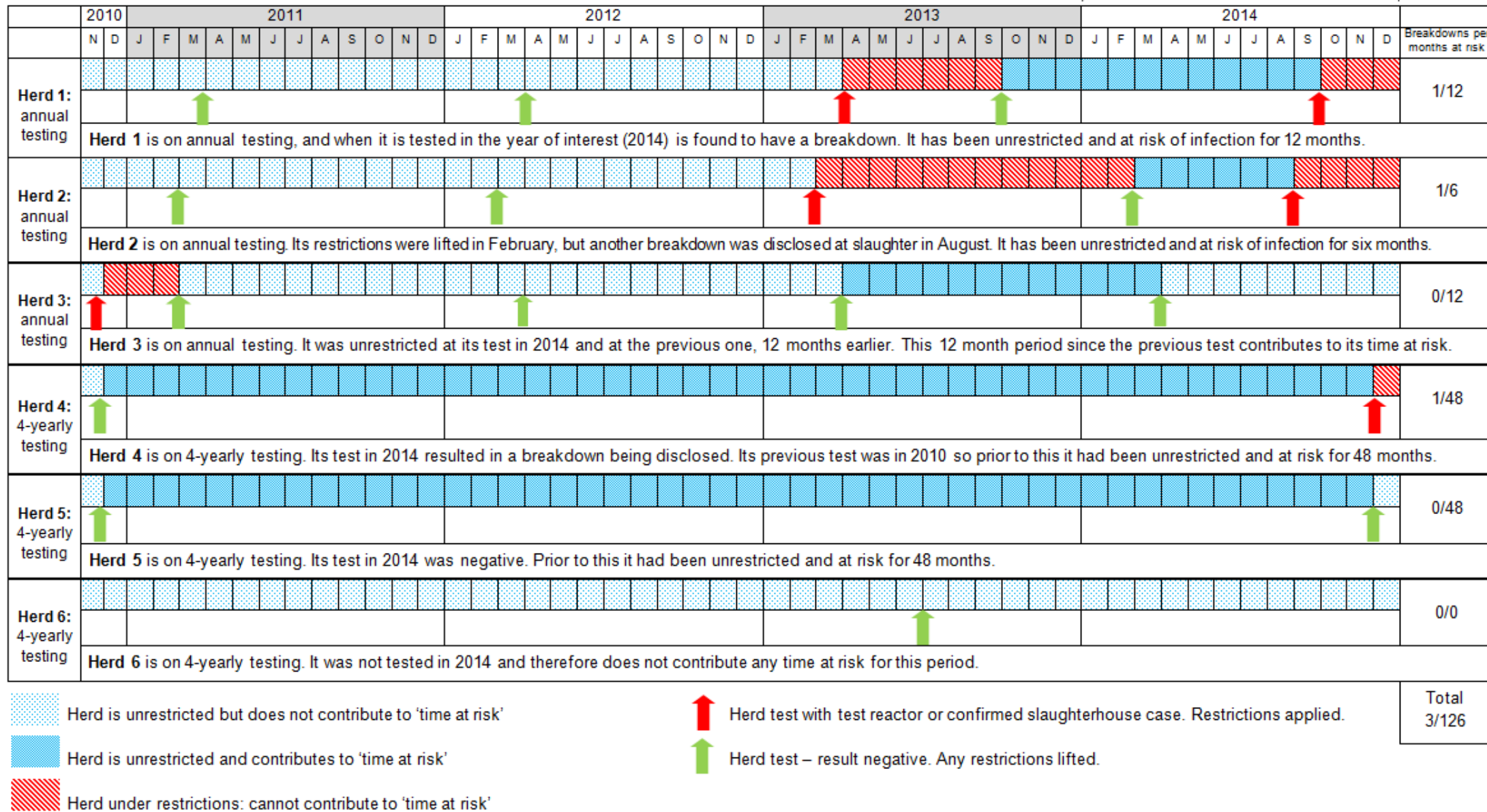
Figure 1 illustrates several different herd scenarios and how they contribute to the time at risk calculation.

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[1] Either through tuberculin skin testing, or through post-mortem surveillance at slaughterhouse.
[2] i.e. identification of at least one tuberculin skin test reactor, or a bacteriologically positive slaughterhouse case.
[3] Officially TB-free status is not withdrawn in all cases. For example, when positive tests cannot be confirmed post-mortem, OTF status may be suspended (OTF-S).

Figure 1: examples of how time at risk is calculated

Tests carried out in period of interest (2014) for incidence rate

	2010	2011	2012	2013	2014	Breakdowns per months at risk

Herd 1: annual testing — Herd 1 is on annual testing, and when it is tested in the year of interest (2014) is found to have a breakdown. It has been unrestricted and at risk of infection for 12 months. — 1/12

Herd 2: annual testing — Herd 2 is on annual testing. Its restrictions were lifted in February, but another breakdown was disclosed at slaughter in August. It has been unrestricted and at risk of infection for six months. — 1/6

Herd 3: annual testing — Herd 3 is on annual testing. It was unrestricted at its test in 2014 and at the previous one, 12 months earlier. This 12 month period since the previous test contributes to its time at risk. — 0/12

Herd 4: 4-yearly testing — Herd 4 is on 4-yearly testing. Its test in 2014 resulted in a breakdown being disclosed. Its previous test was in 2010 so prior to this it had been unrestricted and at risk for 48 months. — 1/48

Herd 5: 4-yearly testing — Herd 5 is on 4-yearly testing. Its test in 2014 was negative. Prior to this it had been unrestricted and at risk for 48 months. — 0/48

Herd 6: 4-yearly testing — Herd 6 is on 4-yearly testing. It was not tested in 2014 and therefore does not contribute any time at risk for this period. — 0/0

Herd is unrestricted but does not contribute to 'time at risk'

Herd is unrestricted and contributes to 'time at risk'

Herd under restrictions: cannot contribute to 'time at risk'

Herd test with test reactor or confirmed slaughterhouse case. Restrictions applied.

Herd test – result negative. Any restrictions lifted.

Total 3/126

Incidence = 3 breakdowns / 126 herd months at risk. 126 months is 10.5 years. 3 / 10.5 = 0.29.

0.29 * 100 = **29 breakdowns per 100 herd years at risk.**

Why use time at risk instead of tests on herds or number of herds tested?

Consider two herds: Herd A and Herd B. Herd A is in an area of the country with persistently high levels of TB and where, consequently, herds are tested annually. It was last tested one year ago. Herd B is in an area with relatively low levels of TB, where testing is on a four-yearly cycle. It was last tested four years ago. If Herd A has a breakdown, it has had one breakdown for every year it has spent unrestricted since its last test. However if Herd B has a breakdown, it has had one breakdown in the four years it has been unrestricted since its last test, which is the equivalent of 0.25 breakdowns each year.

For this reason, Herd B should not carry the same weight in an annual incidence rate as Herd A, which it would if we simply counted herds or tests on herds for the denominator. The time at risk calculation takes these different testing frequencies into account.

In addition, changes in the total amount of testing *over time* can distort other measures of TB incidence. For example, in high-incidence areas more testing is likely to lead to the identification of previously undisclosed disease, and consequently an increase in apparent incidence. Conversely, in low-incidence areas, more testing can lead to *lower* apparent incidence rates if clean herds are tested more frequently than previously (because the denominator is larger but the numerator is not). The herd years at risk method is not affected by underlying changes in testing levels so provides a measure that is comparable over time.

Data source

The data used in this calculation is taken from Sam, the data system used by the Animal and Plant Health Agency (APHA) to collect and store operational data relating to TB testing and incidents. This is the same data source that is used to underpin the other datasets in this National Statistics release such as the number of TB tests carried out and animals slaughtered.

It is well-documented that the monthly statistical counts (for example the number of new TB incidents, restricted herds, animals slaughtered, etc.) are based on administrative data straight from source and that the counts are subject to revisions. However, before the data is used in the incidence rate calculation it undergoes some transformations to make the data as epidemiologically sound as possible. The main reason for this is that the dataset is specifically designed for epidemiological analysis conducted at APHA Weybridge and is used for the *bovine TB Annual Surveillance Reports*. This results in differences between the dataset used for the herd incidence statistic and the rest of the statistics published in the TB datasets. The differences between this dataset and the one used for the other National Statistics are detailed in a paper in the [data and methodology section](#) of the Bovine TB statistics website, but two examples of these differences and the reasons for them are described below.

<u>Breakdowns that are waiting to be closed</u>: for example, to close a TB incident officially, APHA needs to receive a cleansing and disinfection declaration form from the farmer. If a farm has tested clear for TB, but the farmer has not returned this form, legally this farm is still under restrictions. Historically in practice trading is likely to have resumed, so in the dataset underpinning the herd incidence measure, the breakdown would have been set to closed. This means its time at risk would start again at this point. In the National Statistics datasets, which reflect the administrative data and therefore the legal position of the farm, the

breakdown would not close until the cleansing and disinfection form had been received by APHA. From an epidemiological point of view the farm is not continuing to be under a breakdown, but from an operational and legal point of view it is. In the herd incidence measure, a new breakdown on this farm would contribute to the numerator and the time at risk since the herd tested clear would contribute to the denominator.

<u>Herds experiencing more than one breakdown at one time</u>: an example of this is where in the past, some herds affected by TB incidents were 'split' into separate management groups. This led to partial herd restrictions and de-restrictions which can technically result in more than one breakdown on the same herd at the same time.[4] In the dataset used for this incidence measure one of these breakdowns would be removed, because the herd's time at risk can only count towards the denominator once and so a breakdown in the herd should only count towards the numerator once also.

The result of these changes is that the herd incidence headline statistic is based on a smaller number of incidents than published elsewhere in the National Statistics.

Data considerations

A new incident (or breakdown) refers to bTB being disclosed in an unrestricted cattle herd within the reporting period. The OTF status of herds on Sam can be defined as:

- OTF-withdrawn (OTF-W): a herd where at least one test reactor or inconclusive reactor (IR) has post-mortem evidence of *M. bovis* infection (judged by the presence of visible lesions typical of TB and/or identification of *M. bovis* in culture), or at least one slaughterhouse case that yielded *M. bovis* on culture.
- OTF-suspended (OTF-S): a bTB incident in a herd where at least one test reactor (including animals testing two times as IRs) have been identified, but additional evidence of infection was not found via post-mortem examination or laboratory culture of tissue samples. Some herds may have their OTF status temporarily suspended for reasons other than a TB incident, such as overdue TB tests, or IRs detected in a herd with a history of OTFW incidents in the previous three years.
- OTF: herd is free from restrictions.

In the dataset used for the herd incidence statistic, some herds in Wales that would be classified as OTF-S elsewhere in GB are classified as OTF-W because they are considered to have a high probability of infection according to defined epidemiological criteria. These are an *additional* cohort to the OTF-W incidents represented on Sam, described above. It should be borne in mind when comparing across countries that the definition for OTF-W is different in Wales and consequently the OFT-W incidence rate is higher than it would be if the method used in the rest of GB was applied. For **comparisons between the countries in GB the herd incidence rate based on <u>all new herd incidents</u> should be used.**

In the number of new herd incidents published in the National Statistics datasets, new herd incidents with a status of OTF-W only include those with post-mortem evidence of the disease (visible lesions or confirmation of the infection in culture) or culture positive animals at slaughter. This is the case for all countries of GB. The 'epidemiological' subset of Wales

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[4] A recent change in policy has stopped the practice of split management of herds affected by TB incidents. Therefore, all the cattle registered under the same holding ('CPH') lose their OTF status at the same time if TB is disclosed on that holding and also regain OTF herd status and come out of movement restrictions as one unit.

OTF-W cases referred to above appear in the count of new herd incidents with a status of OTF-S.

Annex A – detailed notes and definitions

<u>Numerator</u>

The numerator is the sum of breakdowns occurring as a result of herd tests (tests conducted on the majority of animals in the herd) *and* individual animal tests for bTB during the twelve months of interest. Individual animal tests include tests conducted prior to movement of an animal, tracing tests due to a breakdown in a herd where the traced animal was previously located, routine post-mortem meat inspection in a slaughterhouse and any test conducted on individual animals for other reasons. If a reactor or infected animal is disclosed by an individual animal test the herd is restricted and the whole herd is tested at prescribed intervals until all tests in the herd are negative.

<u>Denominator</u>

A herd was considered to be at risk of a breakdown between a) negative herd tests (herd tests clear of infection) b) a negative herd test and the disclosure of a breakdown and c) from the end of movement restrictions (date of TB10 in GB) after a breakdown to the next herd test or the disclosure of a breakdown. The time at risk is calculated at each test or breakdown as the total time the herd was not under restriction since its previous test. Only periods of risk that end in the time period for which the rate is being estimated contribute to the denominator.

<u>Capping</u>

The calculation of the time a herd is at risk is capped to avoid over-inflating the calculation by including long times at risk. Long times at risk can occur when herds were not tested as they had just sold all of their cattle just prior to their last test(s), and then later re-populated the herd with new cattle. In this example, the time at risk for the newly-populated herd should not include the time that the *previous* animals in the herd spent unrestricted. The time at risk is therefore capped at a maximum of the previous testing interval + 6 months to allow some time for the test to be scheduled. This means that a herd that is on annual testing can accumulate a maximum or 18 months' time at risk, and a herd on four-yearly testing can accumulate a maximum of 4 years and 6 months' time at risk.

<u>New herds</u>

Where a herd is new and has not therefore had a previous test, its time at risk is calculated from the date at which the herd was registered with APHA.

<u>No animals tested</u>

Occasionally herd tests are scheduled for herds where no animals are actually tested (for example if the herd has no eligible stock). The only way for these herds to appear in the numerator is if TB is detected during routine slaughterhouse surveillance, so for the most part they will not appear in the numerator or the denominator. If a case is detected at routine slaughter, the time at risk is calculated as since the date of the animal's last scheduled test, whether this took place or not.