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Background

- *Mycobacterium bovis* homerange maps developed by APHA help visualise areas of England and Wales where strains ('clades') of the bacterium responsible for bovine TB (bTB) are common/expected ('within-homerange') or unexpected ('out-of-homerange'). Homerange maps are used extensively in epidemiological follow-up of new bTB incidents (Figure 1).
- Currently a 25km grid square is defined as a homerange where there have been three bTB incidents with the same clade of *M. bovis* isolated on at least two different cattle premises, over three discrete years within five years. These grids are then combined, and a buffer is applied to generate cohesive areas.
- Research and discussions with users have highlighted the oversimplicity and potentially misleading nature of the binary homerange boundary and suggests there is a preference for overlaying risk ranges in disease maps.
- This project was carried out as part of an integrated MSc-Apprenticeship with APHA and BPP (Business Professional People) University.

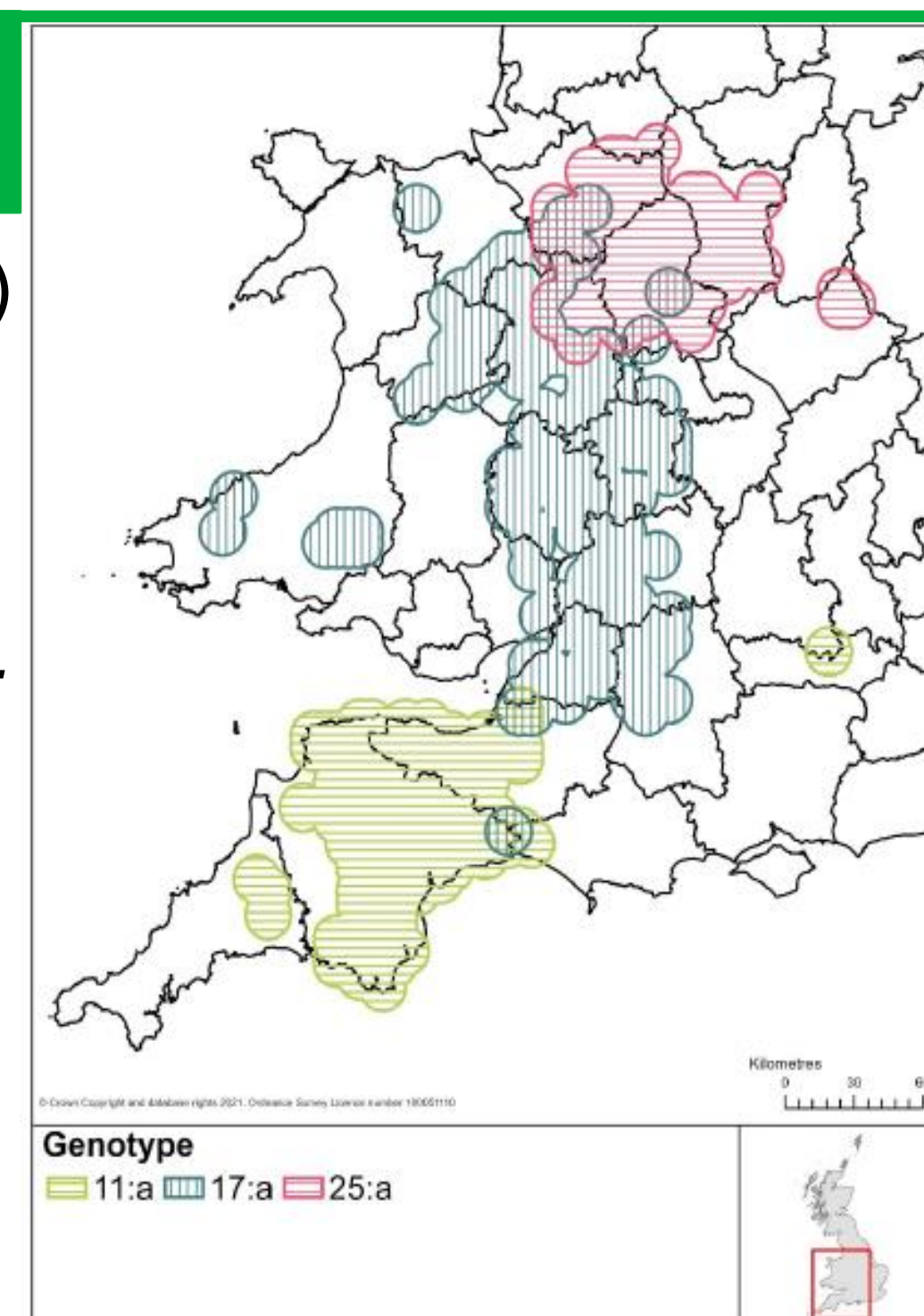


Figure 1: Current homerange map

Approach

Aims:

- Improve the homerange maps by using multiple thresholds of criteria to represent different levels of evidence.
- Increase the number of 'within-homerange' incidents and reduce the number of erroneous 'out-of-homerange' incidents within the homerange area.

Methods:

- Multiple combinations of map parameters were tested. The parameters used to produce final maps were: the threshold criteria values defined in Table 1; 25km grid area; hexagonal grid; 10km buffer.
- Maps were produced on WGS clades in England over two five-year periods (2017-2021 and 2018-2022).
- Trends were analysed between the current and proposed maps, and between different five-year periods
- Figures were produced to compare number of 'within-homerange' vs 'out-of-homerange incidents' using the current vs proposed maps.

Key Figures

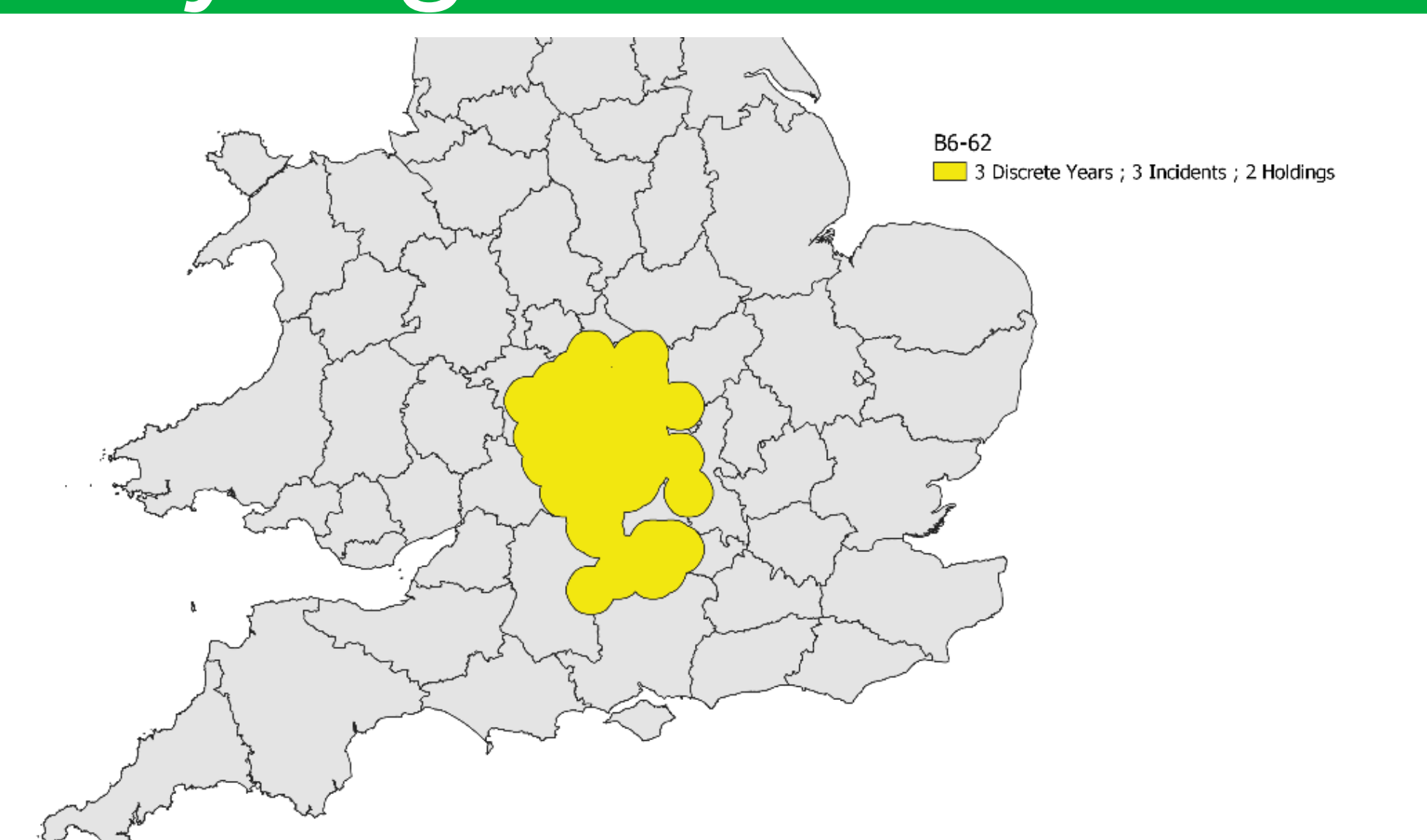


Figure 2: B6-62 homerange using current method (2018-22)

Threshold	Criteria		
	Discrete Years	Separate Incidents	Different Holdings
1 (high)	4	4	3
2 (current)	3	3	2
3 (low)	2	2	2

Table 1: Values used to define proposed homerange thresholds

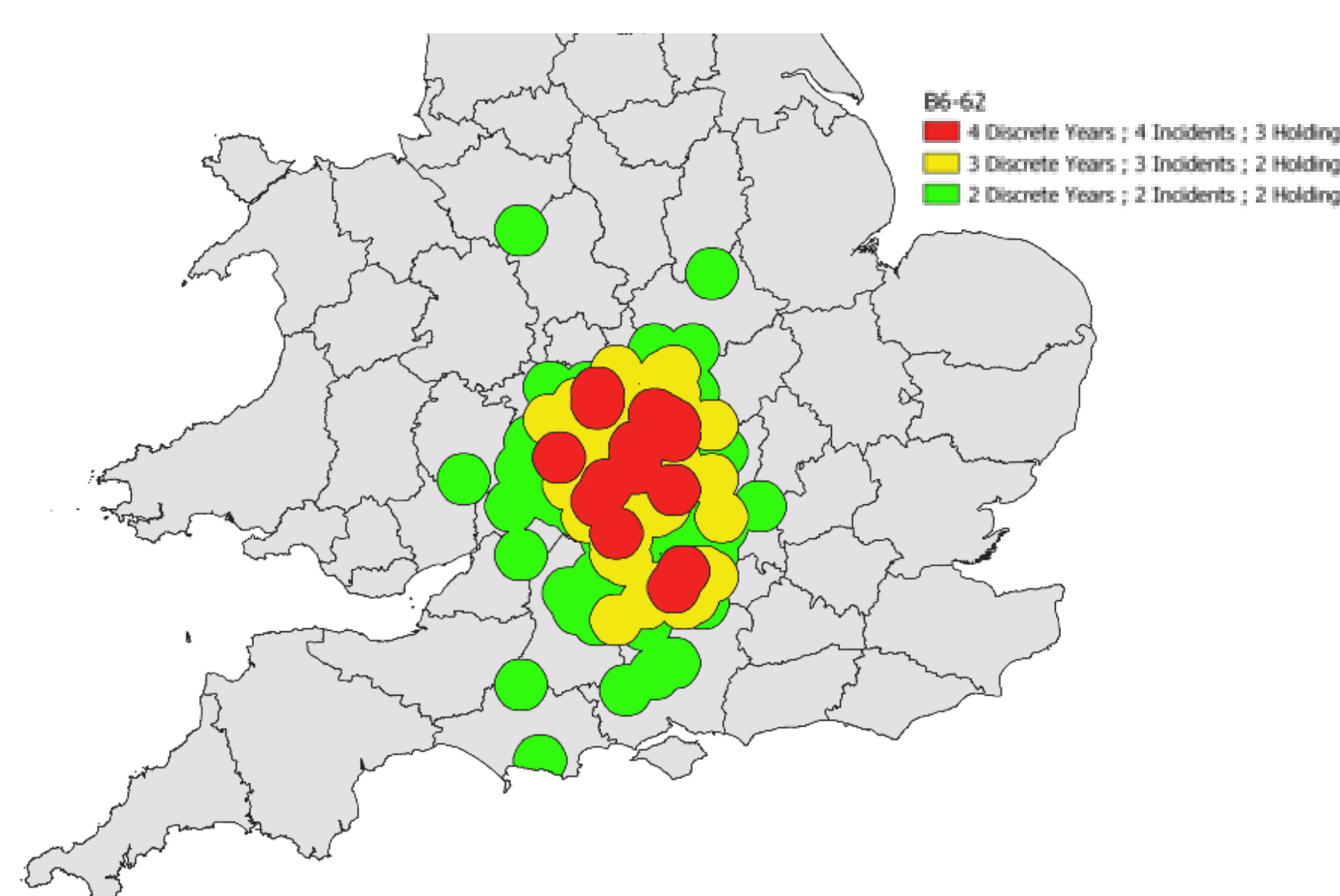


Figure 3: B6-62 homerange using proposed method (2018-22)

Key Findings

- Only 1/23 WGS clade maps were unaffected by the introduction of the additional thresholds.
- Most of the maps generated using the proposed method displayed all three thresholds with additional low-threshold areas, increasing the overall homerange area compared to the current method (Figures 2 and 3).
- The majority of homeranges analysed included more 'within-homerange' and fewer 'out-of-homerange' incidents than the original method, suggesting that the proposed maps are producing improved homeranges.
- The proposed method identified homeranges for two WGS clades which were not identified by the original method – can provide an early alert to emerging homeranges.
- Generating the maps on two five-year rolling periods revealed the potential of the maps to monitor homeranges over time by assessing changes in the thresholds.

Conclusion

The new proposed method:

- Could reduce the number of erroneous out-of-range incidents flagged as 'out-of-homerange' and allow field veterinary staff to target resources more effectively.
- Thresholds can reveal emerging homeranges, facilitating early intervention; visualise the 'intensity' of the homerange areas by showing areas that meet 'milder' or more 'severe' criteria values, which can be used to inform intervention; and be used to assess the development of homeranges over time.
- Offers additional detail while remaining interpretable and useable in practice.
- Could further aid the targeting and delivery of bTB control policies and consequently lead to more efficient and effective spending.
- However, additional validation and evaluation of the proposed solution and potential impact is needed.