Livestock Demographic Data Group:
Cattle population report

Livestock population density maps for GB

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Contributors	Department of Epidemiological Sciences, APHA
	Epidemiology and Risk Policy Advice team, APHA
	Cattle Expert Group, Surveillance Intelligence Unit, APHA
	Science Strategy and Planning Group, APHA
Contacts for queries:	
Freedom of Information (FOI), Environmental Information Regulations (EIR) and Subject Access requests	enquiries@apha.gov.uk
Livestock Demographics Data Groups (LDDG)	lddg@apha.gov.uk
Rapid Analysis and Detection of Animal related Risk (RADAR) data warehouse	RADAR@apha.gov.uk
Epidemiology and Risk Policy Advice, APHA	erpa@apha.gov.uk
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Data year	July 2019

Contents

Who are these reports for?

These reports are suitable for use in animal health and welfare policy work which requires an estimate of the distribution and size of the cattle population at GB level. This type of population level information is often required to assess the economic or social impact of particular animal health policies, for contingency, disease control and resource planning, or to provide evidence to trading partners. There are important assumptions and uncertainties with these estimates which the user needs to take into consideration and can be found at Annex 1.

Who did this work?

The Livestock Demographic Data Groups (LDDGs) were formed in January 2014 and are comprised of APHA representatives from data, epidemiology, species expert and GIS work groups. The LDDGs are grateful to British Cattle Movement Service (BCMS), IBM and APHA Weybridge Data Systems Group (DSG) staff who handled the Cattle Tracing System (CTS) data and the APHA Rapid Analysis and Detection of Animal Related Risks (RADAR) data warehouse for their assistance in producing this report.

What do the data show about the population?

Figures 1 and 2 show either the density of animals, with a smaller map to show how this compares with the density of holdings, or vice versa. In contrast to other livestock species, there is little difference for cattle between the two distributions. Both the cattle population density and holding maps reflect widespread understanding of the cattle industry demographic. The greatest density of cattle population and holdings is generally on the west side of Great Britain; this includes Ayrshire, Dumfries & Galloway, Cumbria, northwest Midlands, southwest Wales, Devon, Somerset and Cornwall. The areas with the sparsest cattle population and holding densities also reflect general understanding of the cattle industry demographic; these include parts of northwest Scotland and parts of East Anglia.

As with Figures 1 and 2, Figures 3 and 4, show population and holding densities across Great Britain. These however are split into Beef and Dairy cattle distributions and then combined as a single bivariate population density and holdings density map, showing the spatial distribution of the Beef and Dairy industries across GB. Separate Beef and Dairy population and holdings density maps can be seen in Figures 5, 6, 7 and 8.

As with the total cattle distributions, the highest densities of both Beef and Dairy population and holdings tend towards the west of Great Britain. Differences in distribution between Beef and Dairy are seen however. In Scotland, for example, Orkney, Caithness, Aberdeenshire, Banffshire, Berwickshire and Roxburgh all show areas of high Beef population density and low Dairy population density. This can also be seen locally in

northeast England, in Northumberland, Durham and North Yorkshire, as well as Buckinghamshire. Areas with the highest Dairy population density, for example in the southwest peninsula of England, Dyfed, northeast Wales, the northwest Midlands, Lancashire, Cumbria, Dumfries & Galloway and Ayrshire, all coincide with either the highest or moderate densities of Beef cattle. No areas of high Dairy population density are coincident with low Beef population density.

How accurate are the data?

The data are derived from the CTS by analysis of all the reported movements and birth registrations of cattle on and off holdings in Great Britain at 1st July 2019; such information is reported continuously and with a slight delay due to data processing timescales. Thus the data best represent the numbers and locations of cattle in the period up to three months before the date the data were extracted (i.e. 1st April 2019). The output of this analysis is stored in 'RADAR', an APHA information management system; where location data are missing in the record due to subsequent updates, RADAR derives this from other information using a 'best address' algorithm. Therefore there can be a discrepancy between the 'RADAR' location and that provided originally through CTS; 88% of RADAR and CTS locations are within 2km, but notably 3% are > 20km apart. The supporting quality statement provides further detail on the limitations in the data (Annex 1).

What do the data not show?

The population dataset represents a single snapshot in time (as at July 1st 2019). It does not draw out the pattern of movements between cattle herds, or the effect of seasonal breeding on the number of young calves.

The representation of the cattle demographic by data from CTS is near complete, but not perfect. A small number of movements are not recorded, either due to non-compliance or are not required to be recorded (for example linked herd movements). However, these are believed to be few and to not significantly impact the data presented.

There is uncertainty inherent in the information displayed. Limitations in the dataset are discussed in the supporting quality statement (Annex 1) and it is important that the user considers these in the context of their work. Similarly population and holding density maps are classified to different scales and units; and due care must be taken regarding their interpretation.

How were the maps produced?

Figures 1 & 2 have been created using the kernel density function in *ArcGIS* software. This tool distributes population information over a defined radius (15km radius for the figures presented within this report), creating a smooth density surface. Two key parameters that

require adjustment are the *search radius distance* and the size of the *output surface grid*. Discussion at the LDDG meetings informed these criteria, and their selection is recognised as a subjective process[1]. A search radius of 15km was deemed sufficient to enable distinction between categories and a 1km grid square was used for the density surfaces themselves. The classification bins were limited to six, to aid in cross referencing areas of the map to the key. Note that the ArcGIS Kernel Density tool does not take into account edge effects[2], and as such density estimates in and around coastal areas may be under estimated.

Comparison between the maps was optimised by assigning similar parameters between the species in this series of reports to those used in previous reports.

Figures 3 & 4 were also created using the kernel density function in *ArcGIS* software to create separate Beef cattle and Dairy cattle density surfaces. Contours of these surfaces were then extracted at the intervals shown on the maps, the contours were then merged into a single set of polygons using the union tool in ArcGIS. This allowed the values of both contour sets to be preserved as a series of overlapping polygons. These were then styled according to their Dairy and Beef values.

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[1] Pfeiffer, D. Spatial Analysis in Epidemiology, 2008. p47.
[2] https://www.e-education.psu.edu/geog586/l5_p15.html
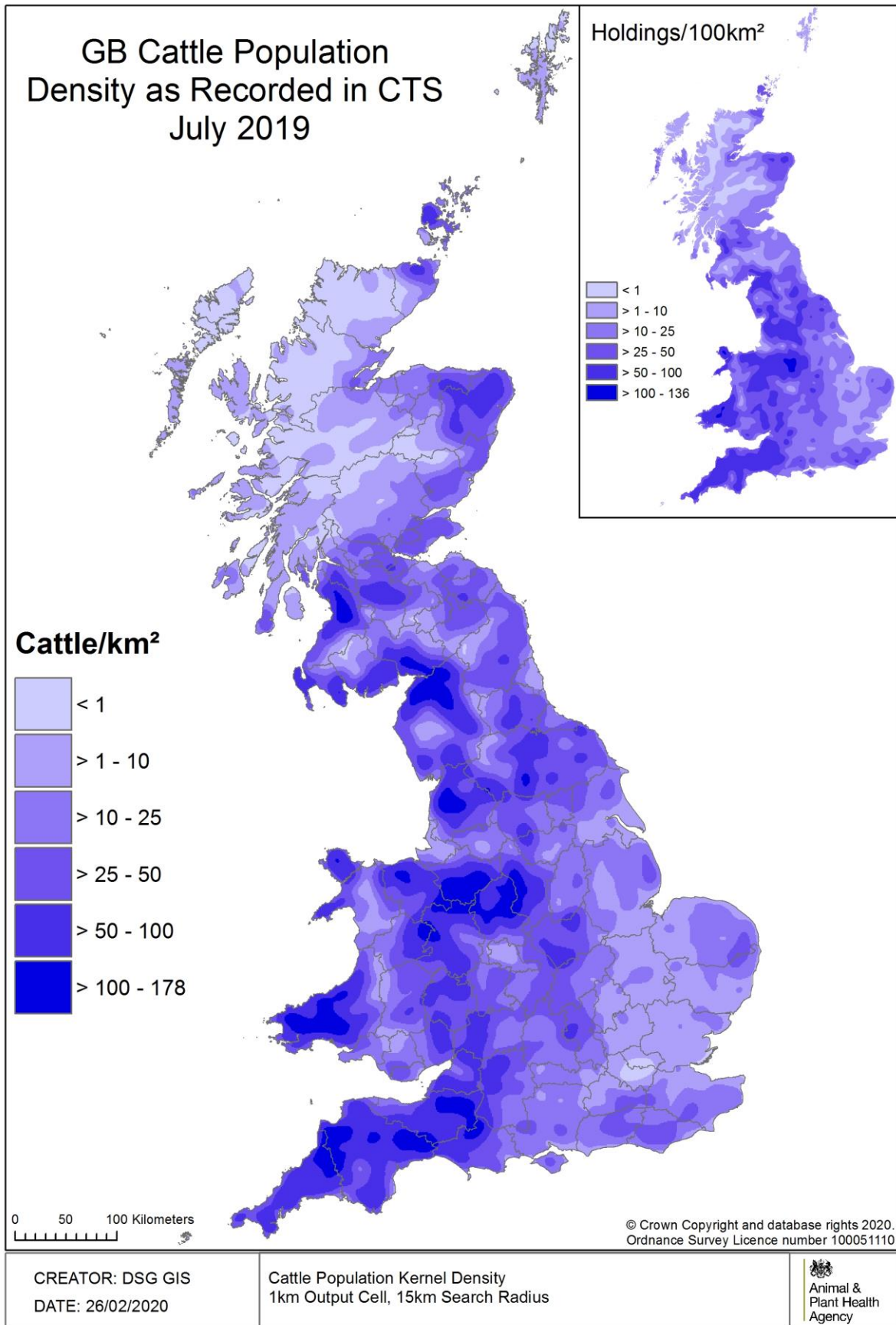
Figure 1: Cattle population density in GB (CTS) with holding density inset
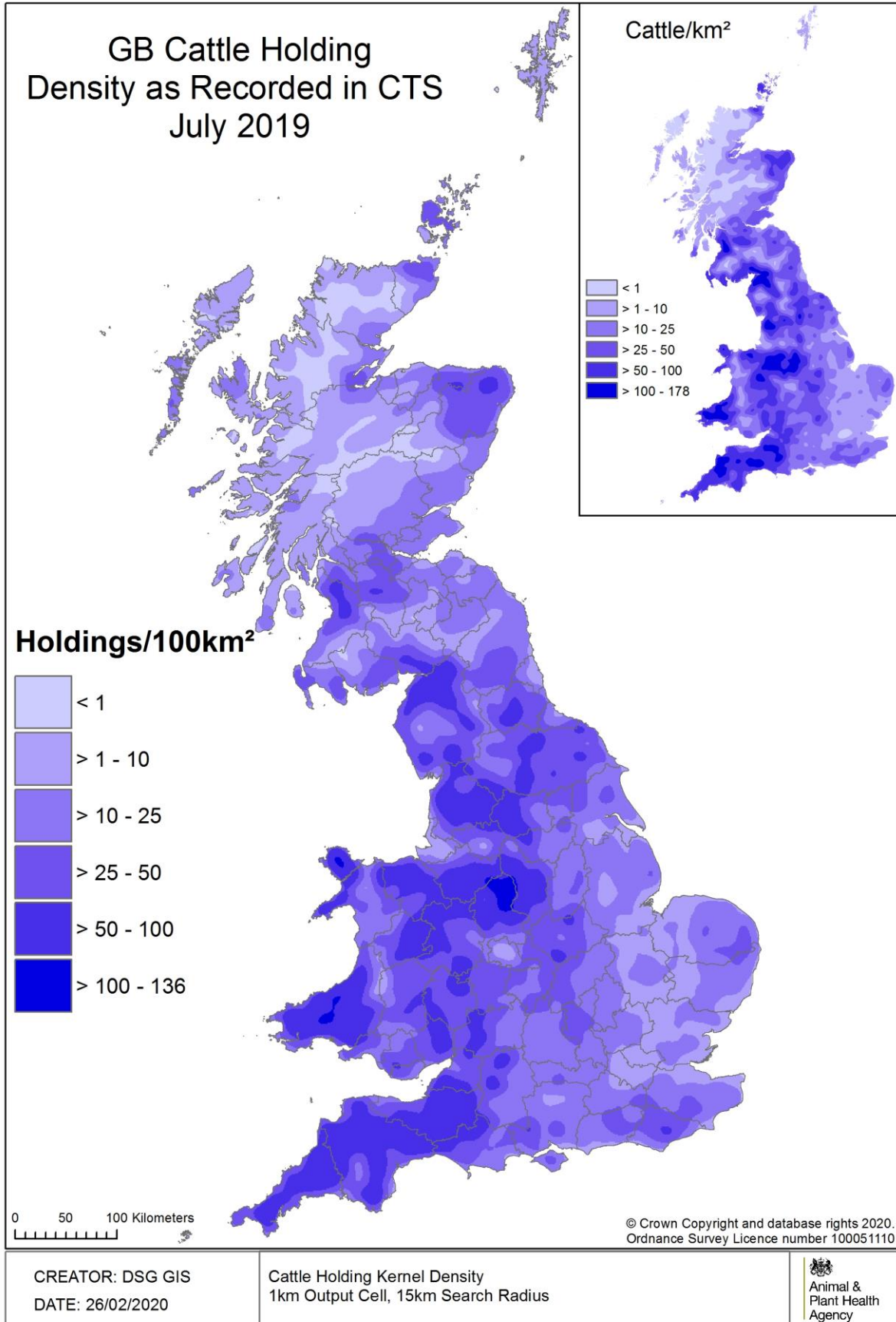
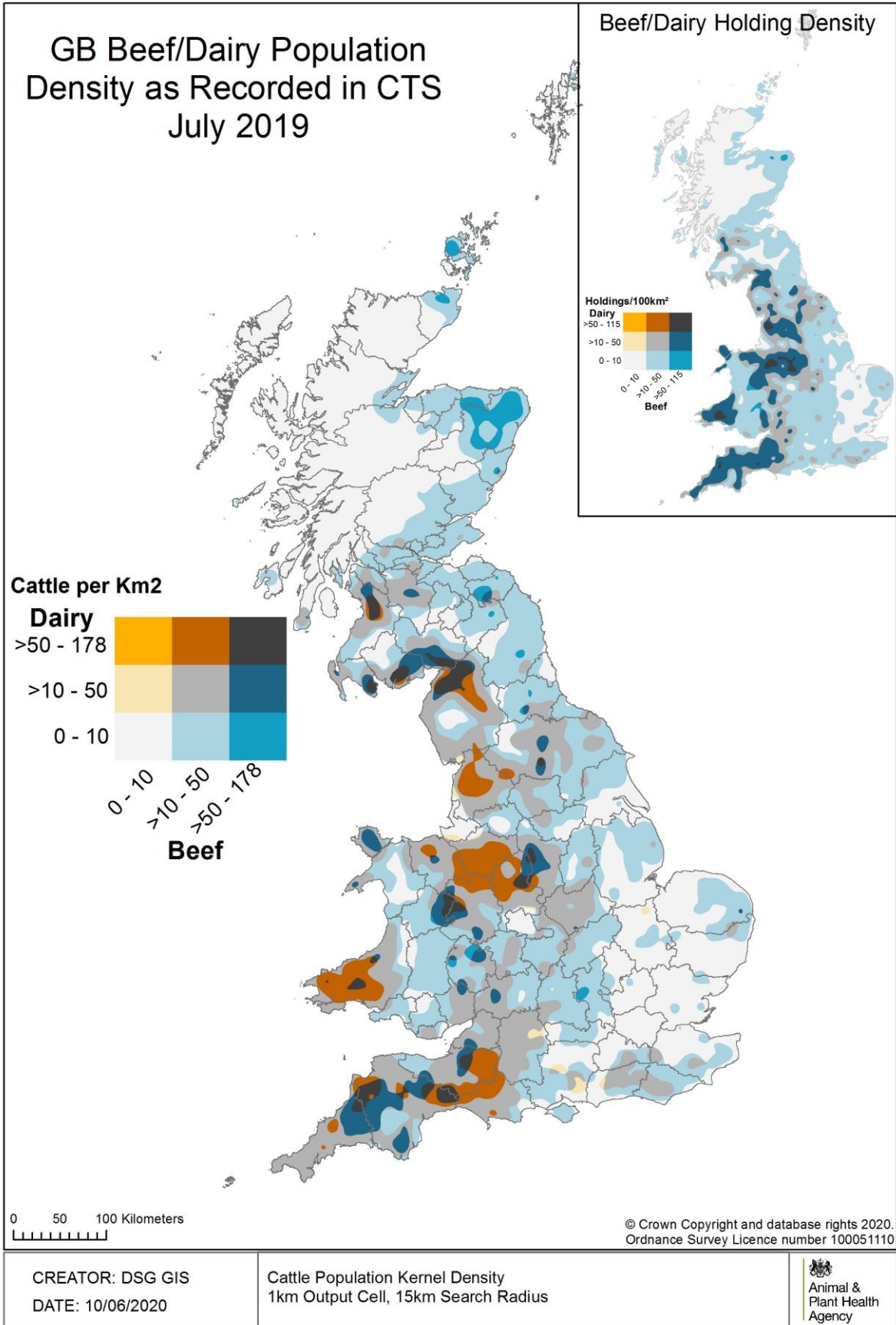**Figure 2: Cattle holding density in GB (CTS) with population density inset**

Figure 3: Bivariate map showing both Beef and Dairy population density in GB (CTS) with holding density inset
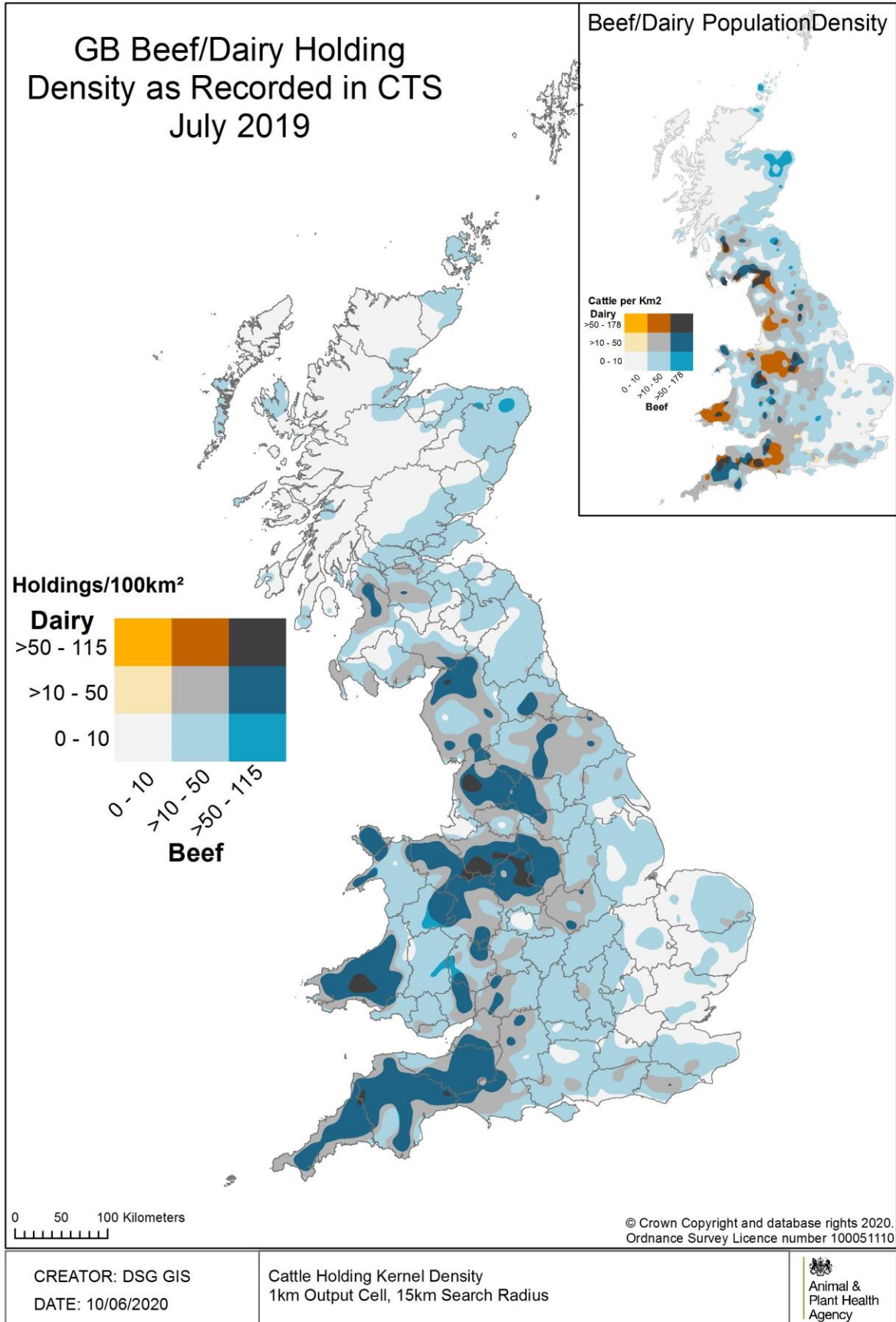
Figure 4: Bivariate map showing both Beef and Dairy holding density in GB (CTS) with population density inset

GB Beef Cattle Population Density as Recorded in CTS July 2019

Holdings/100km²
- < 1
- > 1 - 10
- > 10 - 25
- > 25 - 50
- > 50 - 100
- > 100 - 136

Cattle/km²
- < 1
- > 1 - 10
- > 10 - 25
- > 25 - 50
- > 50 - 100
- > 100 - 178

0   50   100 Kilometers

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CREATOR: DSG GIS
DATE: 26/02/2020

Cattle (Beef only) Population Kernel Density
1km Output Cell, 15km Search Radius

Animal & Plant Health Agency

Figure 5: Beef population density in GB (CTS) with holding density inset

GB Beef Cattle Holding Density as Recorded in CTS July 2019

Cattle/km²

Holdings/100km²

	< 1
	> 1 - 10
	> 10 - 25
	> 25 - 50
	> 50 - 100
	> 100 - 136

Cattle/km² (inset legend)

	< 1
	> 1 - 10
	> 10 - 25
	> 25 - 50
	> 50 - 100
	> 100 - 178

0   50   100 Kilometers

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CREATOR: DSG GIS
DATE: 26/02/2020

Cattle (Beef only) Holding Kernel Density
1km Output Cell, 15km Search Radius

Animal &
Plant Health
Agency

Figure 6: Beef holding density in GB (CTS) with population density inset

Figure 7: Dairy population density in GB (CTS) with holding density inset

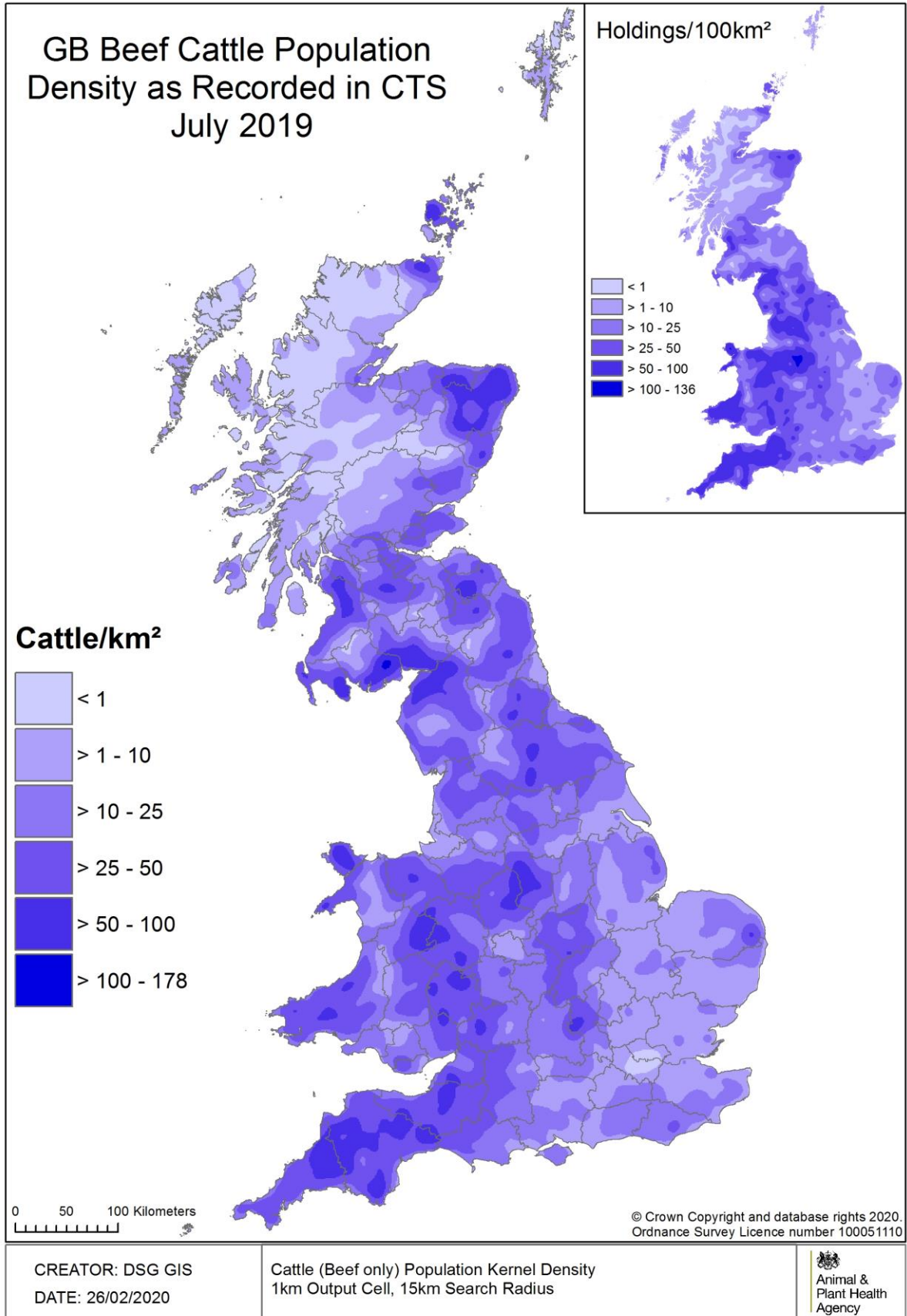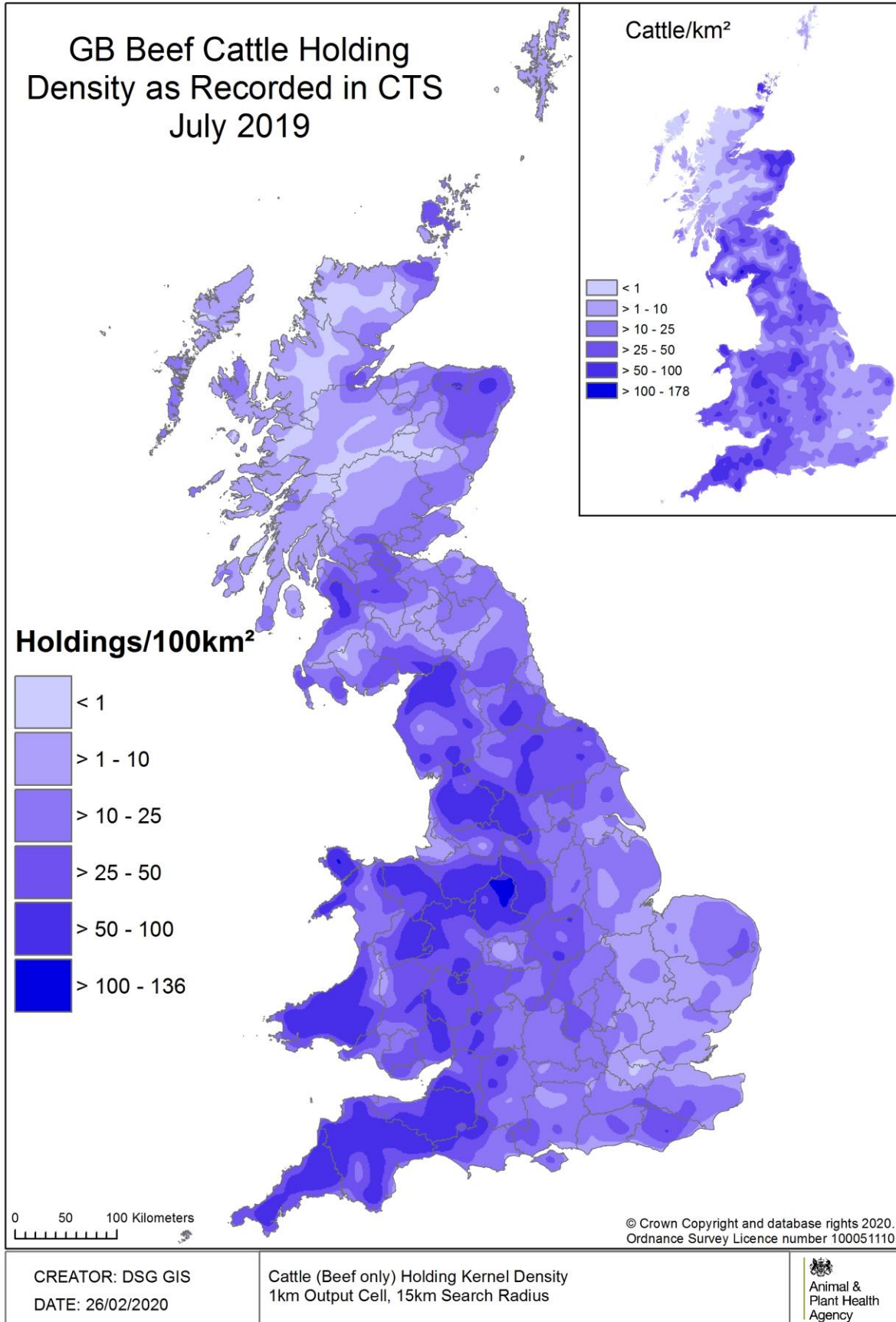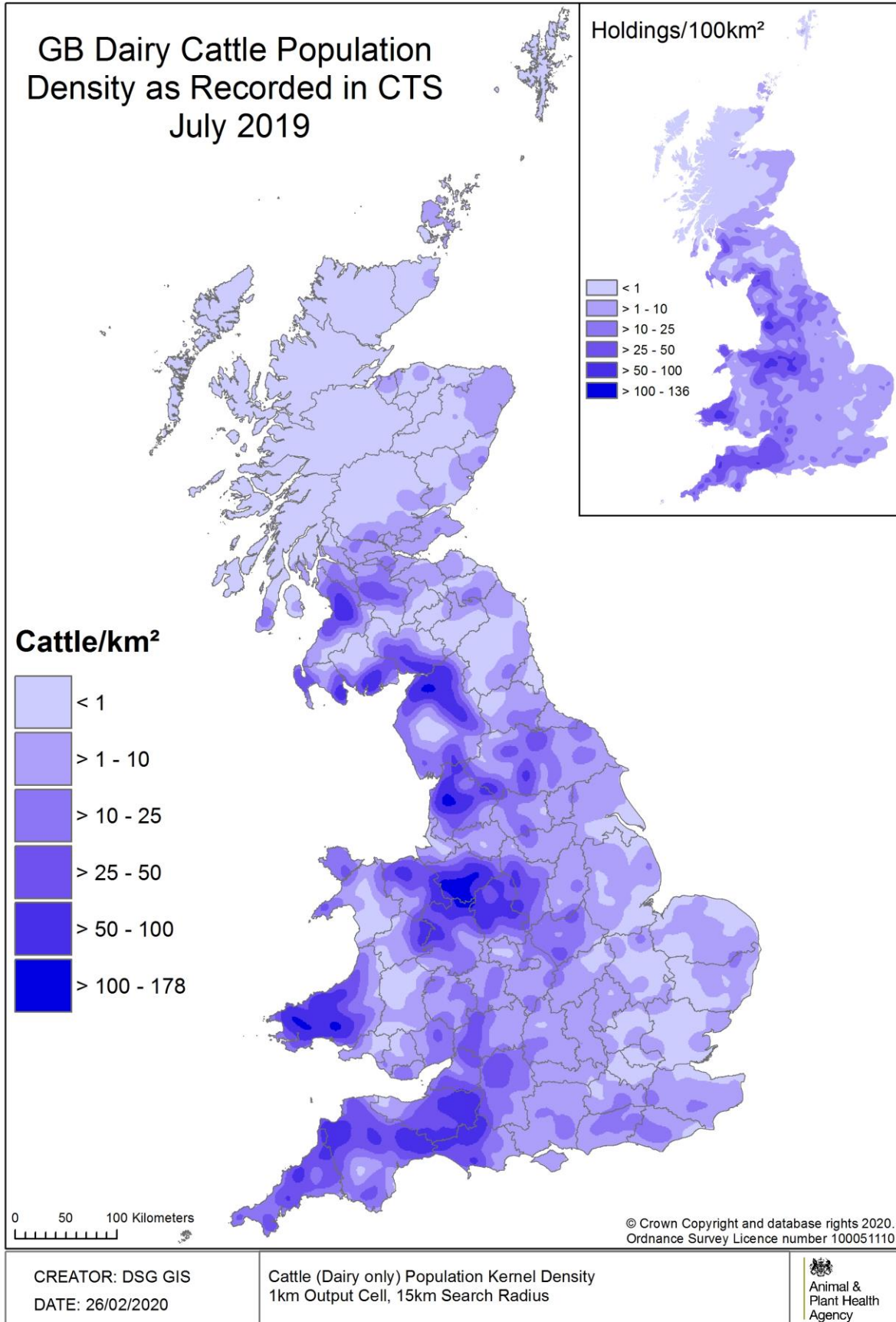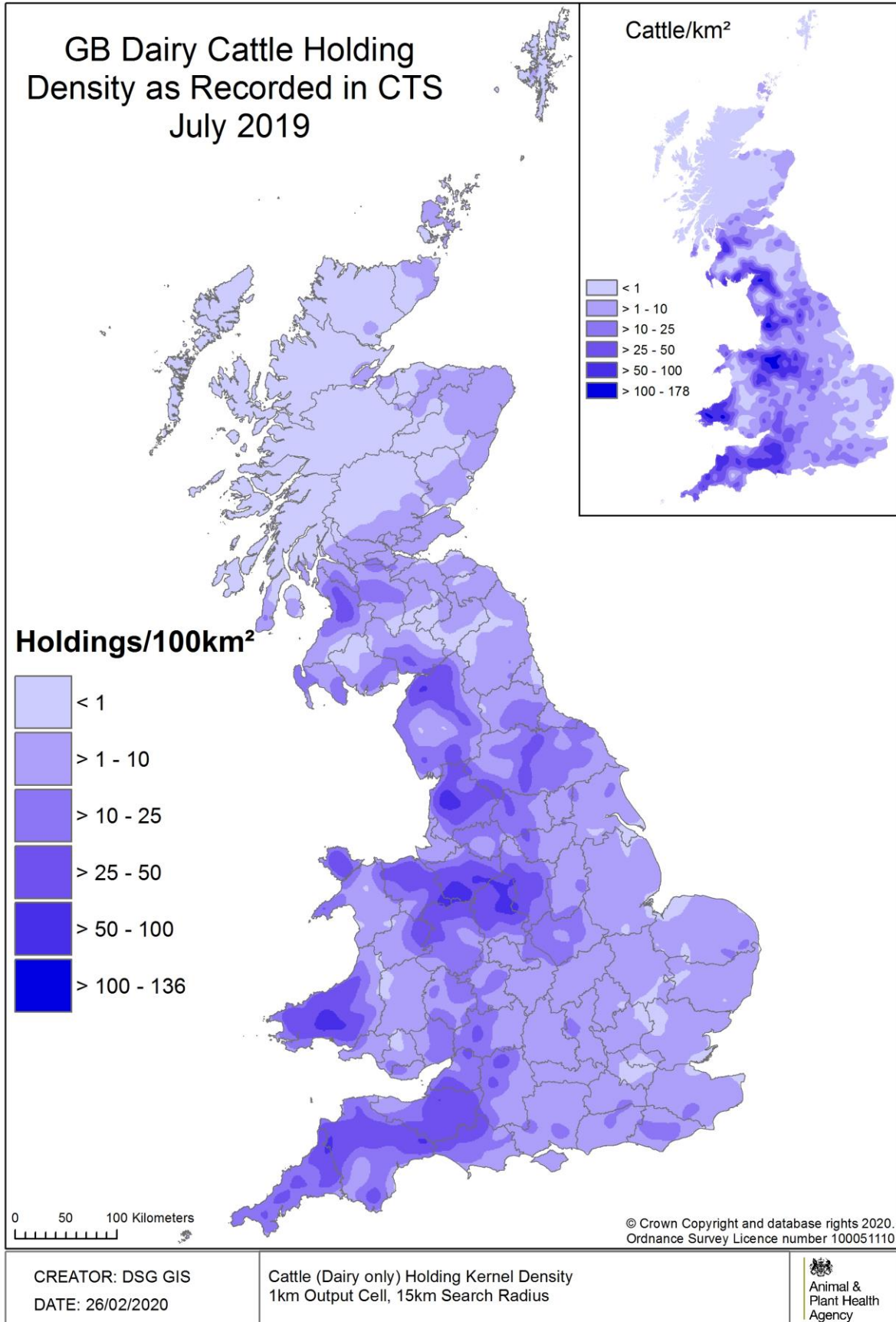**Figure 8: Dairy holding density in GB (CTS) with population density inset**

Annex 1: Data quality statement for cattle (March 2020)

Introduction

This data quality statement provides an overview of the quality of the data used to underpin the kernel density holding and livestock figures. This statement is written in the context of the data being used to provide an overview of the livestock demographics within Great Britain. The statement may not necessarily relate to data quality for other purposes.

Overview and purpose of the source data

Data were supplied by the APHA's Data Systems Group (DSG) and sourced from the Rapid Analysis and Detection of Animal-related Risks (RADAR) data warehouse, the Cattle Tracing System (CTS) database and APHA's Sam database. The CTS dataset describes cattle movement and birth registration data, contributing to the overall cattle count and location data, within GB and is captured by the British Cattle Movement Service (BCMS). It includes further information including location data which can be used to estimate the number of cattle on holdings in GB.

Category [definition]	Quality description
Relevance of data *[degree to which data meets user needs in terms of currency, geographical coverage, content and detail]*	**Spatial coverage:** The data cover Great Britain. **Temporal coverage:** The data presented are for July 1st 2019 and were accessed in December 2019. **Key data items available:** The dataset includes births, deaths and movements for registered cattle. It can estimate the number and location of cattle at any one point in time based on these movement records. It also includes data on breed and sex. Breed information has been used to produce the beef and dairy figures behind the bivariate population and holding density maps seen in Figures 3 and 4. A dual purpose breed was also identified in the data. This represented around 3% of overall cattle, and was included in the total cattle maps but was excluded from the Beef and Dairy bivariate maps in Figures 3 and 4. For the production of beef/dairy holding density maps, a beef holding was defined as a cattle holding with at least one beef breed cattle present on the 1st July 2019. Similarly, a dairy holding was defined as a cattle holding with at least one dairy breed cattle present on the 1st July 2019. Beef and dairy breeds were defined as in CTS.

Timeliness *[the degree to which data represent reality from the required time point]*	**How often are the data collected?** A continuous stream of completed movement forms are submitted to the British Cattle Movement Service (BCMS) by farmers and entered into CTS. Location co-ordinates of holdings are uploaded from APHA's operational database called SAM only once per holding. Data are uploaded to RADAR monthly. **When do the data become available?** Data become available in RADAR up to one month after collection. **Data reference period:** The database is fed continuously but the population data are a snapshot extracted from July 1st 2019. This month was chosen because the cattle population drops approximately 4% over winter but is most stable during summer. **How often are the data updated?** CTS data are generally more accurate the older they are. Completion of most movement form submissions, data entry to be finalised and the database to be updated usually takes place within 3 months, although analysis shows completeness of the upload is over 98% for the most recent month. Holding location coordinates for a CPH are not updated in CTS, and if SAM does not have a record of that holding no coordinates are assigned. Gaps in the initial upload of SAM location coordinates into CTS are filled by the RADAR 'best co-ordinates' algorithm which imputes the location from other data including the address.
Accuracy and precision *[extent of data error and bias and how well data portrays reality]*	**How were the data collected?** Cattle population estimates on each holding are calculated from cattle movement information. Farmers and other CPH holders, i.e. market operators, agricultural shows and abattoirs, are legally required to submit completed records of cattle movements on forms to BCMS. Separate movement forms are submitted as *movements off* and *movements on*; these are 'paired' by IBM prior to being made available, i.e. the *from* and *to* herd forms are combined into a single record. Location coordinates are assigned to a holding from SAM when a submitted form has a new location, but location data will be missing if SAM has no record at the time. SAM amendments to the location are not usually fed back to BCMS. RADAR 'best' coordinates are also available which are calculated with additional information including the current address data for the holding. **Sample & collection size:** There are approximately 380,000 unique CPH records within the CTS dataset, which includes all historical records and changes. Of this there are 145,000 CPHs

that represent individual holdings, and 64,674 of these had at least one bovine animal on the holding, as at 1st July 2019. There are approximately 900,000 movement records per month which are used to calculate changes in the cattle population on each holding.

What steps have been taken to minimise processing errors?
DSG monitors the monthly CTS upload by checking that the file is complete and holds expected data. Checks are made monthly by IBM to ensure the data have loaded into RADAR correctly. BCMS investigate and resolve any cattle movements which appear to be either suspicious or inaccurate.

What are the non-reporting or non-response rates? It has been assumed that very few cattle keepers fail to report cattle movements and births. It is a legal requirement to do so: cattle keepers have faced prosecution for not registering movements with CTS. Unrecorded movements may lead to incomplete data, so inferred movements are calculated when the animal next appears on a movement submission. These movements are unlikely to impact the population counts significantly.

Temporary Holdings (THs) and Temporary Land Associations (TLAs) used for more accurate population data: Sole Occupancy Authorities (SOAs) and Linked Holdings have been described in previous reports but these have been phased out. Since 2016 in England, and 2018 in Wales, THs and TLAs have been introduced in order to more accurately determine where cattle reside at any moment in time. Cattle keepers previously permitted to graze cattle on rented land >10 miles from the parent holding now have to register that rented land as a temporary holding, and movements between it and the parent holding reported. Reporting of movements to rented land within 10 miles of the parent holding is not necessary, as previously, although any land grazed has to be registered. As a result, the total cattle population count is unaffected, but there is greater accuracy of cattle location data. Movements to and from THs are often seasonal, so cattle density mapping will be dependent on the cattle locations at the time of data compilation. There are only 945 active THs (July 2019) and three quarters are within 30km of the parent holding, so the effect on the cattle density map is minimal. TLAs are not represented in the holding density map. This policy differs in Scotland: when keepers temporarily move their animals to a different holding, an additional herd will be registered to that holding and any movements will be reported.

Comparability *[how well these data can be compared with data taken from the same dataset and with similar data from other sources]*	**Within dataset comparability:** Routine checks show that data extracted at different times are highly comparable. **Other dataset comparability:** The CTS data appear to be the most accurate for placing cattle in a place at a point in time. SAM and RADAR may have more up to date information on location coordinates. This will have minimal impact on county level summaries or kernel density smoothed maps.
Coherence *[degree to which data can be or have been merged with other data sources]*	**How consistent are the data over time? If there are differences, what are they and what is their impact? Have there been changes to the underlying data collection?** CTS data are most complete and accurate since 2000. We are not aware of any change in collection methods during recent years but assume minimal bias has been caused. Current location details may be different from when location was first recorded, but should still be of similar geographic location. **Have any real world events impacted on the data since the previous release?** None have been identified **What other data sources are these data comparable with?** Location data are comparable between CTS, SAM and RADAR. There are not thought to be any other datasets that would hold information on cattle movements.
Interpretability *[how well the data is understood and utilised appropriately]*	**Is there a particular context that these data need to be considered within?** This dataset can be used to obtain information regarding animal movements and animal population counts. The cattle population peaks during the summer and dips during the winter. These data are from the summer peak (July 1st 2019). As registration of movements is legally enforced, we expect the data to be a near complete representation of cattle within the agricultural industry. **What other information is available to help users better understand this data source?** We have documentation of what the tables and data represent. IBM have technical documentation for the compilation of the data. **Are there any ambiguous or technical terms that may need further explanation?** The different types of holding/location present may need explaining for recipients of raw data.
Accessibility	**What data are shared and with whom?** Addresses and

[availability of relevant information and access to the data in a convenient and suitable manner]	coordinates of individual locations cannot be released without Confidentiality Agreements. However, summary cattle movement outputs and aggregated data can be shared. The dataset is very large, so provision of individual records would not be easy even with Confidentiality Agreements in place. Aggregated data are a better option. Data are stored within SQL (Structured Query Language) tables on secure servers. **Contact details for data source queries** Agricultural Survey England: farming-statistics@defra.gov.uk Agricultural Survey Wales: stats.agric@wales.gov.uk Agricultural Survey Scotland: agric.stats@scotland.gov.uk Brittish Cattle Movement Service: bcmsenquiries@rpa.gov.uk Rapid Analysis and Detection of Animal related Risk (RADAR) data warehouse: RADAR@apha.gov.uk Data Systems Group (DSG) Animal and Plant Health Agency Weybourne Building, Level 2, Area F, Woodham Lane Addlestone, Surrey KT15 3NB