



Animal &  
Plant Health  
Agency

**Livestock Demographic Data**

**Group:**

**Poultry population report**

**Livestock population density maps  
for GB, using July 2023 data**



© Crown copyright 2024

You may re-use this information (excluding logos) free of charge in any format or medium, under the terms of the Open Government Licence v.3. To view this licence visit [www.nationalarchives.gov.uk/doc/open-government-licence/version/3/](http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/) or email [PSI@nationalarchives.gov.uk](mailto:PSI@nationalarchives.gov.uk)

APHA is an Executive Agency of the Department for Environment, Food and Rural Affairs and also works on behalf of the Scottish Government, Welsh Government and Food Standards Agency to safeguard animal and plant health for the benefit of people, the environment and the economy.

Document information	
LDDG	Poultry
Report reference	PoP23/24
Contributors	Department of Epidemiological Sciences, APHA Science Strategy and Planning Group, APHA Data Systems Group, APHA Weybridge Epidemiology and Risk Policy Advice team, APHA Avian Species Expert Group, Surveillance Intelligence Unit, APHA Field Epidemiology team, APHA
<u>Contacts for queries:</u>	
Freedom of Information (FOI), Environmental Information Regulations (EIR) and Subject Access requests	<a href="mailto:enquiries@apha.gov.uk">enquiries@apha.gov.uk</a>
Management Information and Data Architecture Services (MIDAS)	<a href="mailto:Midas@apha.gov.uk">Midas@apha.gov.uk</a>
Livestock Demographics Data Groups (LDDG)	<a href="mailto:LDDG@apha.gov.uk">LDDG@apha.gov.uk</a>
Epidemiology and Risk Policy Advice, APHA	<a href="mailto:erpa@apha.gov.uk">erpa@apha.gov.uk</a>
Data source	Great Britain Poultry Register (GBPR; now incorporated within the Sam database)
Data year	July 2023

## Contents

Who are these reports for? .....	1
Who did this work? .....	1
What do the data show about the population?.....	1
How accurate are the data? .....	1
What do the data not show? .....	2
How were the maps produced? .....	3
Acknowledgements.....	15
References .....	15
Annex A: Data quality statement for poultry (Dec-23).....	15
Introduction .....	15
Overview and purpose of the source data.....	15
Annex B: Number of poultry holdings and number of poultry per county .....	19
Annex C: Investigation of the impact of Highly Pathogenic Avian Influenza outbreaks on poultry registration. ....	22

## 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 poultry 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 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 with the Quality Statement.

## Who did this work?

The Livestock Demographic Data Groups (LDDG) were formed in January 2014. These are made up of APHA representatives from data systems, epidemiology, species expert and GIS work groups. The work was initiated and completed between September 2023 and December 2023.

## What do the data show about the population?

The maps (Figures 1 and 2) show either the density of birds, with a small map to show how this compares with the density of holdings, or vice versa. The data extract is interpreted as a snapshot of the poultry population in July 2023. These map styles have then been reproduced and applied to the separated species of Poultry in Figures 3 – 10; namely chickens, ducks and geese (species combined), gamebirds (multiple species combined) and turkeys. The methodology for the extraction of species-level data is described below. The GB poultry population density map and the GB poultry holding density map correspond with the Avian Expert Group's current opinion of the geographical distribution of the industry. The significant concerns over data quality discussed below, limit the application of the maps and tables. Our current understanding of the inaccuracy in the data restricts the interpretation to an indication of likely relative density.

## How accurate are the data?

The Great Britain Poultry Register (GBPR) (now incorporated within the Sam database) represents the statutory systematic record of the location, species, usual number of birds and seasonal variations, for holdings with more than 50 birds in Great Britain. Assessment of the GBPR data quality during a survey identified a significant percentage of holding records were ineligible for use in a study on avian influenza, which can be considered a proxy for percentage of inaccurate records. Eligibility varied between species, from turkey fatteners with 21% ineligible to geese at 62%, with an overall average of 46% ineligible due to reasons around inaccurate data (no birds or less than the number specified, moved

away/no longer in business or wrong class of birds) The causes of this inaccuracy are discussed in the quality statement ([Annex A](#)).

Historically there was also some concern regarding the number of unregistered poultry holdings. Registration under the GBPR was only mandatory for holdings with greater or equal to 50 birds. Foot patrol investigations during notifiable outbreaks of highly pathogenic avian influenza has shown good representation of these larger holdings in kept databases. However, it has also confirmed the underrepresentation of holdings keeping less than 50 birds. These are generally referred to as smallholding or backyard poultry however some of these holdings may have some associated commercial activity. For further information please refer to the Data Quality Statement in [Annex A](#). A public consultation on proposed registration requirements for all bird keepers in GB was held 7<sup>th</sup> March – 31<sup>st</sup> May 2023 aiming to address these concerns. The consultation has now concluded and following careful consideration of responses and taking into account government objectives to tackle outbreaks of notifiable avian diseases (such as bird flu) in kept birds, Defra, Scottish and Welsh Governments have agreed to proceed with proposed changes to:

- extend registration to all kept birds, not just poultry, and reduce the threshold from 50 to 1.
- exempt psittacines and passerines (budgies, parrots, canaries and similar species) kept within a dwelling or in a dedicated 'bird house' without any access to the outside, from the mandatory registration requirement.
- mandate all keepers to review their records annually.

The proposed changes will be implemented in 2 phases. The mandatory registration requirements would apply from late summer or early autumn 2024 and the mandatory annual updates 12 months afterwards. [Summary of responses and government response - GOV.UK \(www.gov.uk\)](#)

## What do the data not show?

The data and maps presented here do not show the seasonal variations the population undergoes across the year, instead these data represent the usual capacity of the holdings. For the reports produced in 2020 ([Livestock population density maps for GB 2020 using winter 2019 data \(defra.gov.uk\)](#)), 2021 (re-issued [Livestock population density maps for GB, using July 2021 data \(defra.gov.uk\)](#)) and 2022 (re-issued [Livestock population density maps for GB, using July 2022 data \(defra.gov.uk\)](#)) information is broken down to individual species level for chickens, turkeys, ducks, geese, gamebirds. This dataset does not include details of wild birds or birds in zoological collections.

There is significant uncertainty in the accuracy of the information displayed. Limitations in the dataset are discussed in the supporting quality statement ([Annex A](#)). The creation of maps from incomplete data results in a high risk of incomplete and or misleading information being portrayed. Similarly, population and holding density maps are displayed

with different data classes and units in their respective legends and due care must be taken regarding their interpretation.

## How were the maps produced?

The maps have been created using the kernel density function in *ArcGIS* software. This tool distributes population information over a defined radius, 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<sup>1</sup>. A search radius of 20km 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. Comparison between the maps was optimised by assigning similar parameters between the species. However, further refinement of the parameters for each species dataset could represent the information more accurately.

**Table 1: Number of poultry holdings and number of birds by country in GB, based on July 2023 records, comparing with 2022 records.** The number of poultry holdings and total number of poultry per county, grouped per country, is provided in [Annex B](#).

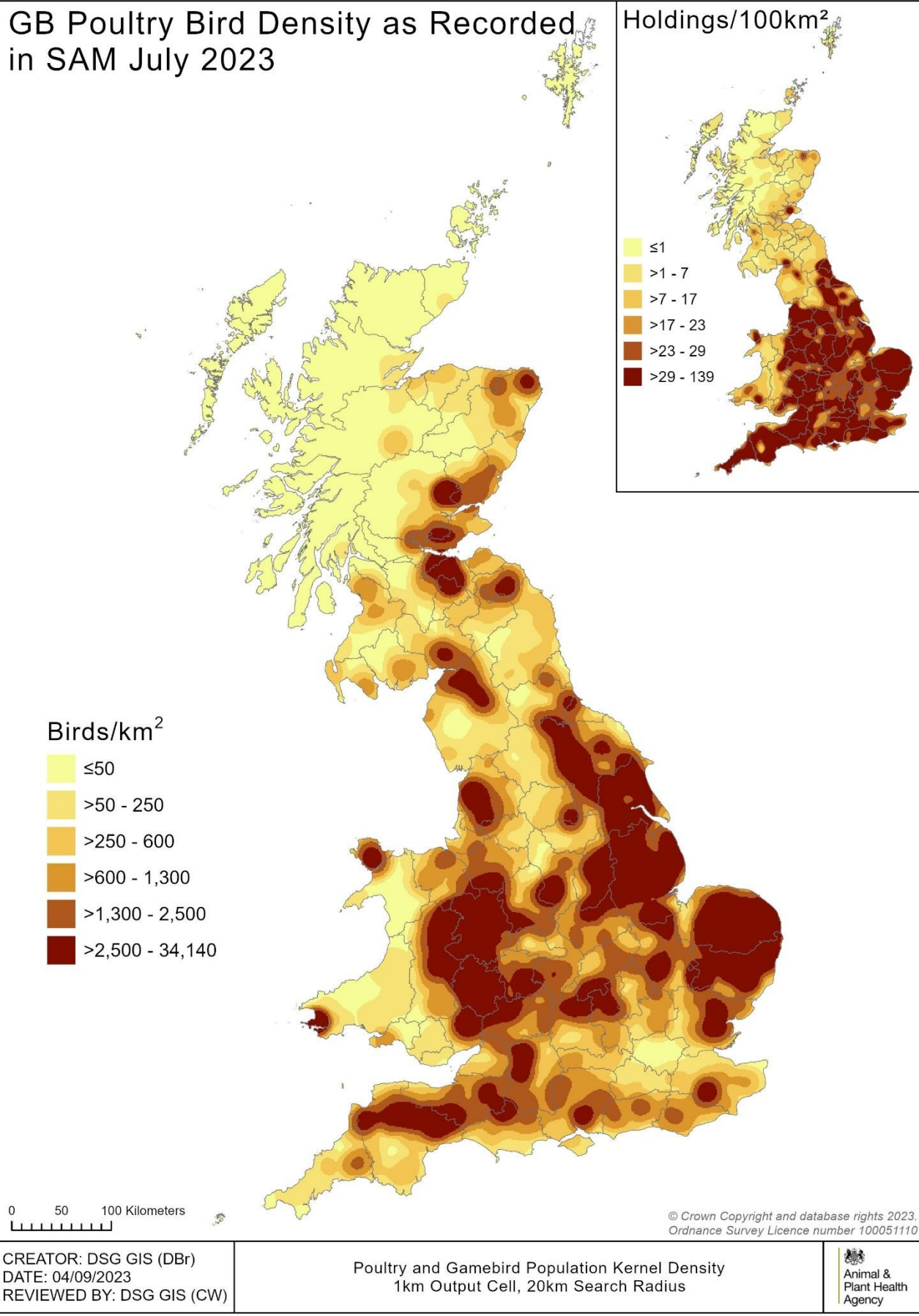
Country	Holdings			Usual Stock Numbers		
	July 2022	July 2023	% Change	July 2022	July 2023	% Change
ENGLAND	44,167	53,138	20.31%	302,643,905	328,141,957	8.43%
SCOTLAND	3,132	4,032	28.74%	32,368,628	32,480,502	0.35%
WALES	3,557	3,915	10.06%	22,562,477	25,085,571	11.18%
GB TOTAL	50,856	61,085	20.11%	357,575,010	385,708,030	7.87%

The reported total number of poultry in GB was just over 385.5 million, which was significantly up from the figure of 357.5 million poultry from 2022 records (Table 1). The reported total number of holdings has also increased from 50,856 in 2022 to 61,085 in this current report based on the 2023 records (Table 1 and [Annex B](#)). This however is subject to the data quality issues addressed above, poultry numbers are dependent on poultry registration which may be affected by the presence of notifiable diseases in poultry. Notifiable disease investigations may force registration updates implying change or

<sup>1</sup> Pfeiffer, D. Spatial Analysis in Epidemiology, 2008. p47.

addition in poultry numbers that in reality were always present. In the event of notifiable avian disease occurrence, there is a statutory requirement to undertake a census and identify all poultry and captive bird keepers within a Protection Zone it is likely that a number of unregistered holdings, particularly smallholding premises, will be registered by APHA as a result. This would likely increase the number of registered holdings whilst having a limited impact on the true number of animals. [Annex C](#) of this document describes an investigation of the impact of this trend undertaken in June 2023.

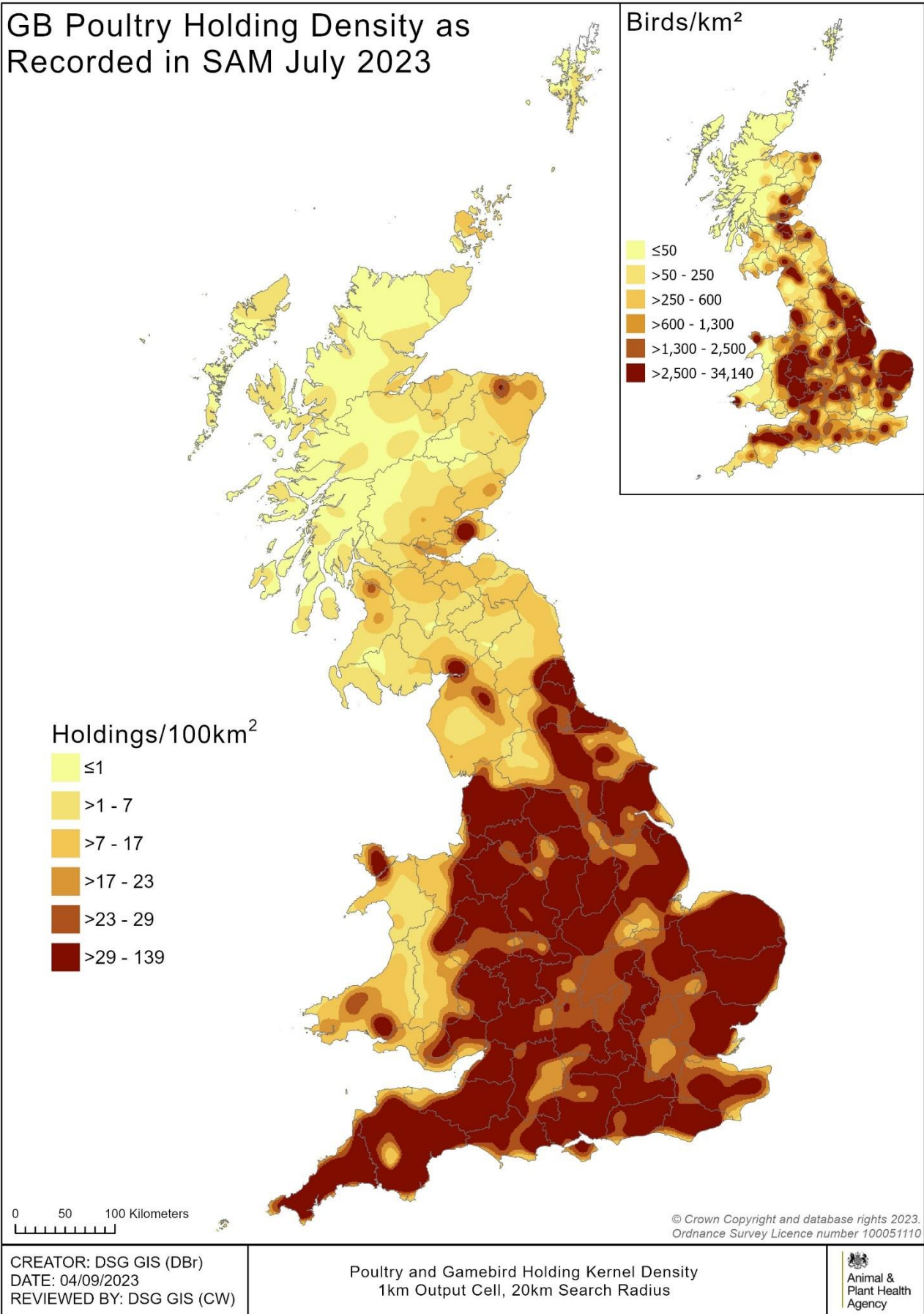
# GB Poultry Bird Density as Recorded in SAM July 2023



**Figure 1:** Poultry population density in GB based on July 2023 records.

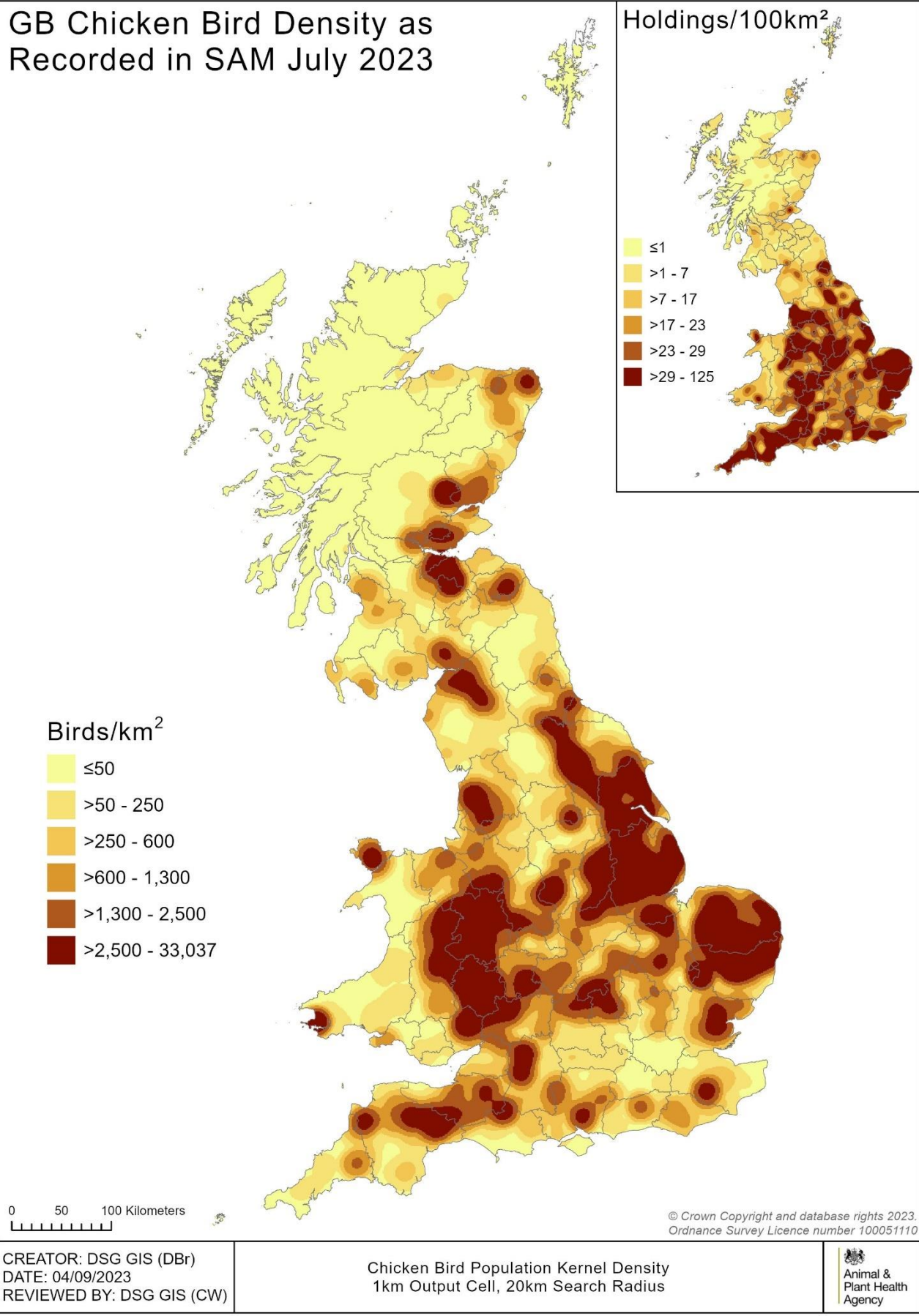


# GB Poultry Holding Density as Recorded in SAM July 2023



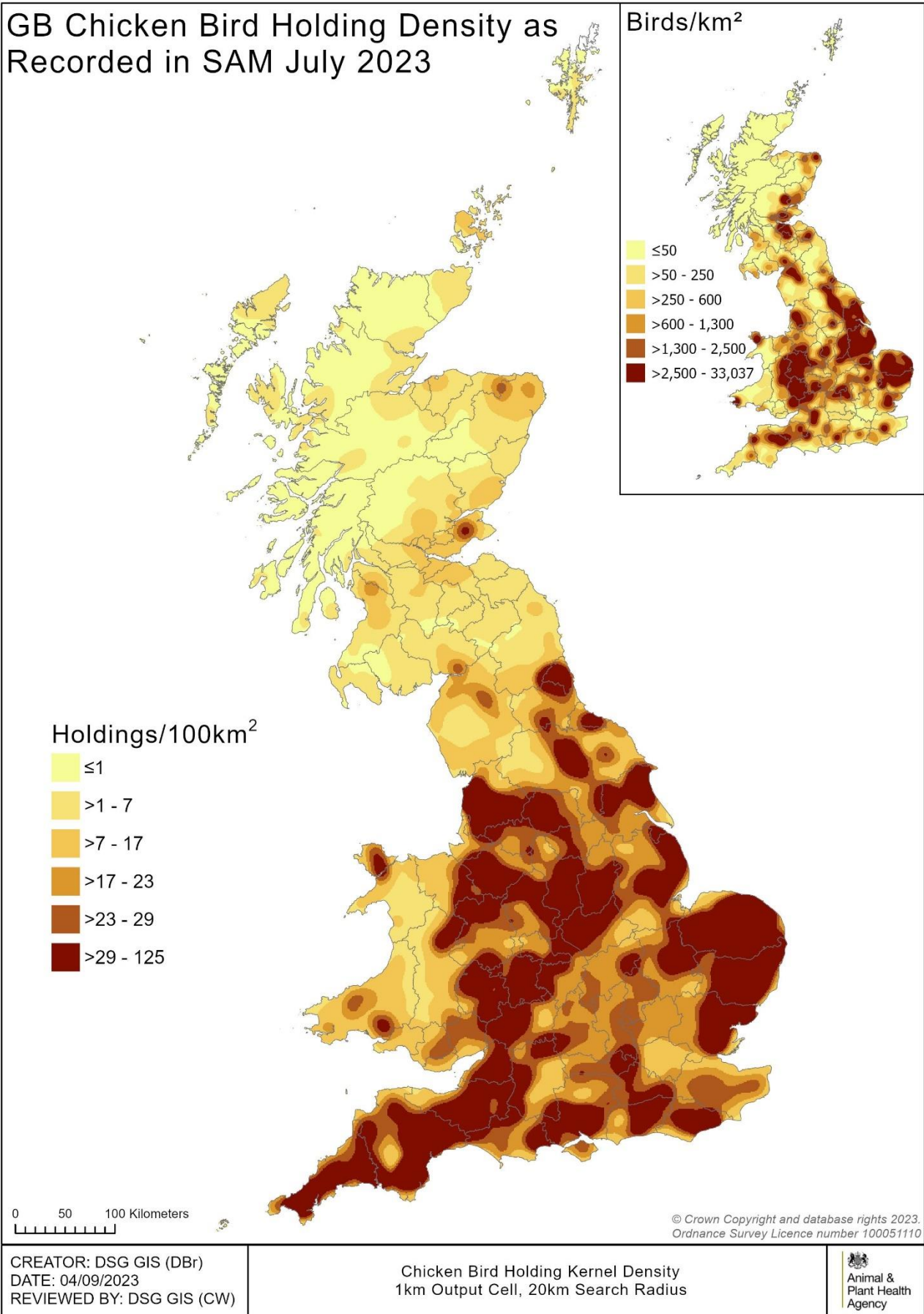
**Figure 2:** Poultry holding density in GB based on July 2023 records.

# GB Chicken Bird Density as Recorded in SAM July 2023



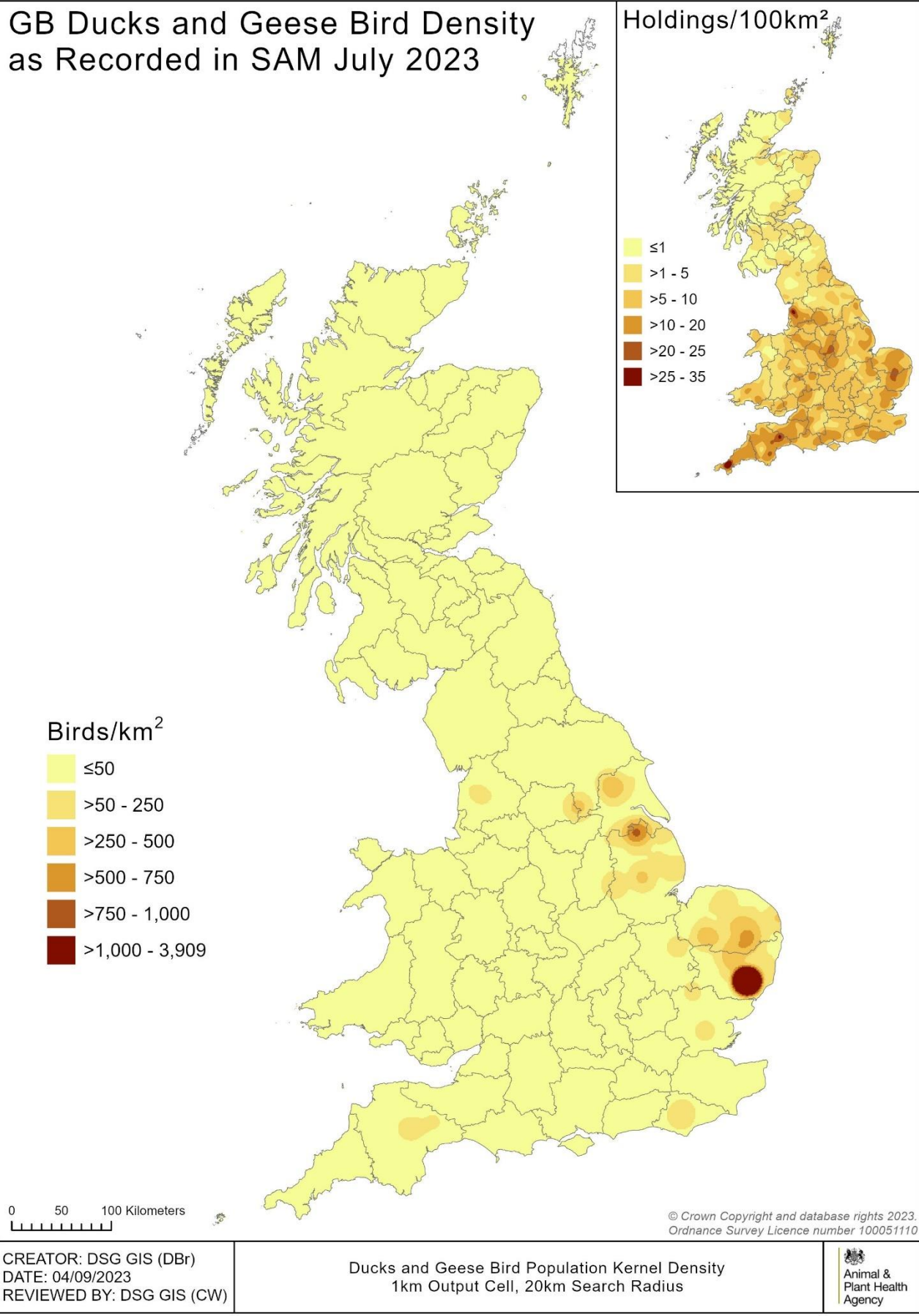
**Figure 3:** Chicken population density in GB based on July 2023 records.

# GB Chicken Bird Holding Density as Recorded in SAM July 2023



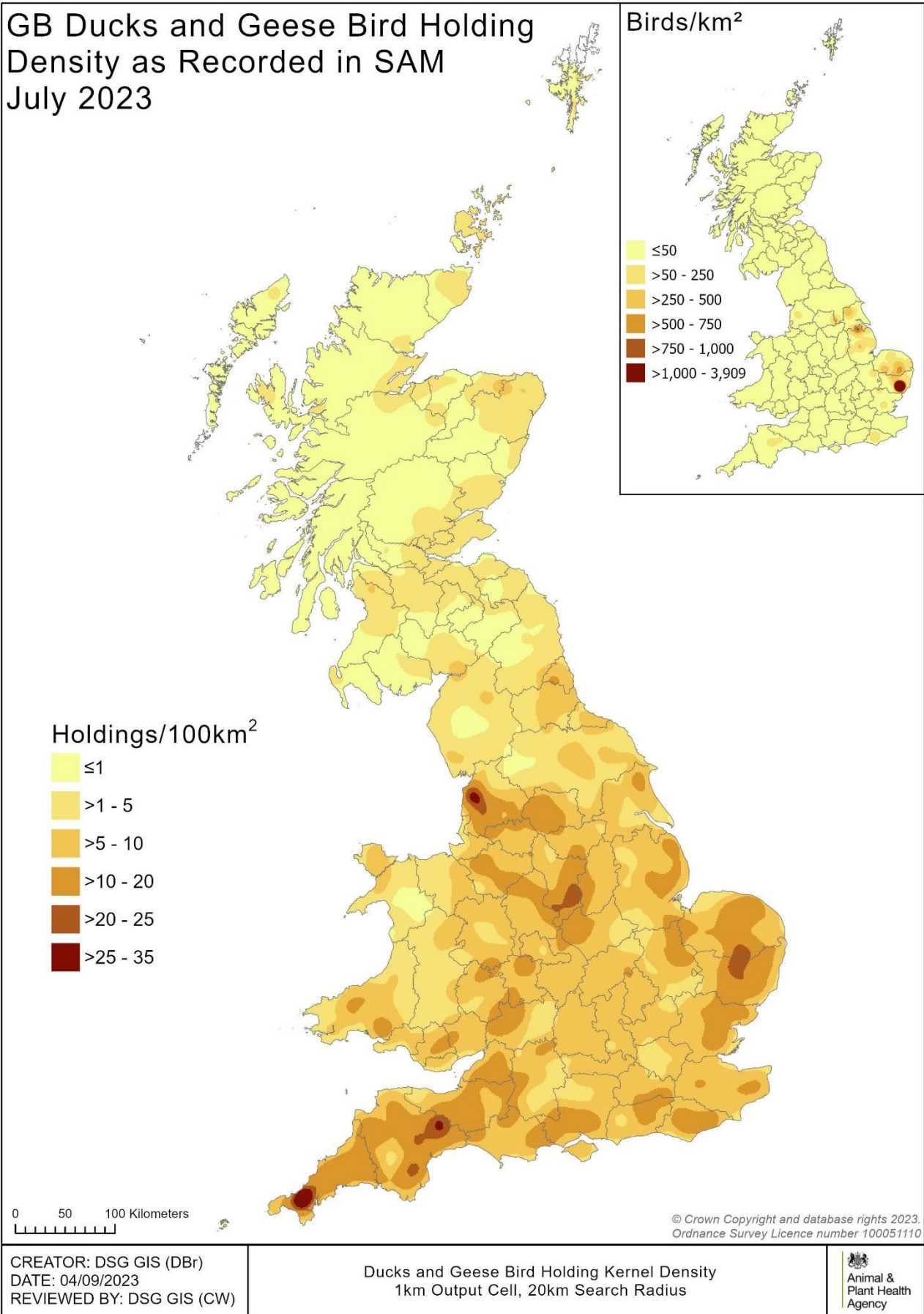
**Figure 4:** Chicken holding density in GB based on July 2023 records.

# GB Ducks and Geese Bird Density as Recorded in SAM July 2023



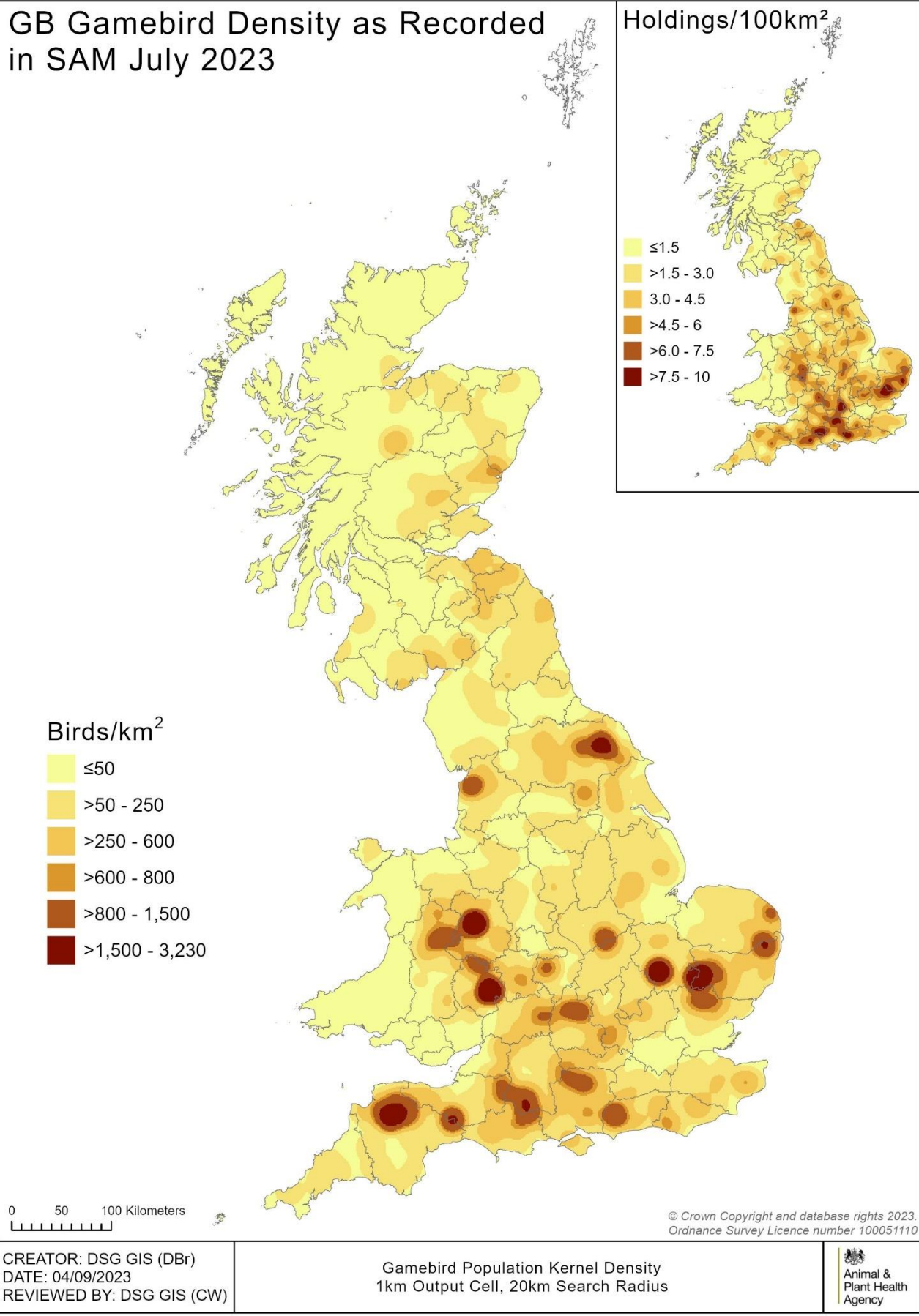
**Figure 5:** Duck and Goose population density in GB based on July 2023 records.

# GB Ducks and Geese Bird Holding Density as Recorded in SAM July 2023



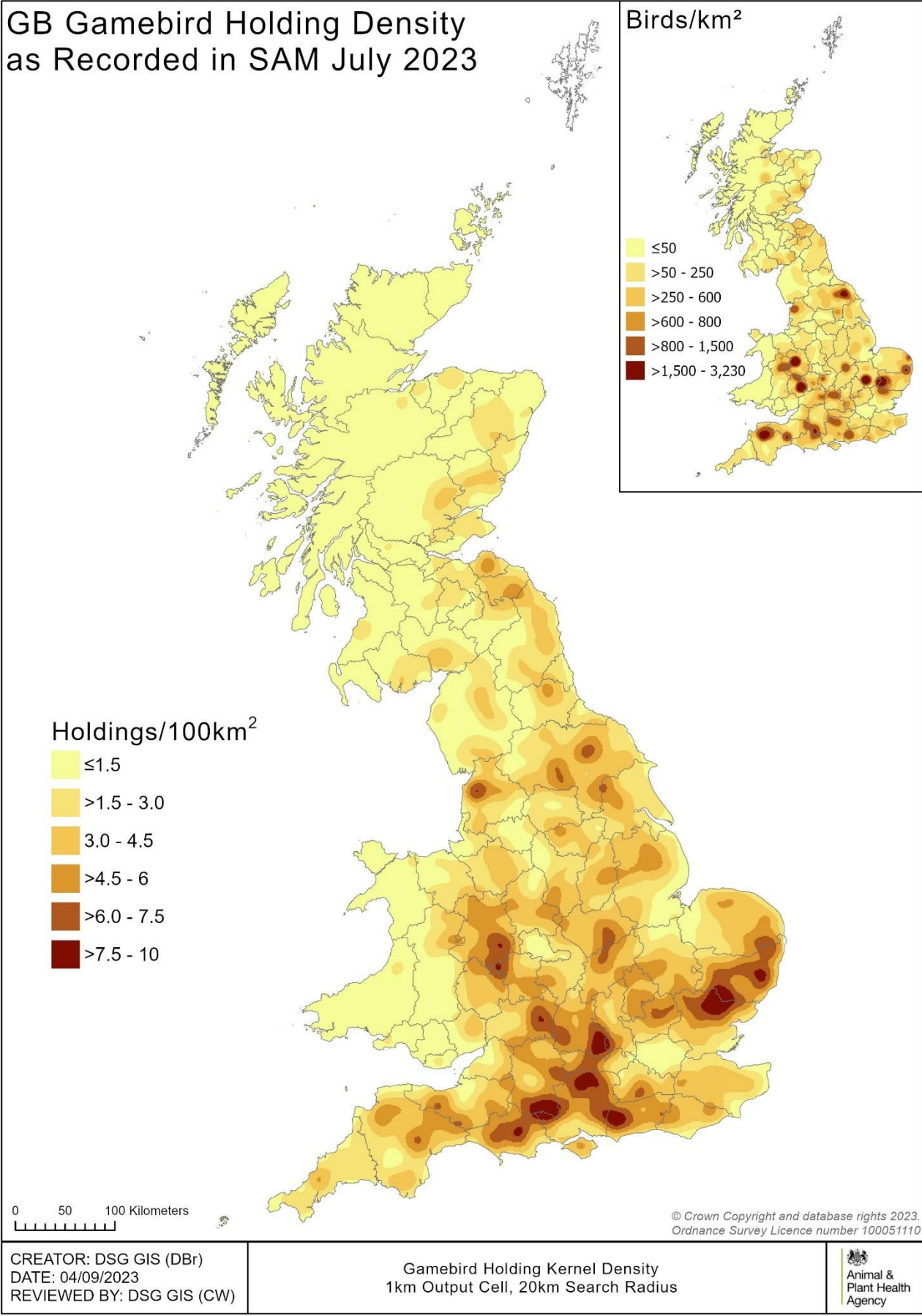
**Figure 6:** Duck and Goose holding density in GB based on July 2023 records.

# GB Gamebird Density as Recorded in SAM July 2023



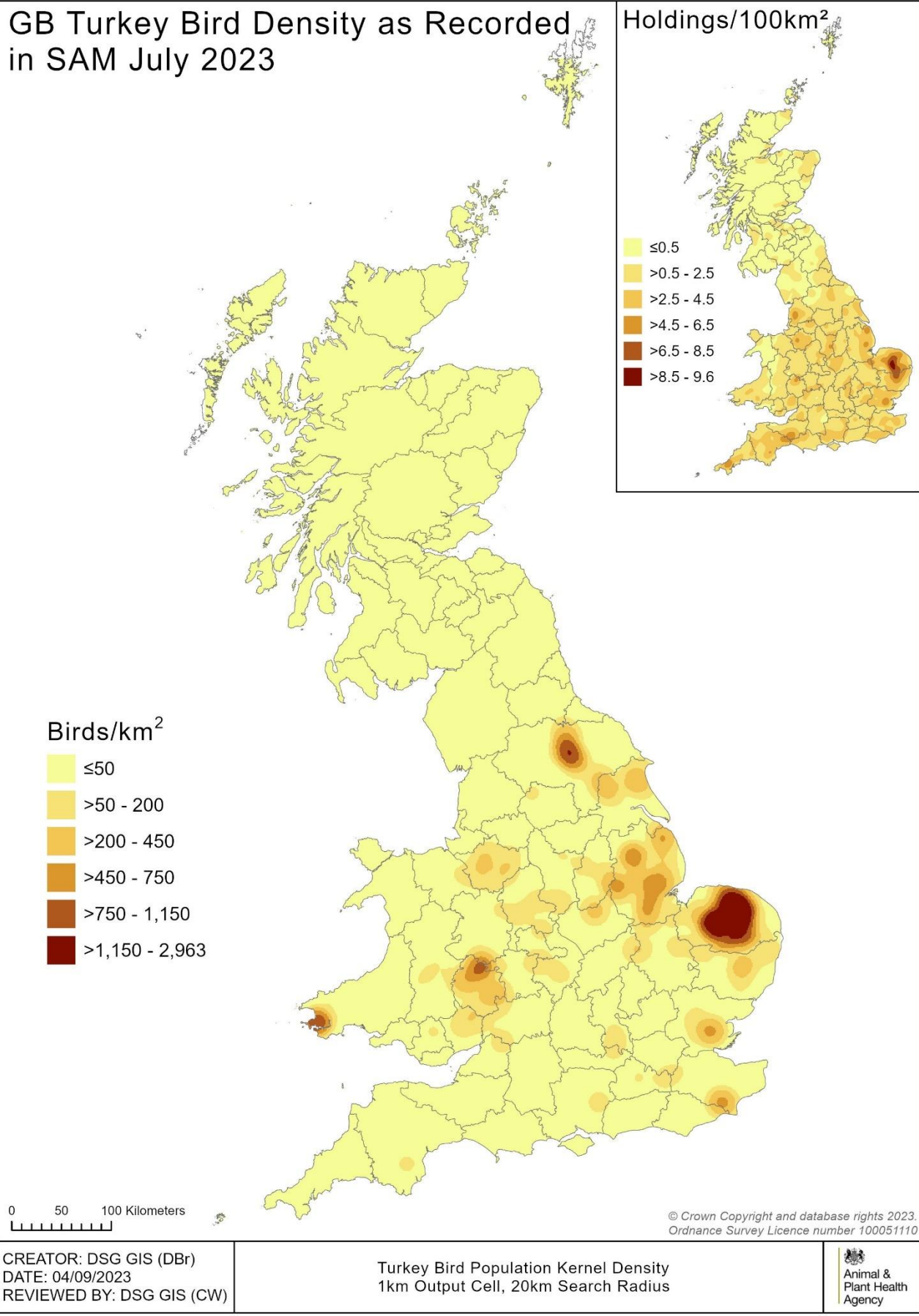
**Figure 7:** Gamebird population density in GB based on July 2023 records.

# GB Gamebird Holding Density as Recorded in SAM July 2023



**Figure 8:** Gamebird holding density in GB based on July 2023 records.

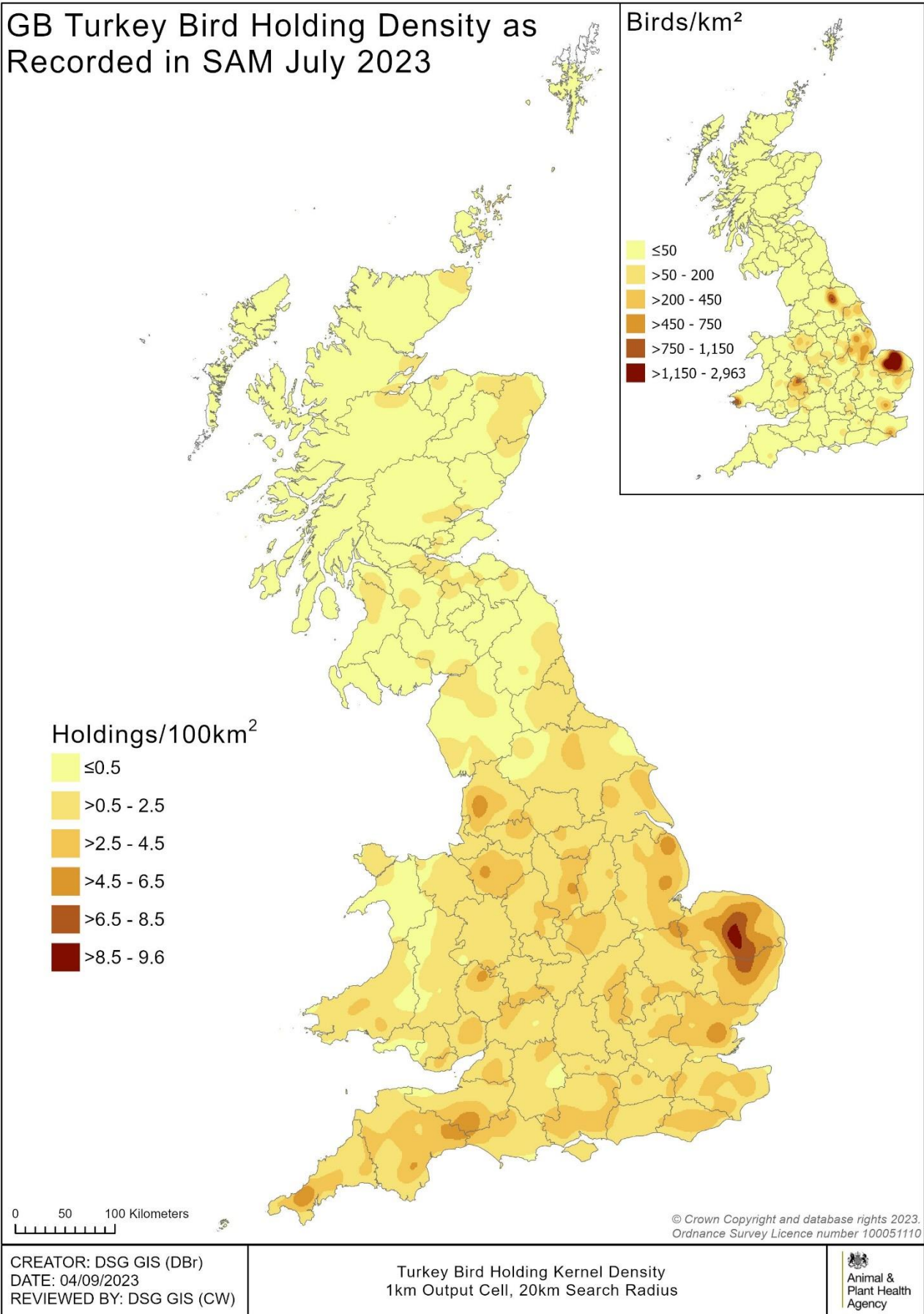
# GB Turkey Bird Density as Recorded in SAM July 2023



**Figure 9:** Turkey population density in GB based on July 2023 records.



# GB Turkey Bird Holding Density as Recorded in SAM July 2023



**Figure 10:** Turkey holding density in GB based on July 2023 records.

# Acknowledgements

The LDDGs are grateful to Defra, Welsh Government, Scottish Government, and APHA Weybridge Data System Group (DSG) staff who handled the Great Britain Poultry Register data (now incorporated within the Sam database) and for their assistance in producing this report.

# References

Charpentier, A., & Gallic, E. (2016). Kernel density estimation based on Ripley's correction. *GeoInformatica*, 20(1), 95–116. <https://doi.org/10.1007/s10707-015-0232-z>

Pfeiffer, D. U., Robinson, T. P., Stevenson, M., Stevens, K. B., Rogers, D. J., & Clements, A. C. A. (2008). *Spatial Analysis in Epidemiology* (1st ed.). Oxford University Press.

# Annex A: Data quality statement for poultry (Dec-23)

## Introduction

This statement provides an overview of the quality of the data used to underpin the kernel density holding and livestock maps. 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

The source data is from APHA's Sam database as in July 2023. The dataset holds information from registration of poultry holdings ≥50 birds. Premises with less than 50 birds are encouraged to register and so a proportion of these premises will be included within the Sam extract.

Category (+definition)	Quality description
<b>Relevance of data</b>  [degree to which data meets user needs in terms of currency, geographical	<b>Spatial coverage:</b> The data cover Great Britain  <b>Temporal coverage:</b> Registrations have been recorded in the GBPR since 2008. The data are an extract from APHA's Sam data source which incorporated the GBPR data after it's decommissioning in April 2013.  <b>Key data items available:</b> The dataset includes information on species, rearing method, industry sector and housing

coverage, content and detail]	type. A metadata document is available with more detailed information from APHA Data Systems Group.
<p><b>Timeliness</b></p> <p>[the degree to which data represent reality from the required time point]</p>	<p><b>How often are data collected?</b> Data were captured continuously from submissions by poultry holding owners that were received by the GBPR team since the start of the register up to its point of decommission and then subsequently by Cardiff Customer Service Centre (CSC) for incorporation into Sam.</p> <p><b>When do data become available?</b> Data are available on request from the Management Information and Data Architecture Services (MIDAS) team in Worcester.</p> <p><b>Were the data updated often?</b> The onus under statute is on keepers to update significant changes, within 30 days. Prior to 2013 keepers could update their own data and GBPR personnel performed data-maintenance. Since its incorporation into Sam, data can no longer be directly updated by the owner and additionally has restricted ongoing data maintenance. Keepers are encouraged to contact Cardiff CSC, to update incorrect or incomplete data. Surveys relying on Sam demographic data such as the EU Avian Influenza Survey provide feedback on data inaccuracies to Cardiff CSC for amendment.</p>
<p><b>Accuracy and precision</b></p> <p>[extent of data error and bias and how well data portrays reality]</p>	<p><b>How were the data collected?</b> Data are entered by the Cardiff CSC from submissions of a registration form which is mandatory for holdings with <math>\geq 50</math> birds. However, examination of the Sam extract shows that about 50% of registrations are for holdings with <math>&lt; 50</math> birds</p> <p><b>Sample &amp; collection size:</b> The dataset lists 64,296 records. Of these, 1,102 have 0 stock recorded and these were removed from the data mapped. 43,733 premises have between 1 and 49 birds (all species).</p> <p><b>What steps have been taken to minimise processing errors?</b> We are unaware of any steps taken to minimise errors in the dataset. Work in other projects indicate that approximately a third of the premises in the GBPR do not contain the poultry types as listed: 35% of the 2023 avian influenza poultry survey which equated to only 21% (219 eligible out of 1046 sent so far) of premises contacted were theoretically eligible for sampling (some were ineligible for practical reasons such as seasonal variation in access to</p>

	<p>birds, unable to contact or game birds already released). However, due to the large number of submissions, it is not possible to take steps to minimise these errors once entered into the database.</p> <p><b>What are the non-reporting or non-response rates?</b> We do not have information on non-reporting or non-response rates for holdings in Sam. It remains a legal requirement for flocks of 50 or more birds to be registered; this requirement has been promoted through industry sectors, and the registration forms (for keepers of both more than 50, and fewer than 50 birds) were updated in January 2019.</p> <p><b>Are any parts of the population unaccounted for in the data collection?</b> Holdings with &lt;50 birds are not required to register with Sam hence this “smallholding” population, is not fully accounted for, and information held almost certainly only represents a snapshot of the smallholding population. For the purposes of this report, all holdings with &lt;50 birds are referred to as “smallholding” premises although the purposes and business objectives of these holdings may vary.</p>
<p><b>Comparability</b></p> <p>[how well these data can be compared with data taken from the same dataset and with similar data from other sources]</p>	<p><b>Within dataset comparability:</b> The format and data analysis methods are similar between years.</p> <p><b>Other dataset comparability: How does the data stored compare to data stored in other data sources?</b> The Agricultural survey only targets holdings of over 1000 birds and last ran a full census in 2010, though little work has been done by the LDDG to compare the GBPR with this dataset.</p>
<p><b>Coherence</b></p> <p>[degree to which data can be or have been merged with other data sources]</p>	<p><b>How consistent are the data over time? If there are differences, what are they and what is their impact?</b> This has not been accurately assessed. More recent extracts indicate the presence of fewer holdings, but it is unknown if this is representative of the population or an artefact due to inaccurate data. This might be clarified if there was a mechanism for owners to update their poultry numbers on a regular basis.</p> <p><b>Have there been changes to the underlying data collection?</b> We are unaware of any changes in data capture methods but do not expect any changes to be significant or impact our use of the data.</p>

	<p><b>Have any real-world events impacted on the data since the previous release? How have these impacts on the data been managed?</b> The introduction of Sam has led to a switch in April 2013 to record data in Sam instead of GBPR. The requirement of holdings to register if they hold ≥50 birds has continued with Sam. It would be appropriate to mention the largest and longest ongoing HPAI outbreak seasons since the 26<sup>th</sup> of October 2021. HPAI outbreak season for 2021/22 closed with a total of 152 confirmed infected premises, followed uninterrupted by the 2022/23 season which closed on the 30<sup>th</sup> of September 2023 with a total of 207 confirmed infected premises (160 England, 39 Scotland and 8 Wales). Although the report recognises their significant importance it is unlikely that the impact can be quantified on the population data.</p> <p><b>What other data sources in society report similar information? How do these data sources compare?</b> Aside from Sam and the Agricultural survey, the Egg Marketing Inspectorate (EMI) database may hold comparable information relating to laying flocks.</p>
<p><b>Interpretability</b></p> <p>[how well the data is understood and utilised appropriately]</p>	<p><b>Is there a particular context that this data needs to be considered within?</b> See comments above.</p> <p><b>What other information is available to help users better understand this data source?</b> Further information on data held in GBPR can be obtained from Cardiff CSC who now hold the GBPR data. The MIDAS Team in Worcester can be contacted to obtain an extract of this data.</p> <p><b>Are there any ambiguous or technical terms that may need further explanation?</b> The UK poultry population is comprised of different poultry species and production types, as follows:</p> <ul style="list-style-type: none"> <li>• Chickens - breeder, layer and broiler flocks.</li> <li>• Turkeys - fattener (meat-type) and breeder flocks.</li> <li>• Ducks - breeder, meat and layer flocks.</li> <li>• Geese - breeder, meat and layer flocks.</li> <li>• Feathered game classified as poultry - breeders and rearer flocks of pheasants, partridges and ducks reared for shooting.</li> <li>• Other minor poultry species including, guinea fowl, quail, pigeons reared for meat, ostriches, emus, rheas.</li> </ul>

	Wild birds and birds in zoo collections are not included within the scope of this document; feathered gamebirds are considered 'wild' once released.
<p><b>Accessibility</b></p> <p>[availability of relevant information and access to the data in a convenient and suitable manner]</p>	<p><b>What data are shared and with whom?</b> Data must be aggregated to at least a county level before publishing so individual farms cannot be identified (e.g. by CPH or postcode). Also estimates based on less than five holdings should not be used as this would breach confidentiality. A confidentiality agreement is required for data that is not publicly available. Some data can be obtained from APHA Cardiff CSC. APHA Weybridge Data Systems Group has a copy of the final extract.</p> <p><b>Contact details for data source queries:</b>  <a href="mailto:customerregistration@apha.gov.uk">customerregistration@apha.gov.uk</a>  Animal and Plant Health Agency (APHA)  Cardiff Specialist Service Centre  Poultry Data Team  Government Buildings  Cardiff Edge Business Park  Longwood Drive  Cardiff  CF14 7YT</p> <p>Agricultural Survey England: <a href="mailto:Farming-statistics@defra.gov.uk">Farming-statistics@defra.gov.uk</a>  Agricultural Survey Wales: <a href="mailto:Stats.agric@wales.gov.uk">Stats.agric@wales.gov.uk</a>  Agricultural Survey Scotland: <a href="mailto:agric.stats@scotland.gov.uk">agric.stats@scotland.gov.uk</a></p>

## Annex B: Number of poultry holdings and number of poultry per county

County totals for all poultry holdings and number of birds, based on July 2023 records. Data for counties with 6 or less holdings have been excluded from this table for data protection reasons.

Country	County	Holdings	Usual Stock Numbers
ENGLAND	AVON	665	1,096,110
	BEDFORDSHIRE	403	1,358,938
	BERKSHIRE	485	755,170
	BUCKINGHAMSHIRE	536	3,053,201

CAMBRIDGESHIRE	1,123	5,640,593
CHESHIRE	1,281	4,463,910
CLEVELAND	366	747,573
CORNWALL	2,071	1,567,845
CUMBRIA	934	6,168,209
DERBYSHIRE	1,613	4,889,441
DEVONSHIRE	3,468	12,239,930
DORSET	1,158	1,972,168
DURHAM	643	2,350,311
EAST SUSSEX	854	1,755,557
ESSEX	1,930	6,324,351
GLOUCESTERSHIRE	1,324	6,002,022
GREATER LONDON	394	31,989
GREATER MANCHESTER	529	753,439
HAMPSHIRE	1,755	5,282,694
HEREFORDSHIRE	1,058	35,062,603
HERTFORDSHIRE	457	1,135,806
HUMBERSIDE	1,558	18,251,383
ISLE OF WIGHT	185	128,331
ISLES OF SCILLY	22	2,417
KENT	1,107	3,098,675
LANCASHIRE	1,994	6,207,032
LEICESTERSHIRE	1,105	4,526,957
LINCOLNSHIRE	2,123	38,706,809
MERSEYSIDE	204	581,887
NORFOLK	3,410	35,496,846
NORTH YORKSHIRE	2,108	17,959,467
NORTHAMPTONSHIRE	695	4,360,931
NORTHUMBERLAND	480	1,205,259
NOTTINGHAMSHIRE	1,004	9,181,178
OXFORDSHIRE	818	3,236,214
SHROPSHIRE	1,197	28,311,959
SOMERSET	1,507	7,793,315
SOUTH YORKSHIRE	502	517,544
STAFFORDSHIRE	1,234	4,537,250
SUFFOLK	2,719	23,717,902
SURREY	629	358,121
TYNE & WEAR	719	56,858
WARWICKSHIRE	646	3,400,552
WEST MIDLANDS	328	113,410
WEST SUSSEX	856	1,891,680
WEST YORKSHIRE	801	1,967,582
WILTSHIRE	1,207	5,728,913
WORCESTERSHIRE	933	4,151,625

SCOTLAND	ABERDEENSHIRE	471	2,865,916
	ANGUS	210	2,386,481
	ARGYLL	83	66,645
	AYRSHIRE	273	1,288,719
	BANFFSHIRE	143	644,153
	BERWICKSHIRE	124	2,786,742
	BUTE	12	3,528
	CAITHNESS	62	38,039
	CLACKMANNANSHIRE	57	842,002
	DUMBARTONSHIRE	15	1,770
	DUMFRIESSHIRE	314	2,377,334
	EAST LOTHIAN	77	517,749
	FIFE	333	2,184,246
	INVERNESS-SHIRE	172	391,584
	KINCARDINESHIRE	70	875,620
	KINROSS	24	1,100,641
	KIRKCUDBRIGHT	101	759,855
	LANARKSHIRE	146	391,298
	MIDLOTHIAN & EDINBURGH	113	2,629,122
	MORAY	117	324,531
	NAIRN	21	89,568
	ORKNEY	151	7,414
	PEEBLES	55	3,283,352
	PERTH	257	3,411,804
	RENFREW	49	6,708
	ROSS & CROMARTY	197	175,732
	ROXBURGH	67	429,169
	SELKIRK	22	297,524
	SHETLAND	55	2,049
	STIRLING	76	30,663
SUTHERLAND	45	18,503	
WEST LOTHIAN	58	1,485,245	
WIGTOWN	62	766,796	
WALES	CLWYD	532	2,696,771
	DYFED	1,000	3,164,718
	GWENT	407	3,600,121
	GWYNEDD	598	2,560,484
	MID GLAMORGAN	248	114,008
	POWYS	866	12,419,428
	SOUTH GLAMORGAN	111	55,467
	WEST GLAMORGAN	153	474,574



## Annex C: Investigation of the impact of Highly Pathogenic Avian Influenza outbreaks on poultry registration.

In the administrative year from October 2022 - September 2023, there were 206 incidents of Highly Pathogenic Avian Influenza (HPAI) in Great Britain. As part of the preventative measures for disease control as set out in [The Avian Influenza and Influenza of Avian Origin in Mammals \(England\) \(No.2\) Order 2006](#), the competent authority “*must ensure that premises containing poultry and other captive birds within a protection zone are identified as soon as possible.*”. This requirement is fulfilled using foot patrols of the 3km Protection Zone around each infected premise by trained investigative staff. Any premises identified during the foot patrol that are not currently registered in the GBPR are then registered regardless of the number of birds on the premises.

The hypothesis of this investigation was that the forced registration of smallholdings (<50 birds on premises) due to local incidents of HPAI was increasing the number of holdings registered in GBPR with little effect on the number of birds as estimated by this publication. The methodology used to examine this impact involved using spatial units derived within ESRI ArcGIS Pro v2.2 to look at coverage of PZ's in the east of England. The counties used to test the hypothesis were Norfolk, Suffolk, Lincolnshire and Cambridgeshire, as these adjacent counties were particularly affected by HPAI in the autumn of 2022. These spatial units were then used to identify newly registered holdings (July 2022-March 2023) and how they corresponded to PZ coverage.

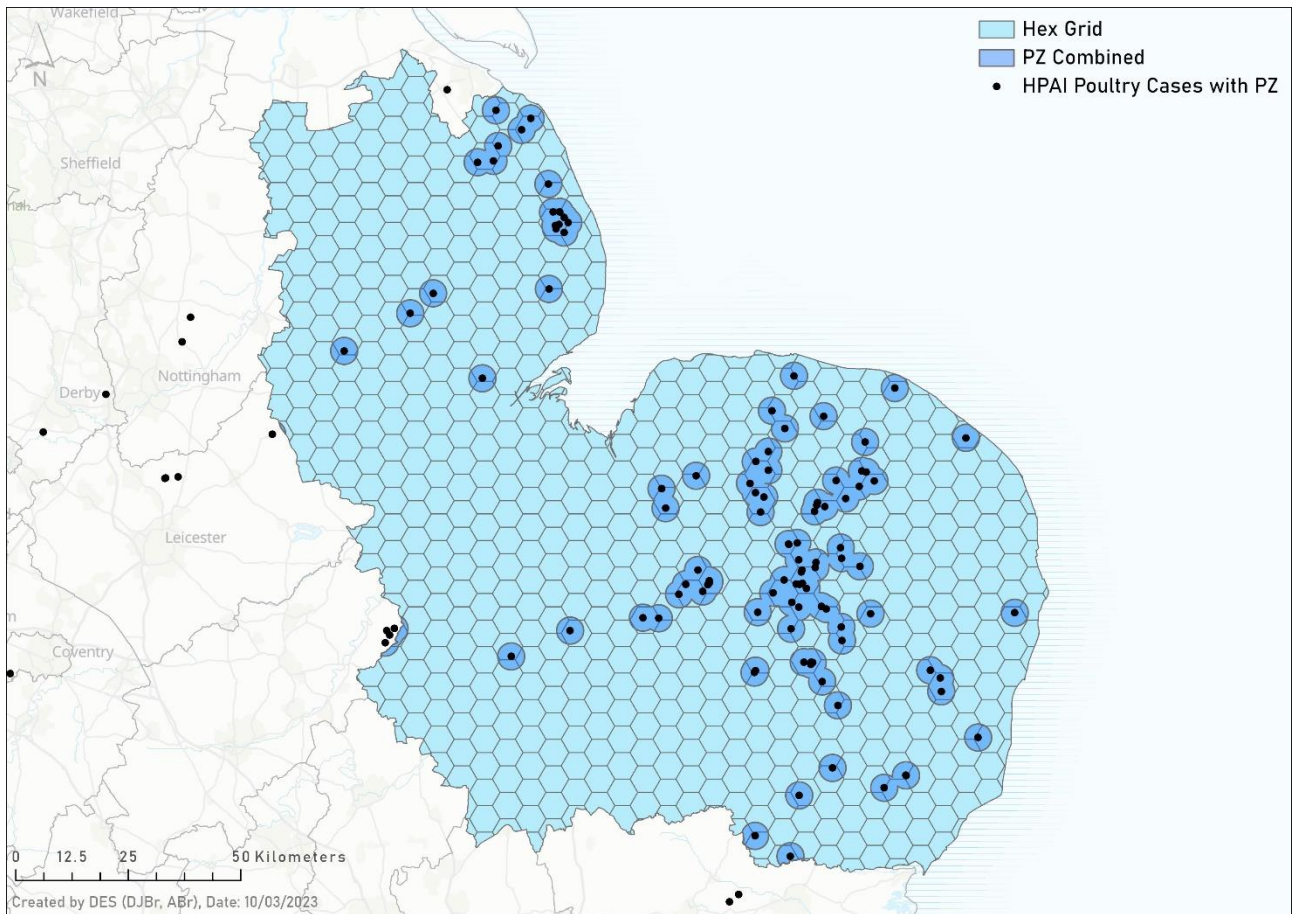


Fig C1: PZ coverage in Norfolk, Suffolk, Lincolnshire and Cambridgeshire from HPAI cases in Autumn 2022.

Figure C1 above shows the poultry outbreaks of HPAI that generated a Protection Zone in Autumn 2022. These are generated over a hex grid spatial unit. In total 11.96% of the counties of Norfolk, Suffolk, Lincolnshire and Cambridgeshire was covered by a protection zone in this period.

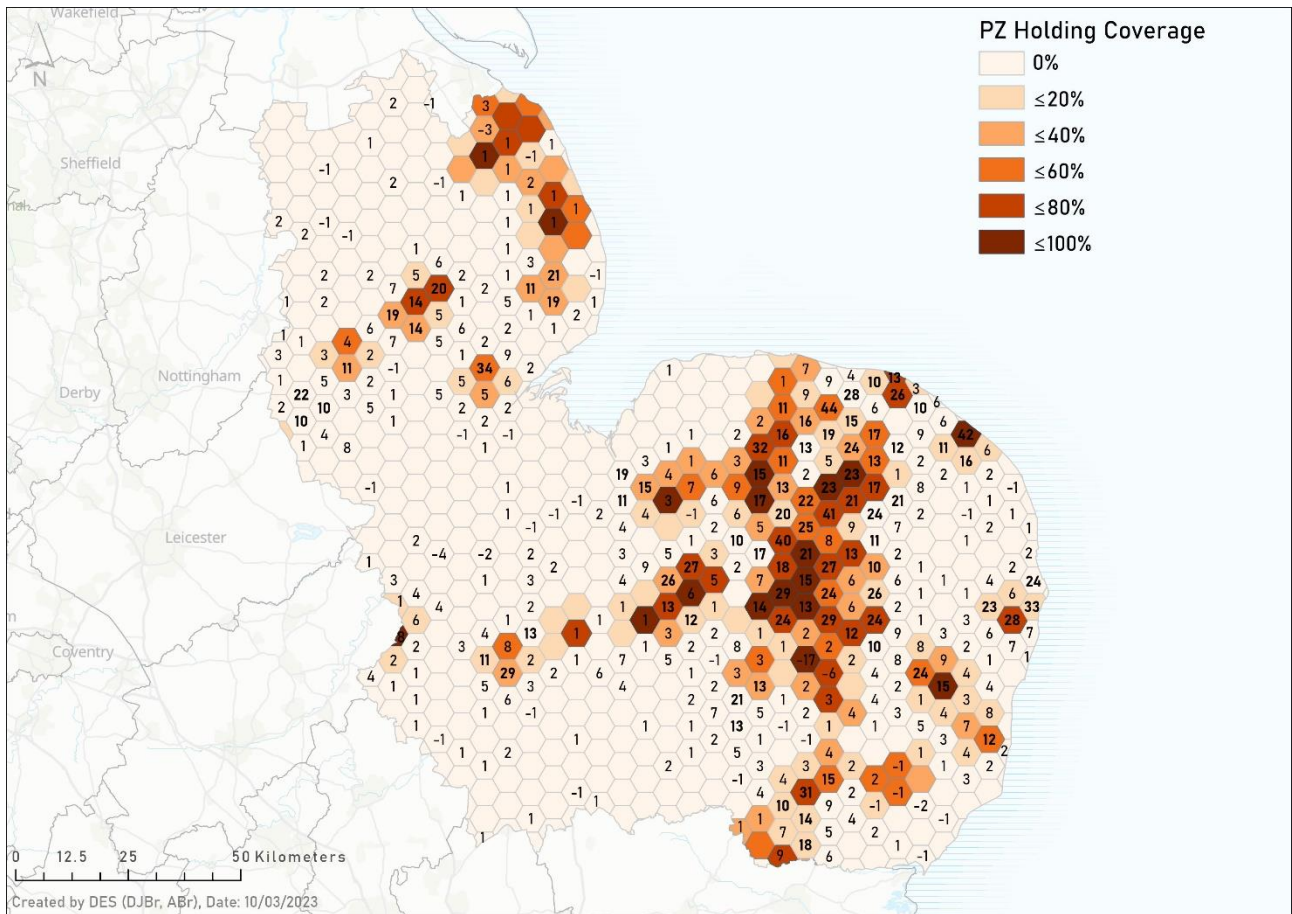


Fig C2: Change in registered poultry holdings between July 2022 and March 2023 in the east of England.

Within Figure C2 the hex grids are coloured depending on the percentage of PZ in each unit, with the grid coloured darker the higher the proportion of the grid is covered by PZ. The numbers in each hex grid unit show the change in poultry holdings from July 2022 to March 2023.

Figure C2 shows that the hex grid units covered by Protection Zones in 2022 have had increased poultry registrations between July 2022 and March 2023. Most of these newly registered holdings were small holdings of <50 birds. Figure C3 below shows the same data as Figure C2 but only for holdings that were registered with more than 50 birds.

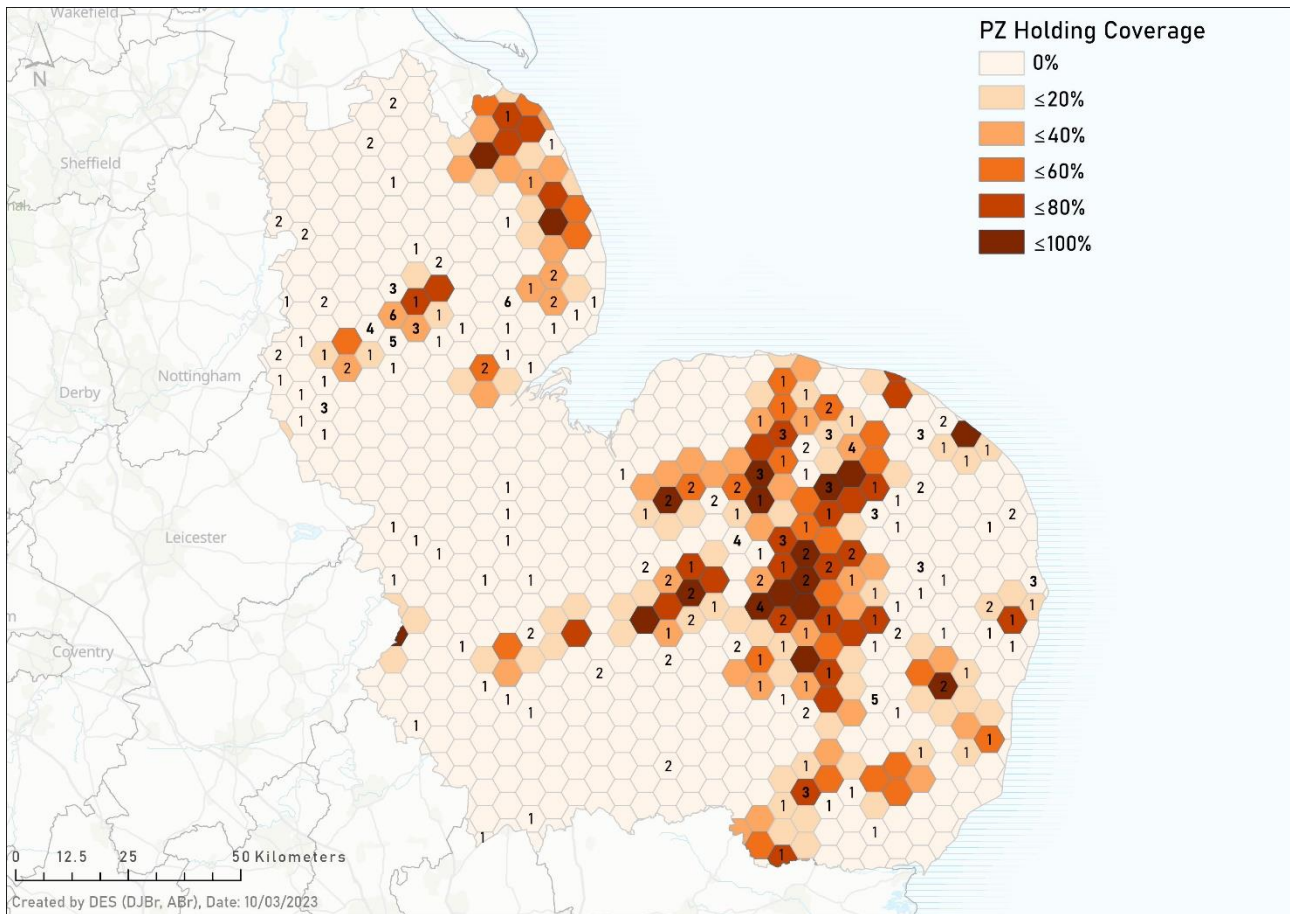


Fig C3: Change in registered poultry holdings (registered with over 50 birds) between July 2022 and March 2023 in the east of England.

Within the counties examined (Norfolk, Suffolk, Cambridgeshire and Lincolnshire), registered flocks of over 50 birds made up 35% of the total holdings in July 2022. In March 2023, after emergency registration of newly discovered holdings after an unprecedented HPAI epizootic event, only 9% of poultry registrations were made up of holdings with over 50 birds.

In conclusion, HPAI outbreaks will cause increased registration, particularly of smallholdings with less than 50 birds. This will skew the density holding maps (Fig 2) as areas with HPAI outbreaks will have a higher volume of registered small holdings compared to unaffected areas. In addition, this work shows that larger holdings are more accurately represented in GBPR than small holdings.