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Spatial patterns of avian influenza in Danish wild birds - challenges using passive surveillance data

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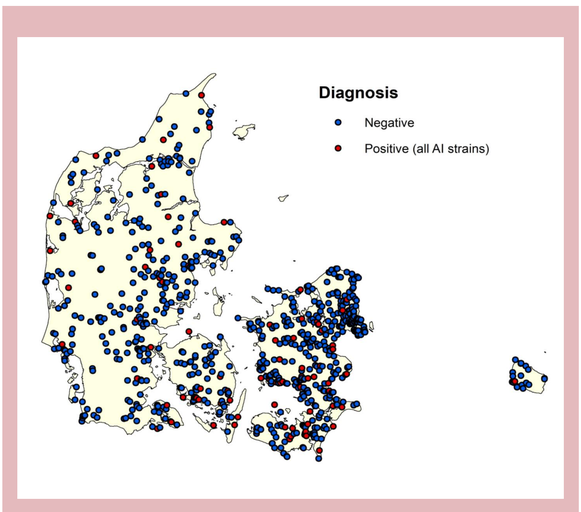
Introduction

Avian influenza (AI) is a contagious disease of birds with zoonotic potential. AI is caused by Influenza A virus, and can be divided into low pathogenic and high pathogenic subtypes. All species of birds can be affected by AI, but differ in their symptoms and mortality. Poultry is particularly sensitive to AI, and outbreaks in poultry farms can cause great economic losses. Assessing the distribution and incidence of AI may aid in targeting areas at risk for disease outbreaks or help pinpoint disease hot spots or cold spots in need of further surveillance. Passive surveillance data on dead wildlife species submitted by the public can be a great source of information but may be challenging as these kind of data are often biased by varying detection probabilities as well as human accessibility to wildlife areas.

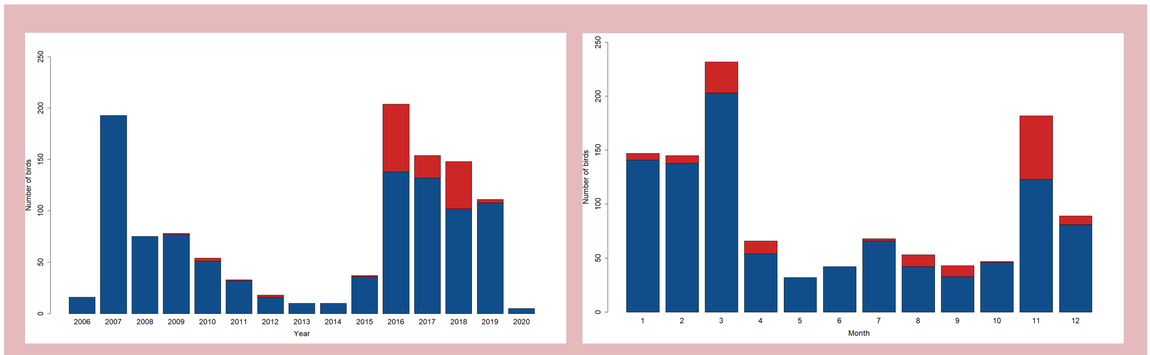
In this preliminary study, we investigate potential submission bias in Danish passive AI surveillance data from 2006-2020 and look at spatial clusters of virus positive and virus negative samples from the submitted wild birds in the data.

Materials and methods

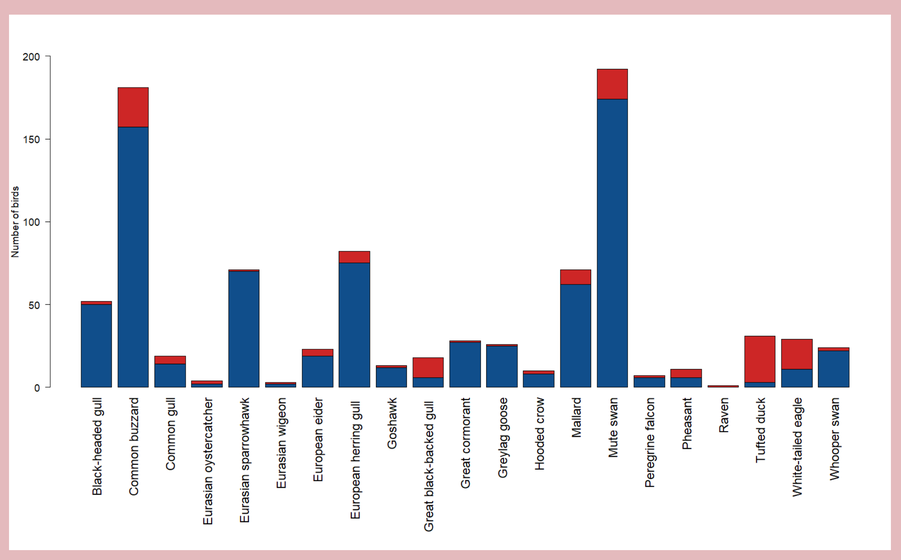
- We obtained passive AI surveillance data through the Danish Veterinary and Food Administration.
- To asses potential submission bias, we extracted data for each location on human population density, distance to nearest city (≥200 inhabitants/km^2), distance to coast line (beaches are all public in Denmark), and distance to the nearest road.
- We generated 882 random points within Denmark, and extracted the same parameters as above for these random locations. We used a Kolmogorov-Smirnov test to test for differences between our records and the random locations.
- We used SatScan to identify hot spots and cold spots of AI within Denmark, assuming that number of submissions were independent of outbreak locations and years.



Locations of public submissions of dead wild birds in Denmark, 2006-2020. The dataset contained a total of 882 reporting sites from 2006-2020, with 90 sites having at least one bird testing positive for AI virus. Blue colours depict sites, where birds tested negative for AI virus, whereas red colours depict sites, where AI virus was confirmed in at least one bird by diagnostics (all AI strains).



Yearly and monthly numbers of wild birds reported and tested for AI virus through passive surveillance, Denmark 2006-2020. Blue bars depict the number of birds testing negative for AI virus, whereas red bars depict number of birds, where AI virus (all strains) was confirmed.

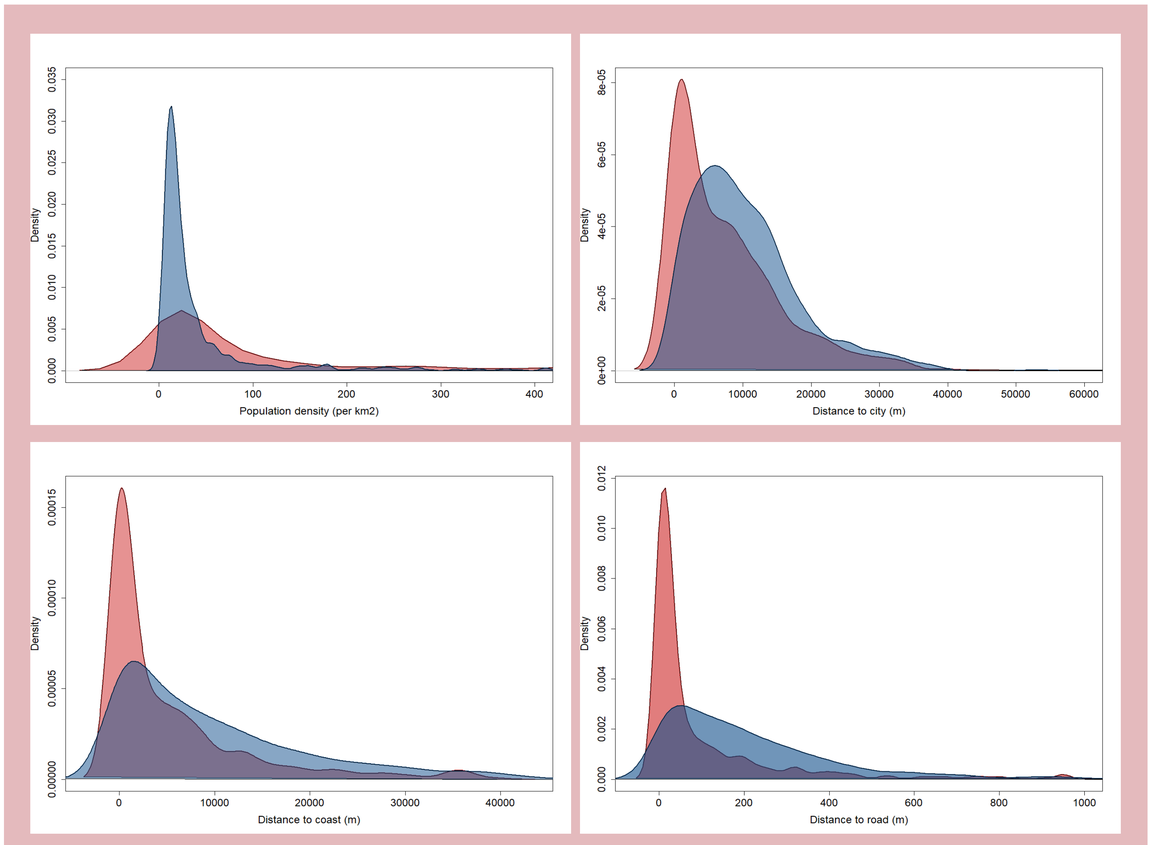


Wild bird species reported and tested for AI virus through passive surveillance, Denmark 2006-2020. Blue bars depict the number of birds testing negative for AI virus, whereas red bars depict number of birds, where AI virus (all strains) was confirmed. Only species having at least one bird testing positive for AI virus are depicted.

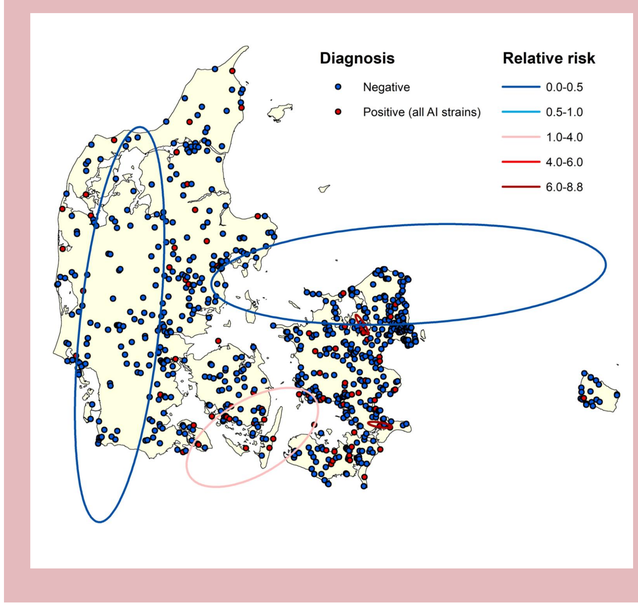
Results

The passive AI surveillance data significantly differed from random locations within Denmark for all parameters investigated (all P < 0.001). Reported birds were generally found in areas with low population densities, but closer to cities and closer to roads. A majority of the records were additionally found closer to the coast.

The SatScan spatial analysis showed potential small hotspots on the island of Zealand and the Island of Møn. A potential hotspot was also found encompassing the islands of Langeland, Ærø and the south of Funen. Cold spots were found along the middle of Jutland, mid-eastern Jutland and North Zealand.



Density plots of locations recorded through passive AI surveillance in Denmark, 2006-2020 (red) and random locations in Denmark (blue) in relation to population density, distance to nearest city (≥200 inhabitants/km^2), distance to coast and distance to nearest road. All x-axes have been truncated to omit low density observations.



Clusters of hots spots (red) and cold spots (blue) based on passive AI surveillance data in Denmark, 2006-2020. Relative risk is calculated by SatScan as the estimated risk within a cluster divided by the estimated risk outside the cluster.

Conclusions

Our results suggest that accessibility to wildlife areas may bias Danish passive surveillance data. The majority of recorded locations were within 20 km of a larger city and within 500 m of roads. Public access to Danish beaches may also explain numerous records close to the coast.

Hotspots of AI findings should be interpreted with caution as the assumption of independent observations may be compromised by yearly submissions potentially being affected by AI outbreaks.

These results show that submission bias may be prevalent and should be taken into account when analysing passive surveillance data.

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