Characterization of a Swine Interstate Movement Network in Ohio for Disease Spread Modeling

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ABSTRACT:

Certificate of Veterinary Inspection (CVI) records, the official documents that prove the listed animals have been inspected and meet all federal requirements, are widely used in modeling animal movement between states. Commuter Herd Agreements (CHA), which document inter-state animal movements within the same ownership instead of using a CVI, have been mostly neglected in previous analyses. The goal of this study is to map the directionality and frequency of swine movements in and out of Ohio and identify regions with intense movement events using network analysis. The cloud-based Google Geocoding service in R program was first unitized to transform the origin and destination addresses into geographic coordinates. In addition, locations that could not be geocoded went through a zipcode-to-county matching process, which identifies their county by zipcode. By grouping the movements based on their origin and destination counties, we were able to capture swine movement at the county level. Five choropleth flow maps were created using county-level movement data, including total aggregate movements, the import and export from CVI, and the import and export under CHA. These maps were created in R using the Leaflet package (v. 2.2.1) and published as interactive web maps using the Shiny package (v. 1.8.0). Additionally, the R package igraph (v. 1.6.0) was used for degree centrality computation. Compared to imports, Ohio swine exports have a much larger geographic distribution, with the most frequent movements occurring between Ohio and Indiana, Illinois, and Michigan. While significant animal imports are noted from Indiana, Oklahoma, and Illinois. From May to October, CHA, constituting 6.3 percent of total records, accounts for 15.5 percent of the total number of animals transported, while CVI, making up 93.7 percent of the records, represents 84.5 percent of the moved population. The median animal count for CHA records is 1,250, compared to 91 for CVI records. Considering both import and export movements, the highest in-degree (n = 49) was observed in Jefferson, KY, indicating the greatest number of inbound animal movements. Similarly, Fulton, OH obtained the highest out-degree (n = 72), i.e., the highest number of movements that the county directed to others. The results show frequent swine movements to/from Ohio were attributed to neighboring states, which could behave as disease transmission hotspots during outbreaks. In addition, a share of swine movements with substantial animal counts was not recorded by CVIs and may be neglected for traditional animal movement tracing approaches. This information should be incorporated to fill gaps in future animal movement mapping and disease transmission modeling.

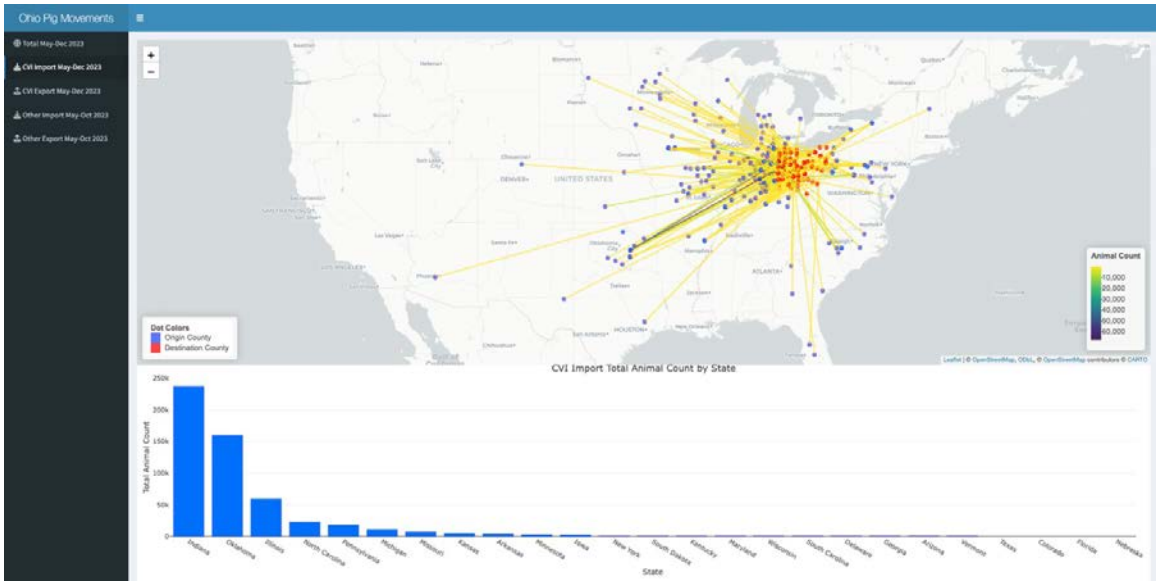

Figure 1. Snapshot of Ohio Swine Movement web map user's interface. Full map can be accessed in the conference. Users can click on a county's dot to access information about that county, click on a line to view the number of animals being moved, and consult the chart at the bottom to see the number of animals being moved, group by state.

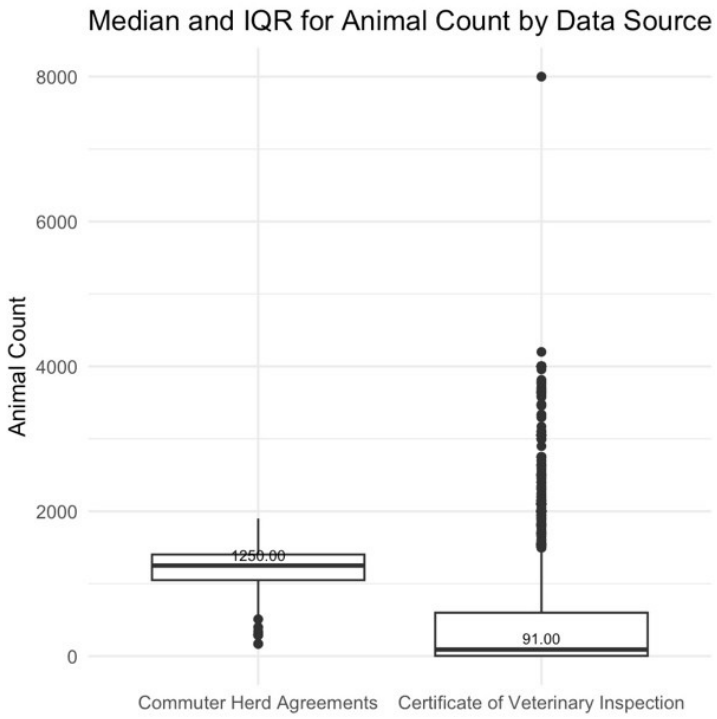

Figure 2. Median and IQR for Animal Count by Data Source.

KEYWORDS: *disease modeling, animal movement network, network analysis*

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