

Hunting for Tularemia: Exploring hunting and median household income as risk factors for *Francisella tularensis* infection in the United States

Introduction

Tularemia is a zoonotic disease caused by infection with *Francisella tularensis* bacterium and is endemic in North America. Every year, the United States experiences between 90 and 300 incident cases¹. The vast majority of those cases occur in the south-central U.S. There are several different types of tularemia, depending on the location the bacteria enter the body. Symptoms are widely variable, ranging from swollen and painful lymph glands, eye pain, vomiting and diarrhea, to difficulty breathing or splenomegaly². Likewise, treatment for this disease can range from simple outpatient care to inpatient hospital treatment for severe cases².

Ticks are a known vector of tularemia. The disease commonly affects rabbits and other mammals, which can also serve as vectors for tularemia infection in humans. A number of studies conducted during or after small outbreaks have concluded that outdoor recreation, including hunting and other activities, and exposure to ticks are risk factors of tularemia^{3,4,5}. However, no analyses have evaluated these trends across the U.S. Further, no studies have examined median household income or socioeconomic status as a potential risk factor for tularemia infection.

The objectives of this study are to examine the potential risk factors for tularemia in the United States by mapping 1) cumulative incidence of tularemia by state, 2) cumulative incidence of tularemia against per capita hunting licenses, and 3) socioeconomic status, as represented by median income.

Methods

For these analyses, I used data from U.S. Centers for Disease Control and Prevention, U.S. Fish and Wildlife Services, and U.S. Census Bureau. Cumulative incidence rates were calculated from number of cases of tularemia per state for years 2008-2018 and total population of each state for years 2008-2018. Hunting licenses per capita was calculated by averaging the number of hunting licenses sold to state residents and dividing that number by average population per state for years 2008-2018. Lastly, 2017 median household income data were obtained from a U.S. Census Bureau survey. Median household income for years 2008-2016 and 2018 were not located. As 2017 falls in the time period for which cumulative incidence rates were calculated, data from this year were used in this analysis. These calculations were conducted in a *Microsoft Excel 16.30* spreadsheet.

Data were imported to *ArcGIS 10.3* mapping software from the MS Excel spreadsheet. The MS Excel table was joined to an *ESRI* map of the U.S. by state name. New table fields were created to divide raw data into three classes. Classes were chosen such that a roughly equal number of states were placed in each. A univariate choropleth map of cumulative incidence rate per state was created (Figure 1). Further, two bivariate choropleth map were created. The first shows rate of hunting licenses sold and cumulative incidence of tularemia (Figure 2). The second maps median household income and cumulative incidence rate of tularemia (Figure 3).

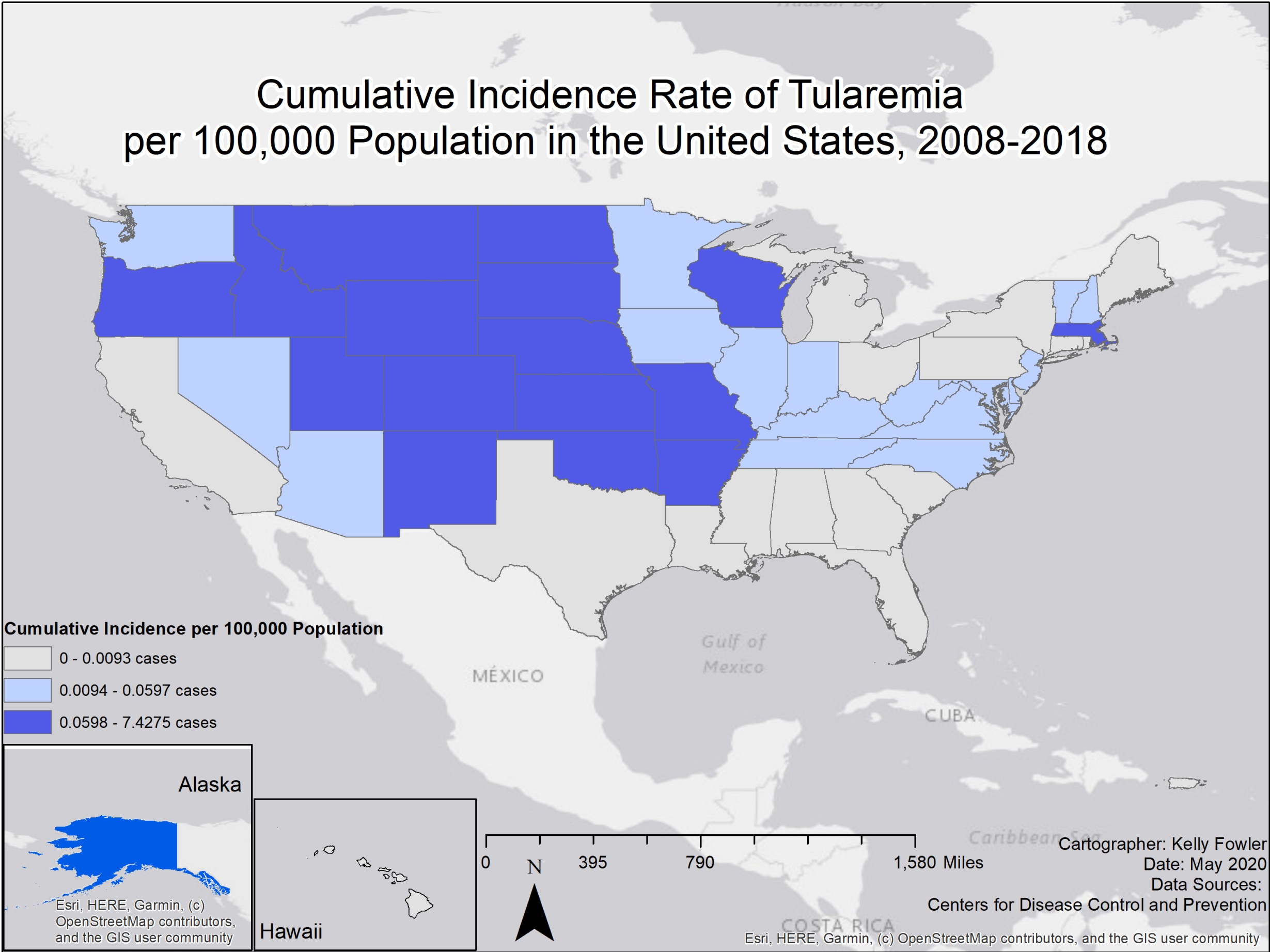


Figure 1. Univariate choropleth map of cumulative incident rate of tularemia per 100,000 population for each state in the U.S. (2008-2018)

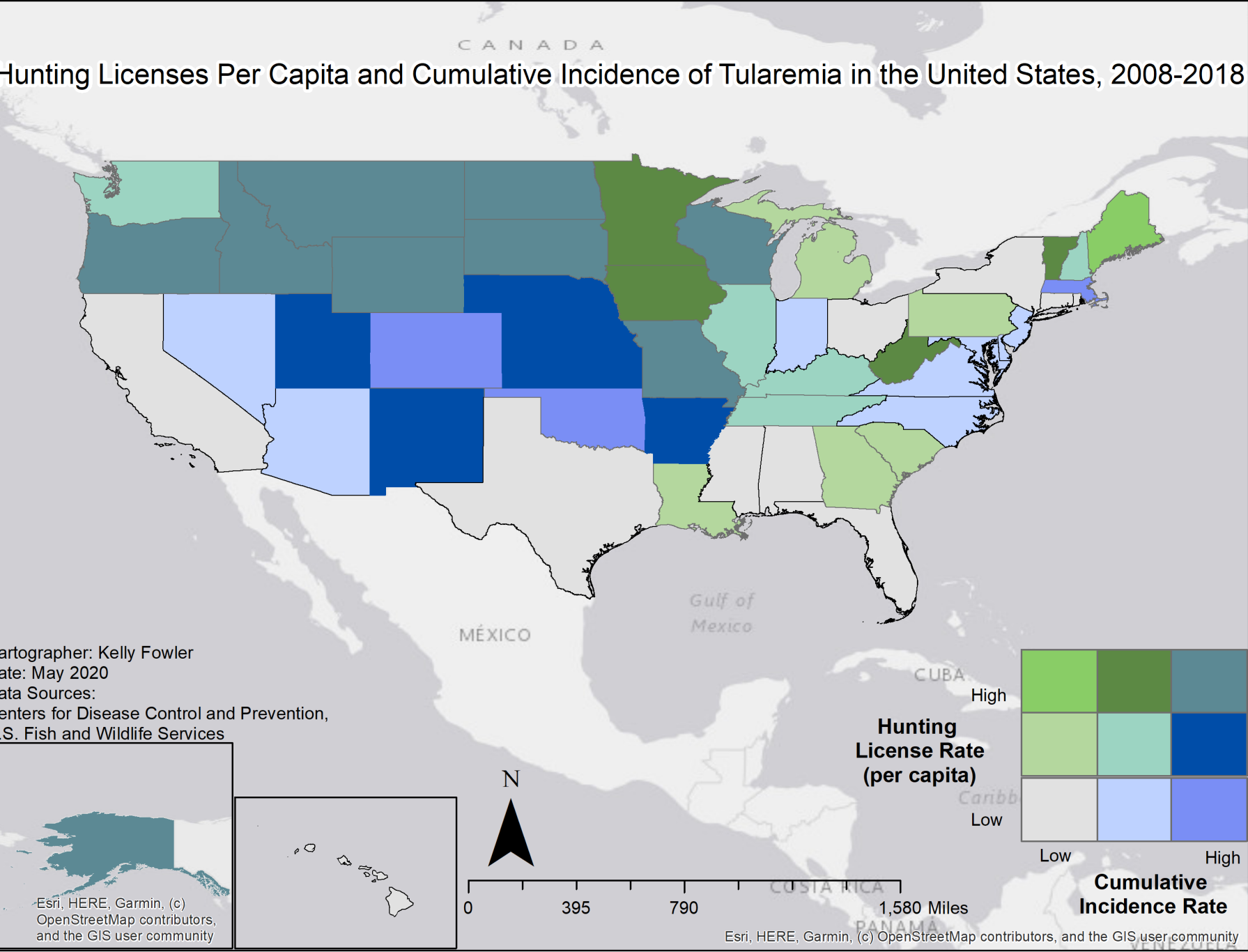


Figure 2. Bivariate choropleth map of hunting licenses per capita and cumulative incidence rate of tularemia (2008-2010) in the U.S.

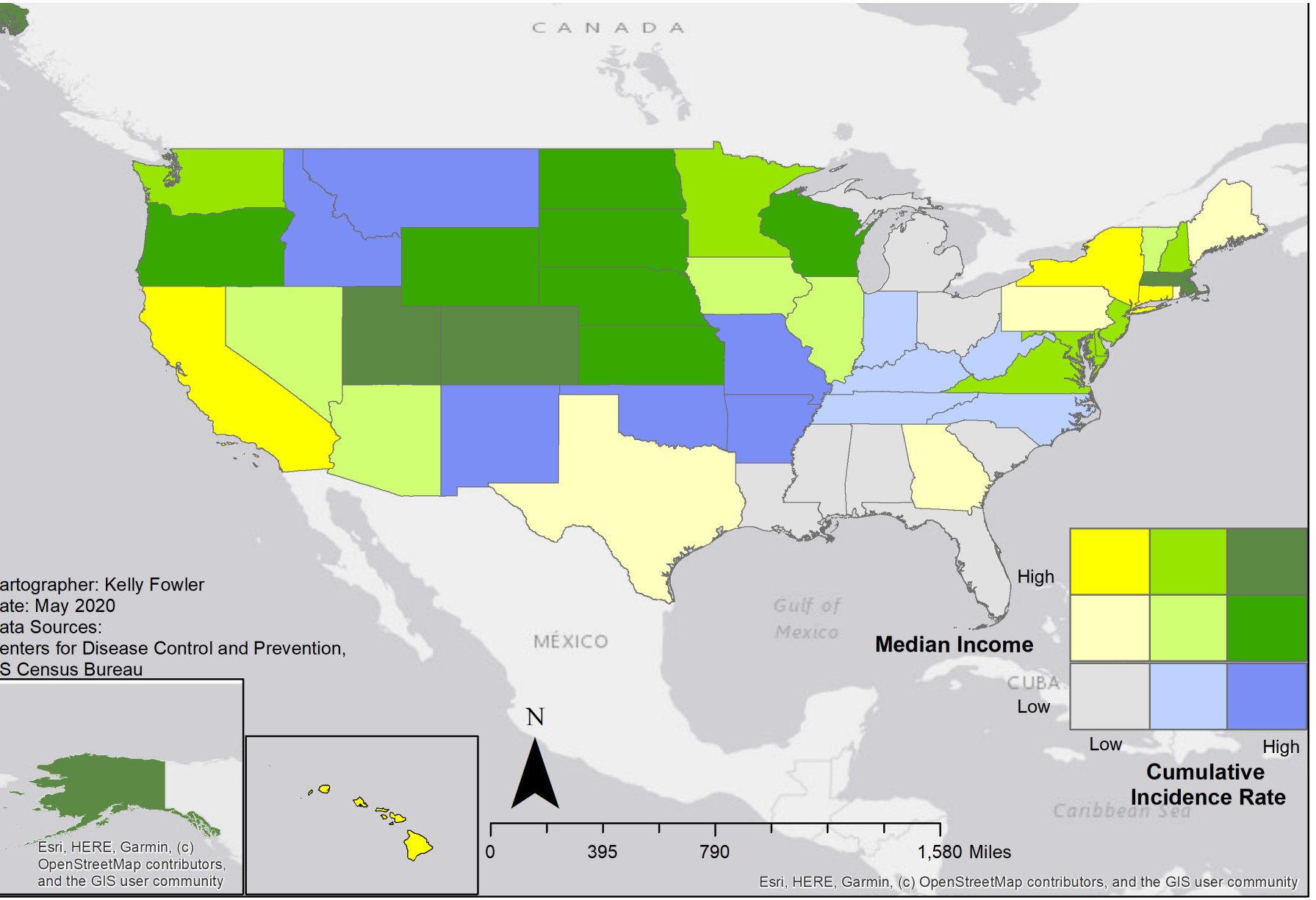


Figure 3. Bivariate choropleth map of median household income (2017) and cumulative incidence rate of tularemia (2008-2018) in the U.S.

Results

The univariate map of cumulative incidence rates for each state suggests that the highest burden of tularemia falls on states in the central U.S, in addition to Oregon, Wisconsin, Alaska, and Massachusetts (Figure 1). Figure 2 shows an association between hunting licenses sold per capita and cumulative incidence of tularemia. This map suggests that states with relatively high cumulative incidence often also have high or medium rates of hunting licenses sold, compared to other states in the U.S. Of the 17 states with high cumulative incidence rates of tularemia (0.0598-7.4275 cases per 100,000 population), 15 states have high or medium rates of hunting licenses sold (10=high; 5=medium). The second bivariate choropleth map shows median household income and cumulative incidence rate of tularemia (Figure 3). It suggests that states with low or medium household income often experience the highest cumulative incidence rates of tularemia. 13 of the 17 states with the highest cumulative incidence rates of tularemia have low or medium household income (6=low; 7=medium).

Discussion

This study sought to map and compare cumulative incidence rates of tularemia in the U.S. and to explore potential associations between 1) hunting and cumulative incidence, and 2) median household income and cumulative incidence. The findings of this study suggest that hunting and median household income may be risk factors for tularemia infection. Further, the univariate map of cumulative incidence supports current knowledge of case numbers by state in the U.S.⁶ Strengths of this study include the use of cumulative incidence, rather than incidence for a single year, which varies widely. Moreover, the data used for this study were of good quality, as they were obtained from trusted governmental organizations. There were, however, limitations to this study. First, median household income for only the year 2017 was used. Secondly, these associations were assessed using state-level data. Nuances in these trends may be better explored using disaggregated data. Future studies should seek to assess these associations using county-level data. Additionally, public health officials may use these results to encourage hunters to perform regular self-tick checks and to wear protective gear when handling dead animals.

Citations

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Data Sources: Centers for Disease Control and Prevention; U.S. Census Bureau; U.S. Fish and Wildlife Services
Geographic Coordinate System: GCS_WGS_1984
Datum: D_WGS_1984
Prime Meridian: Greenwich

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