

Risk of Aerial Importation and Outbreak of Disease X

Introduction:

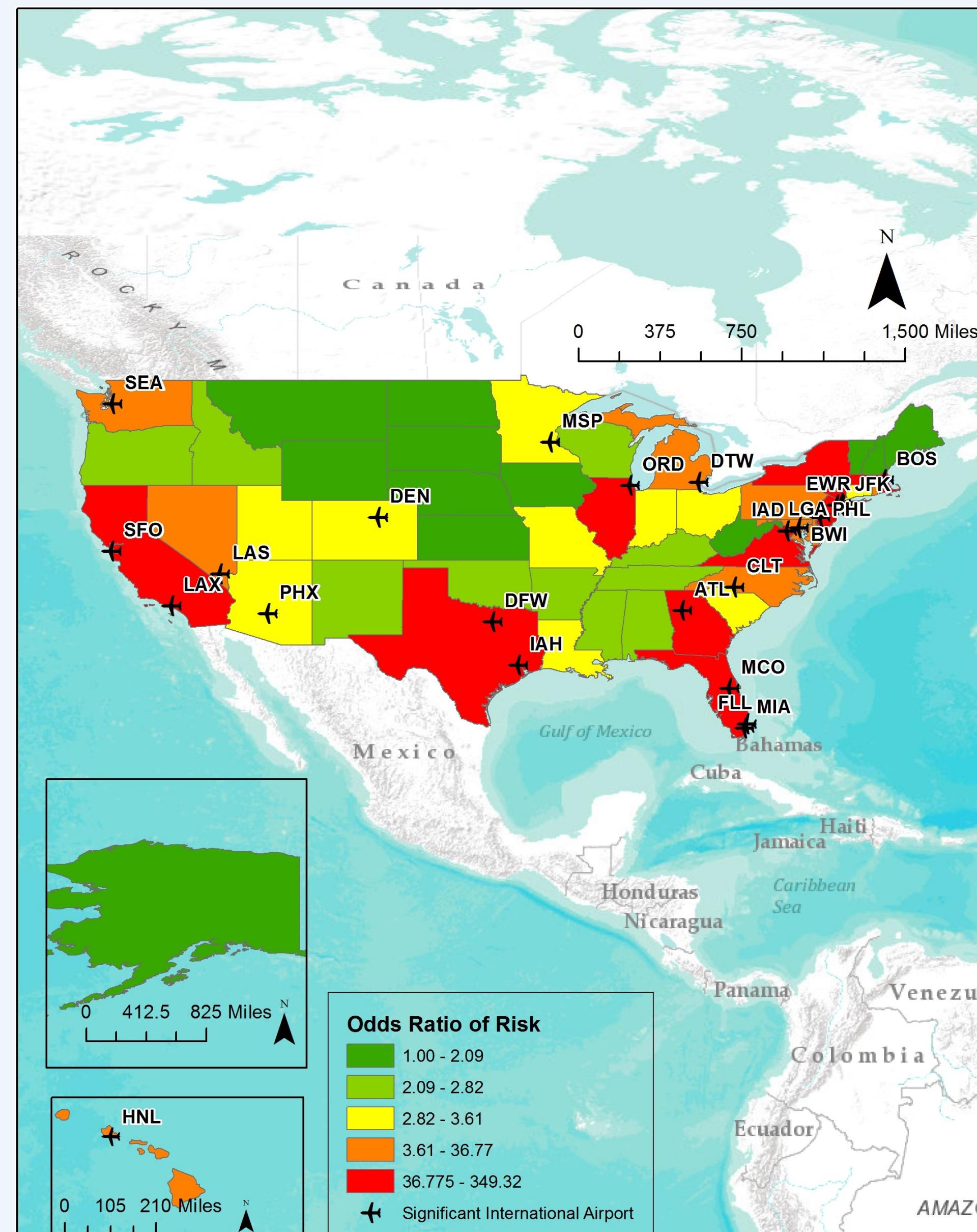
Disease X is a WHO created theoretical disease that “represents the knowledge that a serious international epidemic could be caused by a pathogen currently unknown to cause human disease.” Despite the inherent lack of information about Disease X’s origin, transmission, or pathology, it is possible and necessary to predict relative risks of states of an outbreak so as to maximize efficient use of resources to prevent those outbreaks. As the world becomes more interconnected, airports provide an increasingly large potential source of an outbreak. The object of this project is threefold:

1. Determine the relative risks of importing a case of Disease X through each of the 40 largest US international airports given a random disease origin.
2. Determine relative risk of states of an outbreak of a disease based general demographic and sociological data.
3. Predict which states are at relatively higher risk of importing a case of disease X through international air traffic, and having that case result in an outbreak in the state.

Methodology:

The passenger traffic of the top 40 US international airports was obtained, including manifests as to which major international routes went through each respective airport as well as the proportion of traffic these routes made up. The airport pairs of these major US-international routes were determined, and risk was assigned to each international airport as a direct function of total travel through the airport. Next, risk posed by significant international routes was determined and the total risk posed by international airport traffic through the US airport was determined by 1. The volume of the international route, and 2. The risk of the international airport. The datasets were attribute joined based on IATA code to a shapefile for US international airports.

The second portion of analysis involved determining relative risk of an outbreak given general health demographics. These datasets were attribute joined to the US states. Airports and their respective risk were spatially joined to each state and summed to give a new variable of total risk for each state. Finally a new variable that represented total risk of importing a case of Disease X and the risk of that case resulting in an epidemic was generated as a function of both summed state importation risk and general epidemic risk.



Analysis/Results:

While calculating risk, it was possible to see that there was not an even distribution of international travel; airports on the coasts carry the vast majority of international flights, while those in the interior are generally much less likely to carry any significant international traffic. For example, Hartsfield-Jackson Atlanta International Airport carries more international traffic than the entire states of Montana, Colorado, North Dakota, South Dakota, Nebraska, Iowa, Kansas, Missouri and Idaho combined.

Analysis Continued:

This means that there are international ‘hubs’ or ‘gateways’ as the US Department of Transportation refers to them that proportionally receive more US international travel. The next section of analysis determined that the top region at highest risk of an outbreak was: Maryland, followed by District of Columbia, New Jersey, Pennsylvania, and Illinois. These states have a large proportion of their population utilizing mass transport as well as relatively high population densities. These regions all had at least four times the odds of the least outbreak prone state (North Dakota). The lowest risk states were: North Dakota, South Dakota, Montana, Nebraska, and Kansas. These states were primarily lowest due to their extraordinarily low population density as well as lack of reliance on mass transport.

The final stage of Analysis revealed that California was the most likely state to both import a case of Disease X, and have that case result in an outbreak, while the least likely state was, unsurprisingly, North Dakota. California had nearly 350 times the odds of North Dakota of an outbreak due to an aerially imported case. The next highest risk states were New York (286x) Florida (126x), Illinois (82x) and Georgia (61x).

Limitations:

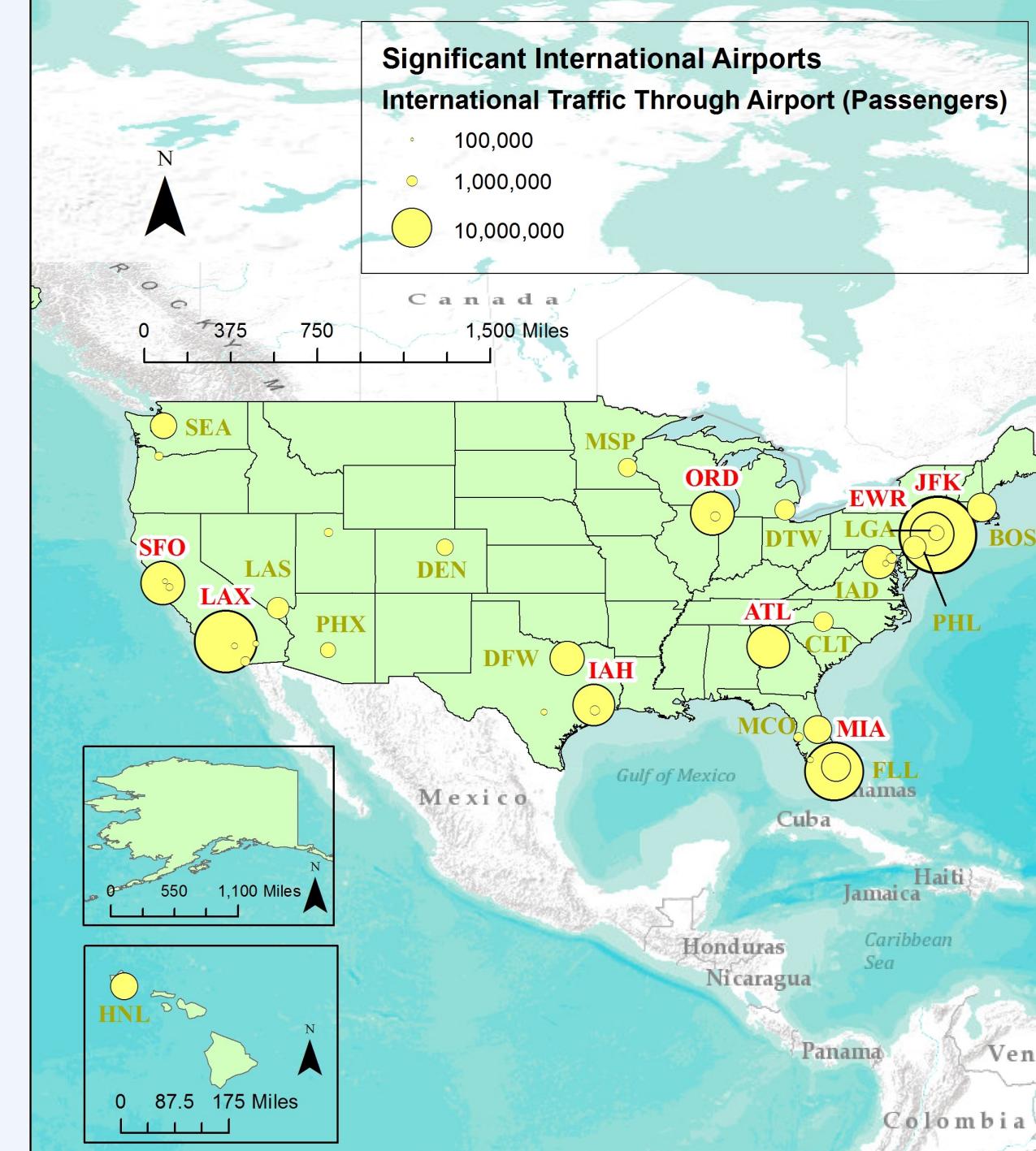
While these data are useful in estimating relative risk of US states, there are far more factors that can be considered when calculating risk of a state to infectious diseases. Epidemiology was streamlined, and in reality, certain areas would be at higher risk than others, such as New York City as opposed to upstate New York.

This model would assume that the majority of people flying out of an airport reside in that state. While this is largely applicable, this downplays the importance of residence of international travelers in different US states from their gateway airports.

This model gives greater weight to larger airports than smaller ones, as only the largest 40 US international airports were considered. However, this is somewhat negligible, as the ‘gateways’ to the US service the vast majority of international travel between the US and abroad.

Lastly, this model does not account for individuals crossing into the US states by non-aerial methods. However, the focus of this study was on aerial importation.

Airport Traffic



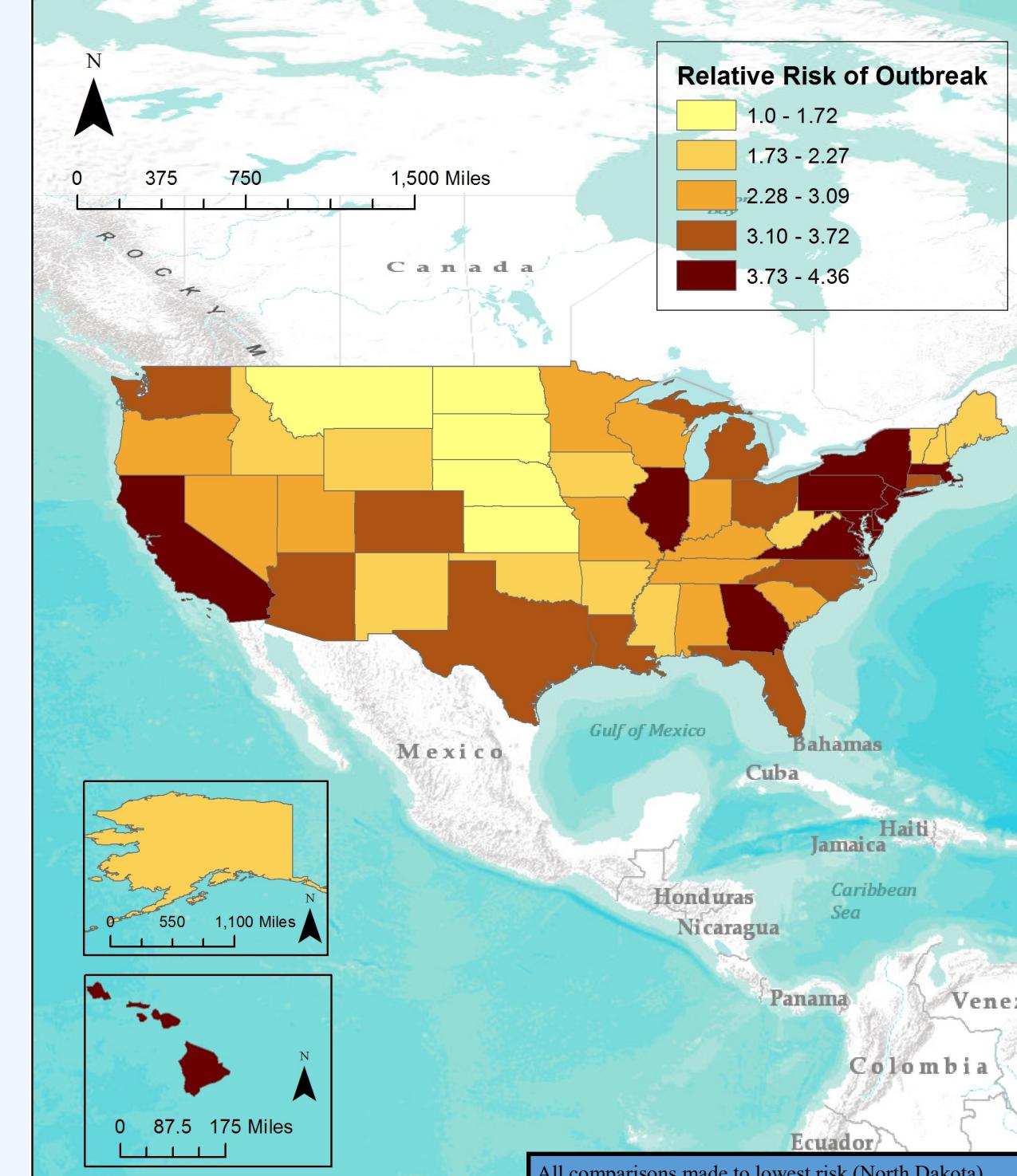
Note: Airport Codes in red receive greater than 10 million international travelers per year, while airport codes in yellow represent airports receiving more than 1 million but less than 10 million passengers per year.

Conclusions and Policy Recommendations:

While there are significant limitations to this study, it nonetheless provides useful information as to relative risks of states. States such as California, Florida, and New York should receive increased surveillance at international airports while states such as Ohio, Alaska, and the Dakotas should receive relatively less. Efficient resource allocation is essential to countering importation risks and the rough odds calculated here could serve as relative guidelines for public health surveillance spending.

It may not be possible to determine where the next pandemic may arise from, but with efficient resource allocation, it may be possible to prevent it from ever entering the US.

Outbreak Risk



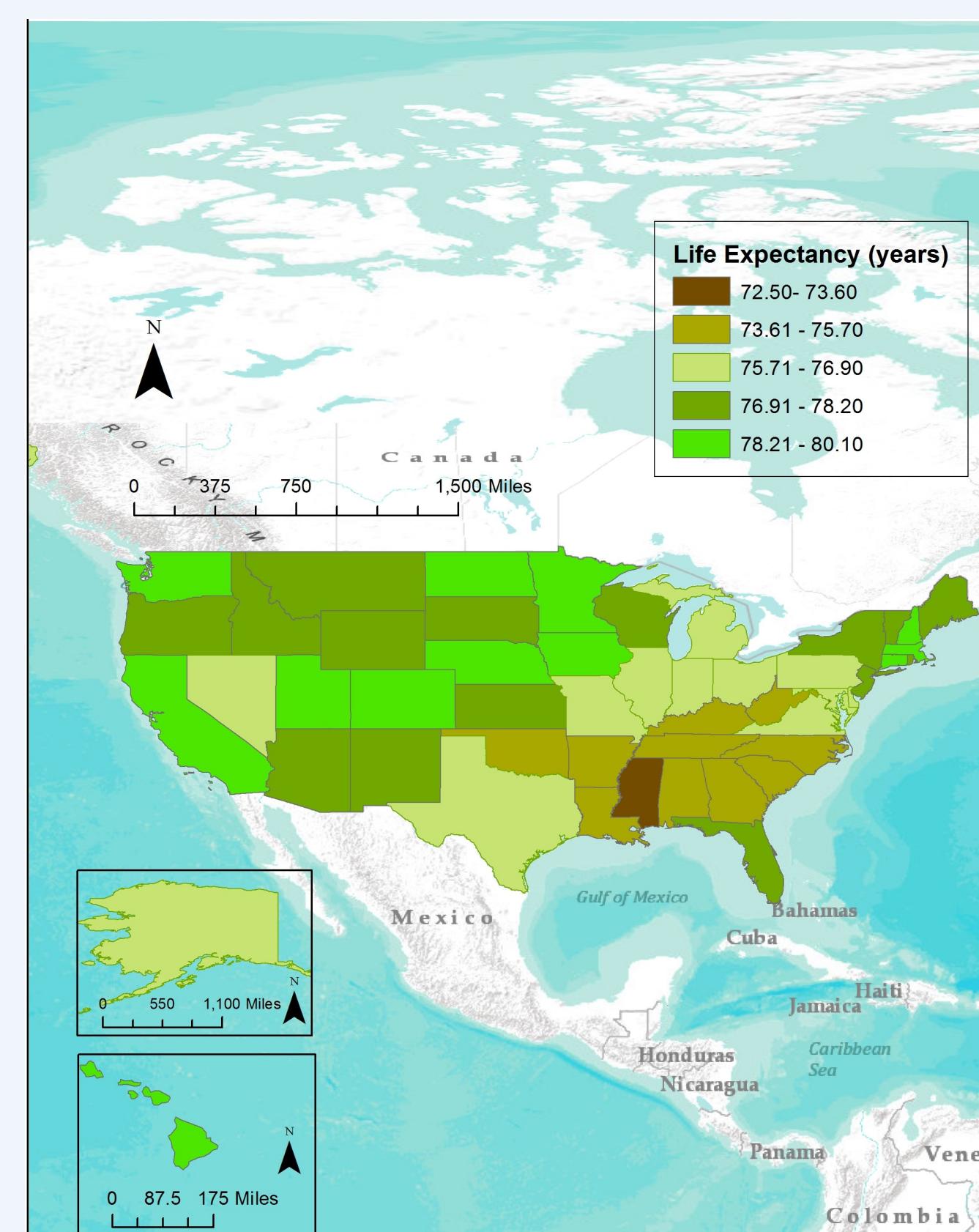
Data sources: United States, Department Of Transportation, FAA, Henry Kaiser Foundation, United States Census Bureau, CDC, WHO, BOG International Airport, GDL International Airport, SDQ International Airport, EZE International Airport, GRU International Airport, STI International Airport, LIM International Airport, CUN International Airport, USGS, Esri, DeLorme, NPS, NOAA.

References:
["List of Blueprint Priority Diseases."](http://www.who.int/blueprint/priority-diseases/en/) World Health Organization, World Health Organization, 14 Mar. 2018, www.who.int/blueprint/priority-diseases/en/.

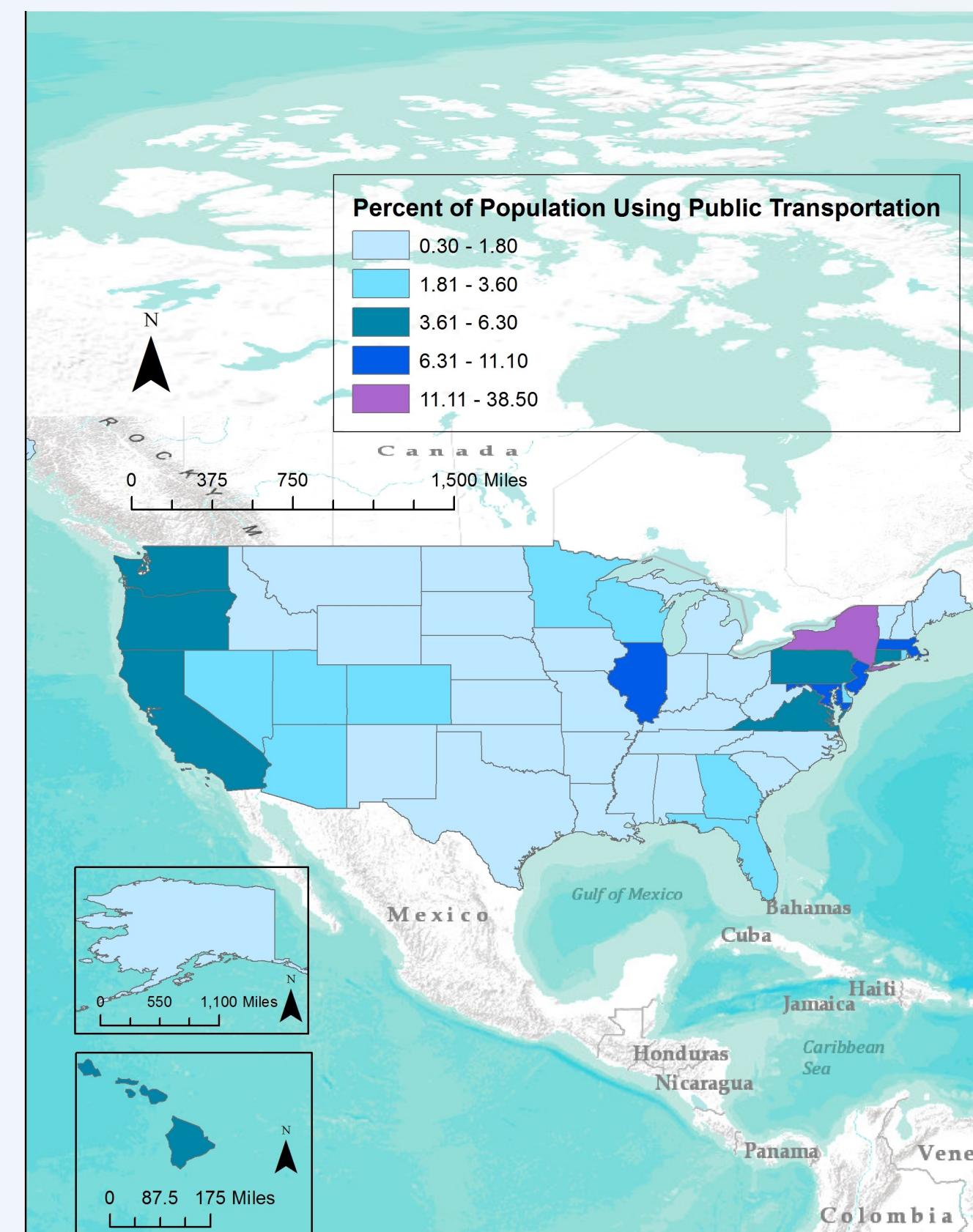
"Lesson 1: Introduction to Epidemiology." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 18 May 2012, www.cdc.gov/ophss/cses/dsepd/ss1978/lesson1/section1.html.

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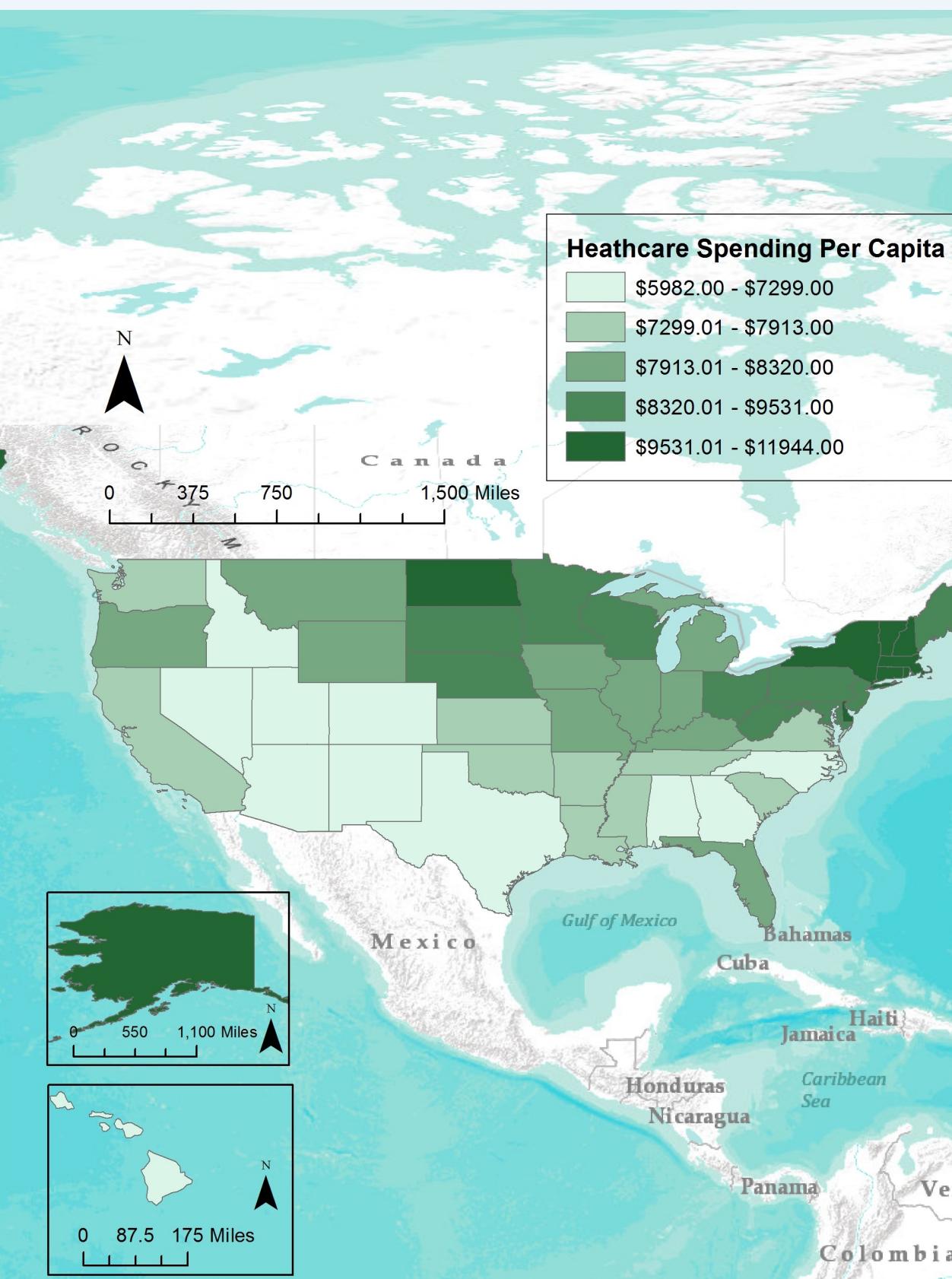
Life Expectancy



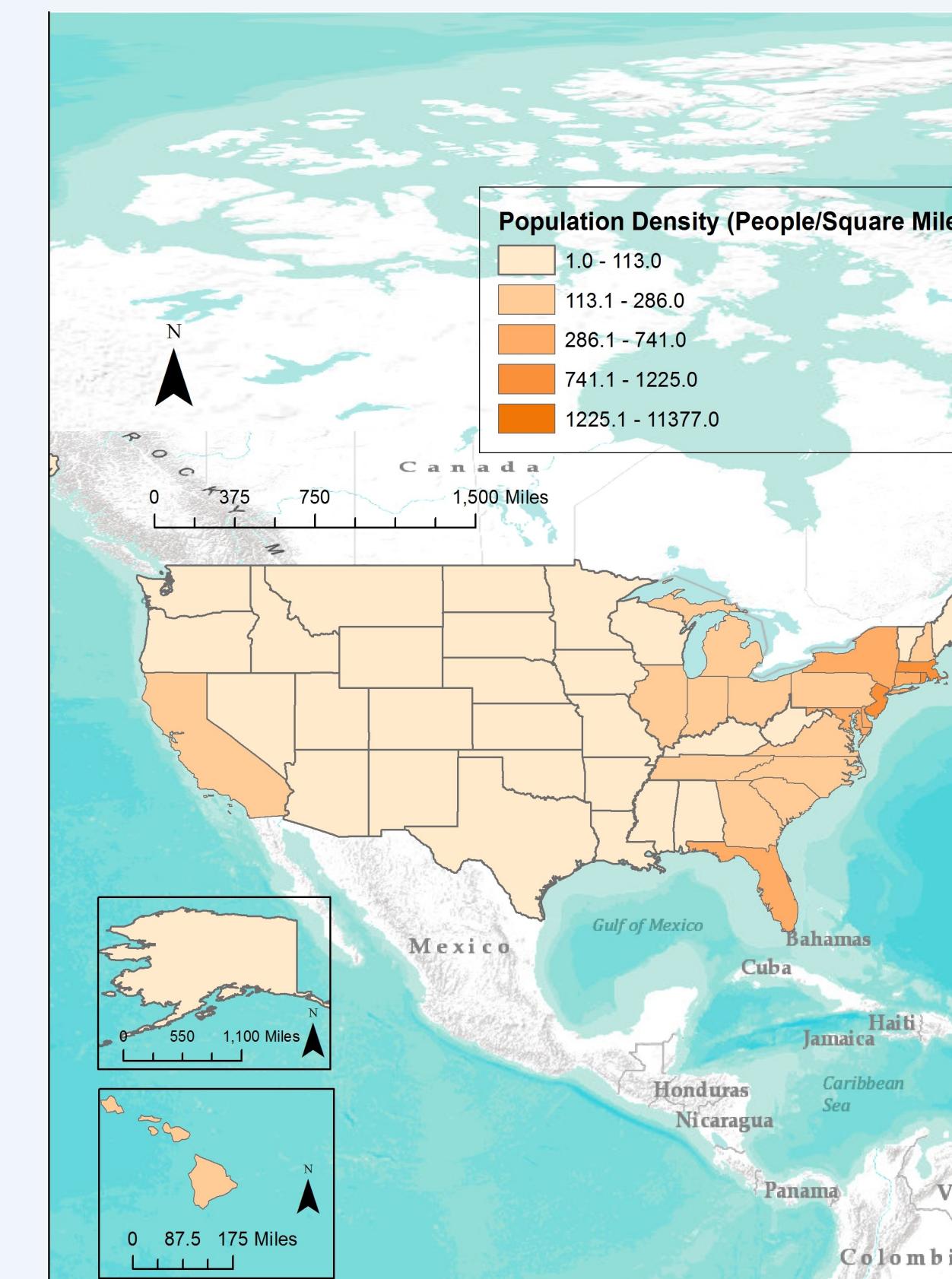
Public Transportation



Healthcare Spending



Population Density



Cartographic Information
 Cartographer: Joe Pajka
 GIS-0101
 May, 7, 2018
 WGS 1984
 Web Mercator Auxiliary Sphere