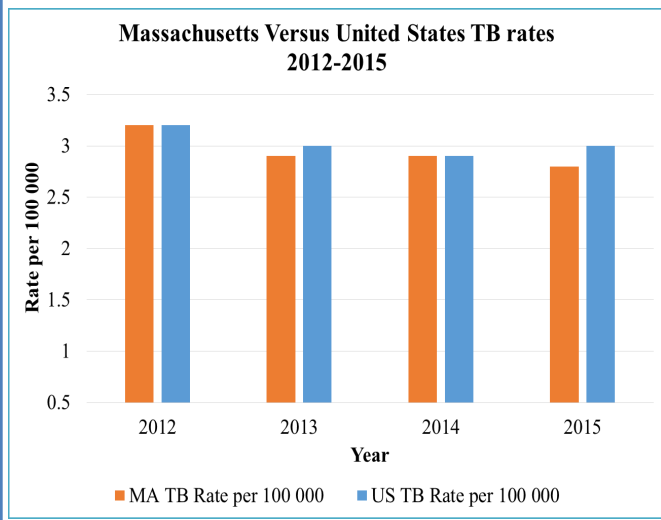


Socio-Demographic Indicators Associated With the Spatial Distribution of Massachusetts Mycobacterium Tuberculosis Cases From 2012-2015



INTRODUCTION



Tuberculosis (TB) ranks alongside HIV as a leading cause of death worldwide. In 2014, an estimated 9.6 million people developed TB and 1.5 million died from the disease.¹ A total of 9,563 TB cases, a rate of 3.0 cases per 100,000 persons, were reported in the United States (U.S.) in 2015, suggest leveling of the TB incidence in US.²

The Massachusetts (MA) TB rate has slowly been decreasing, and was 2.8 per 100 000 in 2015;³ however the National TB Program Objectives and Performance Targets for 2020 is 1.4 per 100 000.⁴

Tuberculosis disproportionately affects members of socioeconomically disadvantaged and minority populations in the U.S. CDC data from 2015 shows that the total U.S.-born TB cases Native Hawaiian/other Pacific Islanders had an incidence rate of 12.7 per 100 000 (88 cases), followed by American Indian/Alaska Native with a rate of 6.8 (141 cases), non-Hispanic Blacks had a rate of 3.3 (1444 cases), Asians: 2.1 (141 cases), Hispanics: 1.8 (661 cases), and lastly; non-Hispanic Whites with a rate of 0.5 (991 cases).²

TB genotyping is a laboratory approach to analyze the genetic material (DNA) of Mycobacterium tuberculosis. It has been successfully used in epidemiologic research to study, track, and understand the transmission dynamics of TB in a community. Genotyping is required for reviewing TB clusters. Although there is data regarding TB incidence cases in MA, spatial mapping, socio-demographic indicators associated with the spatial distribution, and an analysis of U.S. born TB cases has hitherto not been performed.

Based on data from the study “A genotypic and epidemiologic analysis of Massachusetts Mycobacterium tuberculosis cases from 2012-2015” this GIS study fills a knowledge gap of describing the geospatial distribution of TB incidence in Massachusetts, and spatially map socio-demographic indicators associated with TB. These studies together may allow for a geo-epidemiologic understanding of Massachusetts TB incidence cases and clusters to better target local TB prevention activities in collaboration with community-focused efforts to reduce health disparities.

METHODOLOGY

The study was conducted at the Massachusetts Department of Public Health (MDPH), Division of Global Populations and Infectious Disease, TB program. Secondary data analysis was done on an existing database of TB cases in the period 2012-2015, n=799.

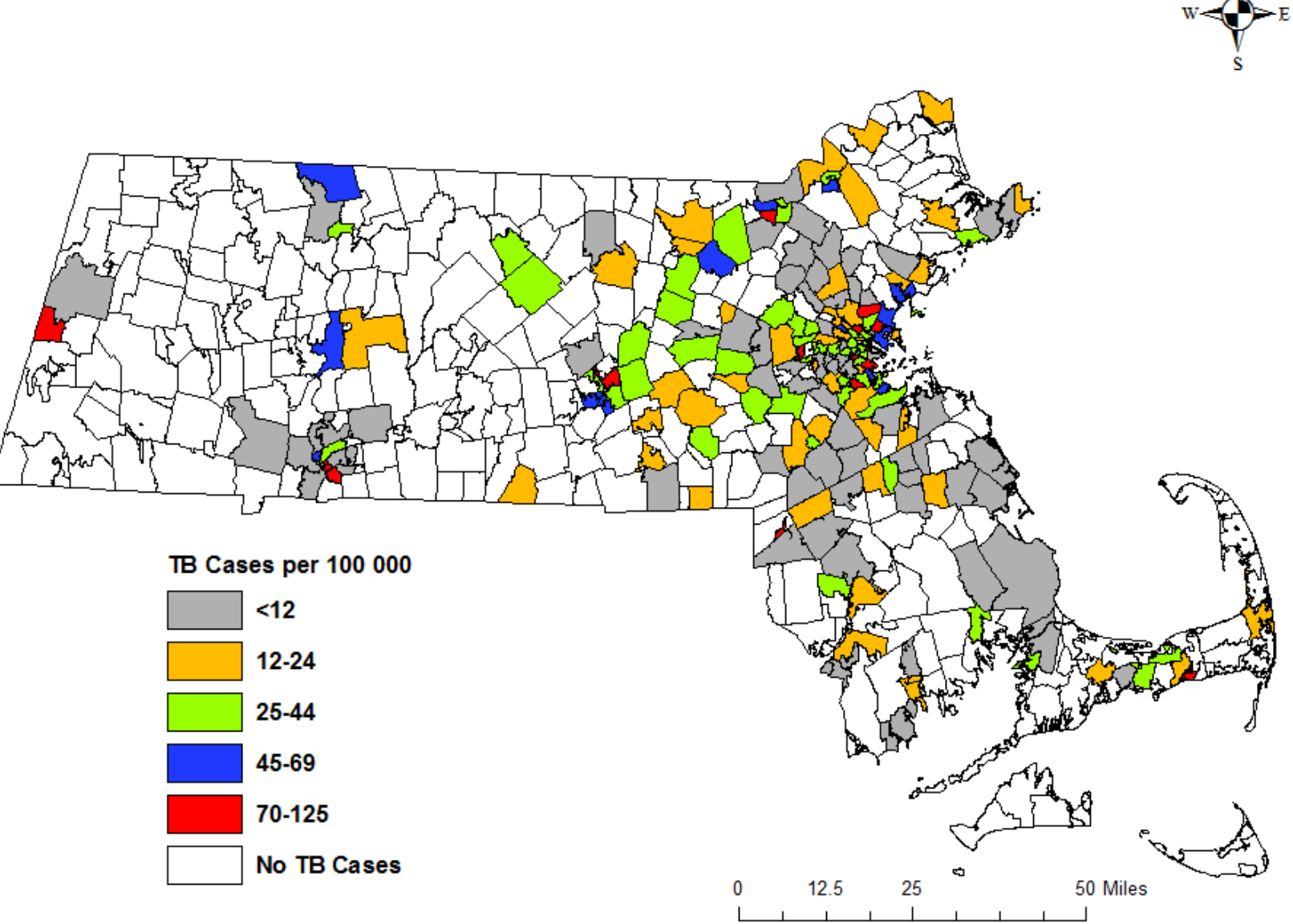
The TB dataset was linked to the genotypic database from the CDC's TB Genotyping Information Management System database (TB-GIMS) to be able to create cluster data. TB cluster definition: A genotype cluster was defined as two or more TB patients with matching genotypes linked by time and space, when the time period was defined as within a three year period, and space was defined as a genotype cluster in the same geographic area defined by no more than 50 km radius, [performed by using radius around a point (TB case)]. A total of 85 individuals divided into 32 clusters were identified.

Zip code population data was downloaded from the American Community Survey (ACS) 5 year data and used for calculations of incidence rate. Similarly, income data by zip code was collected from ACS 14, 5 year data. Race/Ethnicity composition for Massachusetts was obtained from the TB dataset and calculated by population data from U.S. Census Bureau.

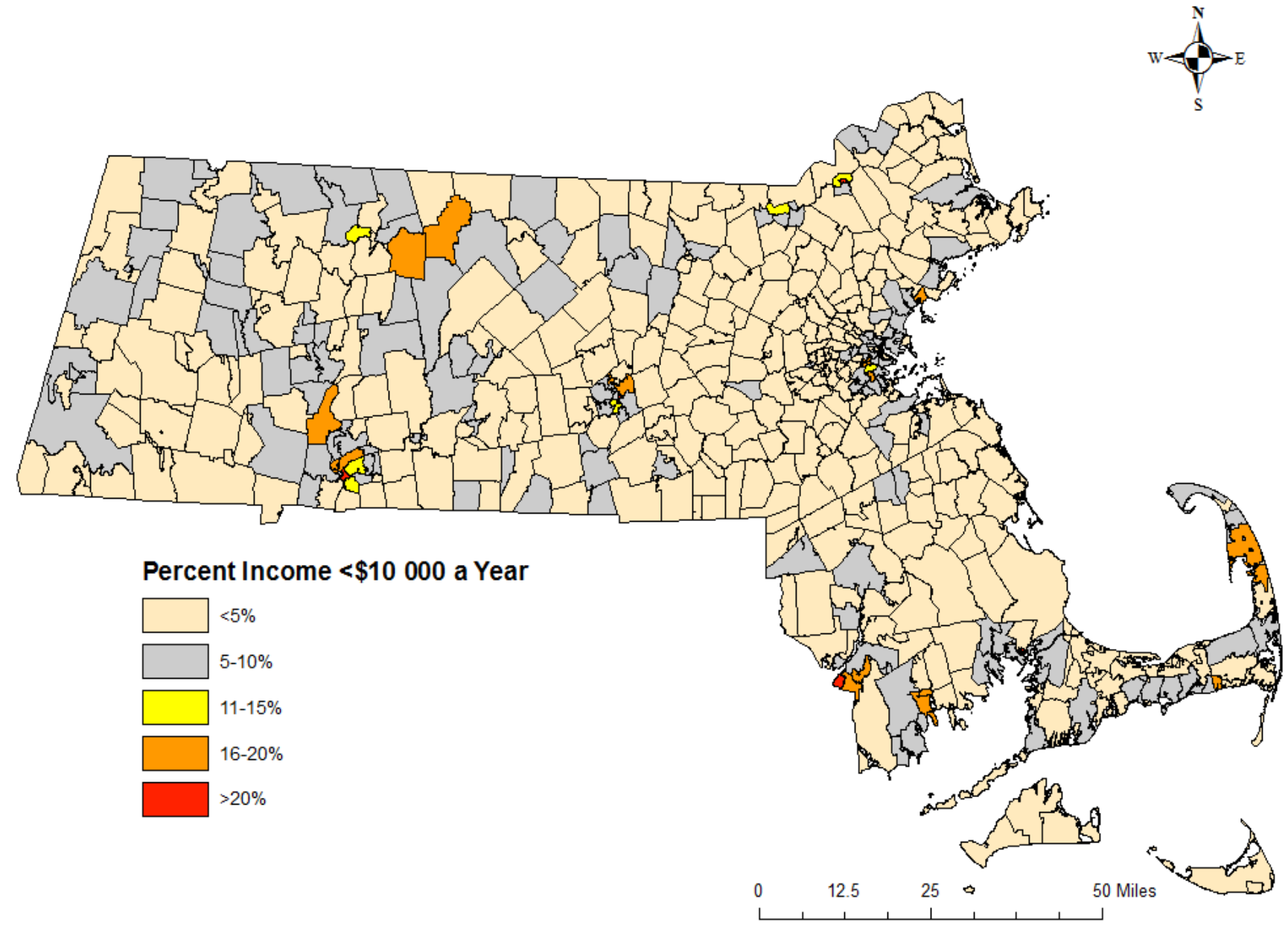
A “hot-spot” is a specific geographic unit that has a statistically significantly higher value than the global average and is also surrounded by neighboring units that have significantly high values, while a “cold-spot” is the inverse. The hot spot analyses were done by using the Getis-Ord-Gi statistic, corresponding z-score and p-value were calculated for each zip code with a “hot spot” defined as a zip code with a high z-score and $P < 0.05$, whereas a “cold spot” was defined as a zip code with a low z-score and $P < 0.05$. A higher absolute value of the z-score signified more intense clustering.

Choropleth maps of TB incidence cases, clusters, and hot spots were created in ArcGIS 10.3.

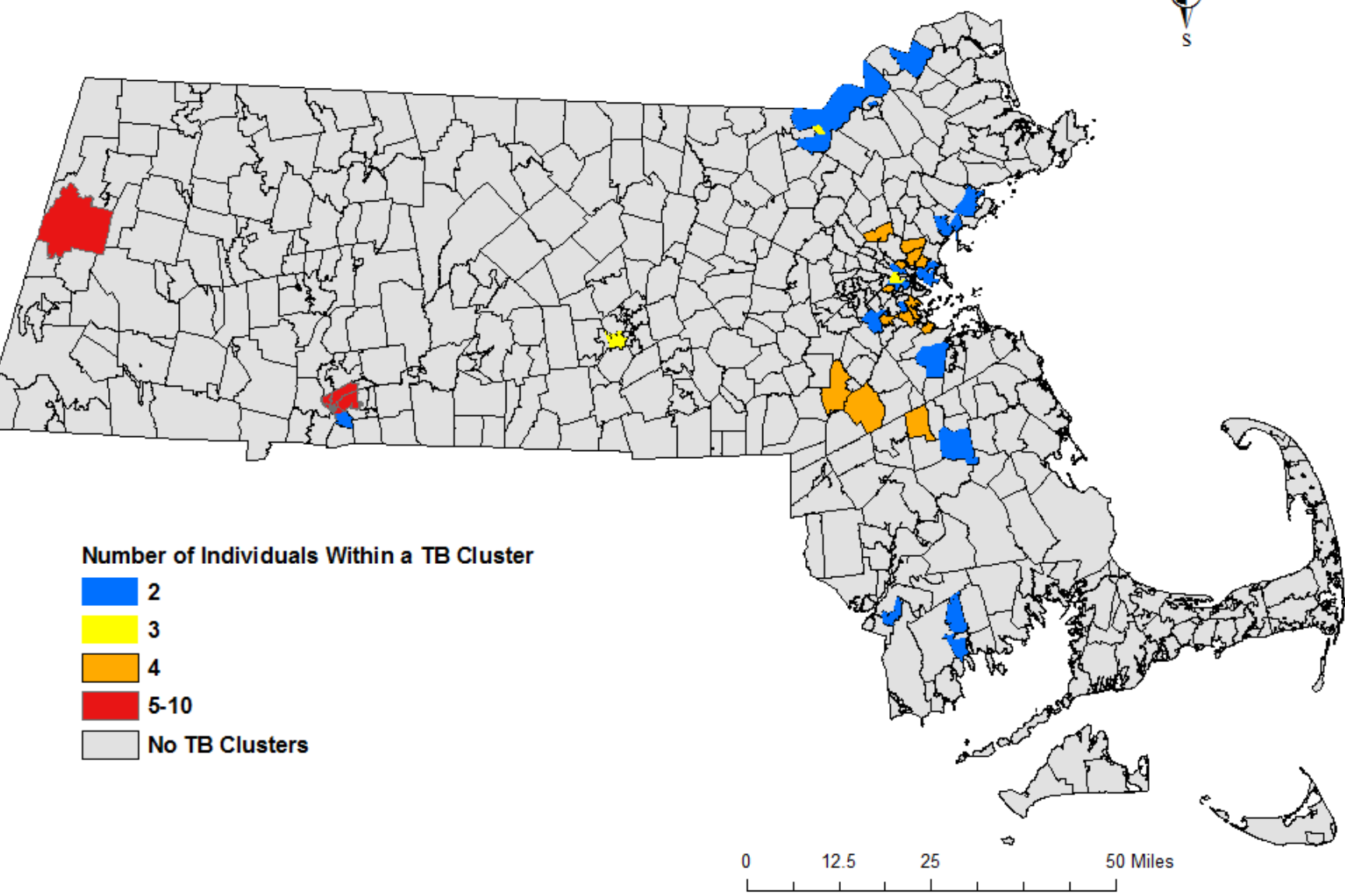
Tuberculosis Incidence Cases per 100 000, MA, 2012-2016



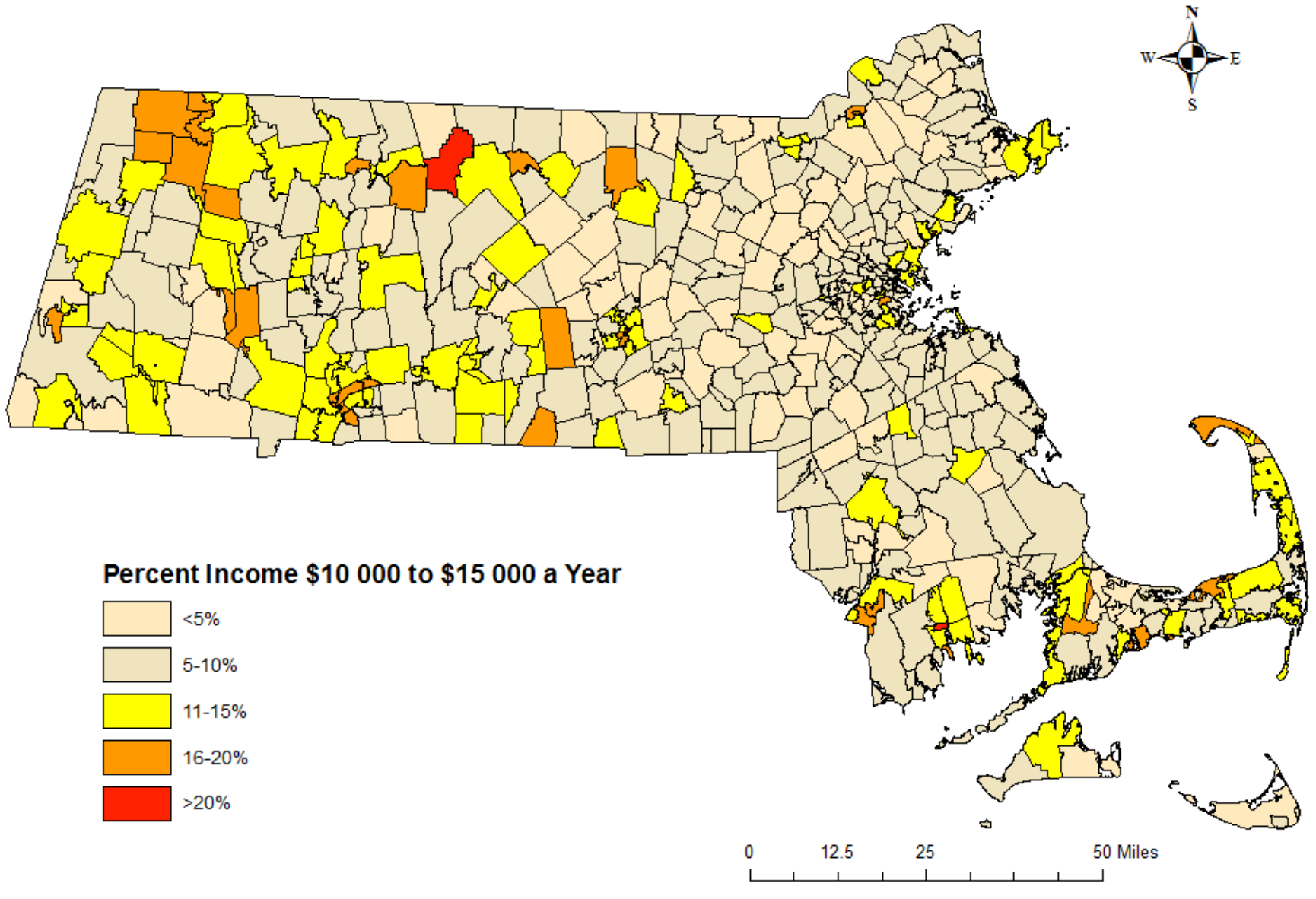
Percent Income <\$10,000 a Year, by Zip Code, MA, 2014



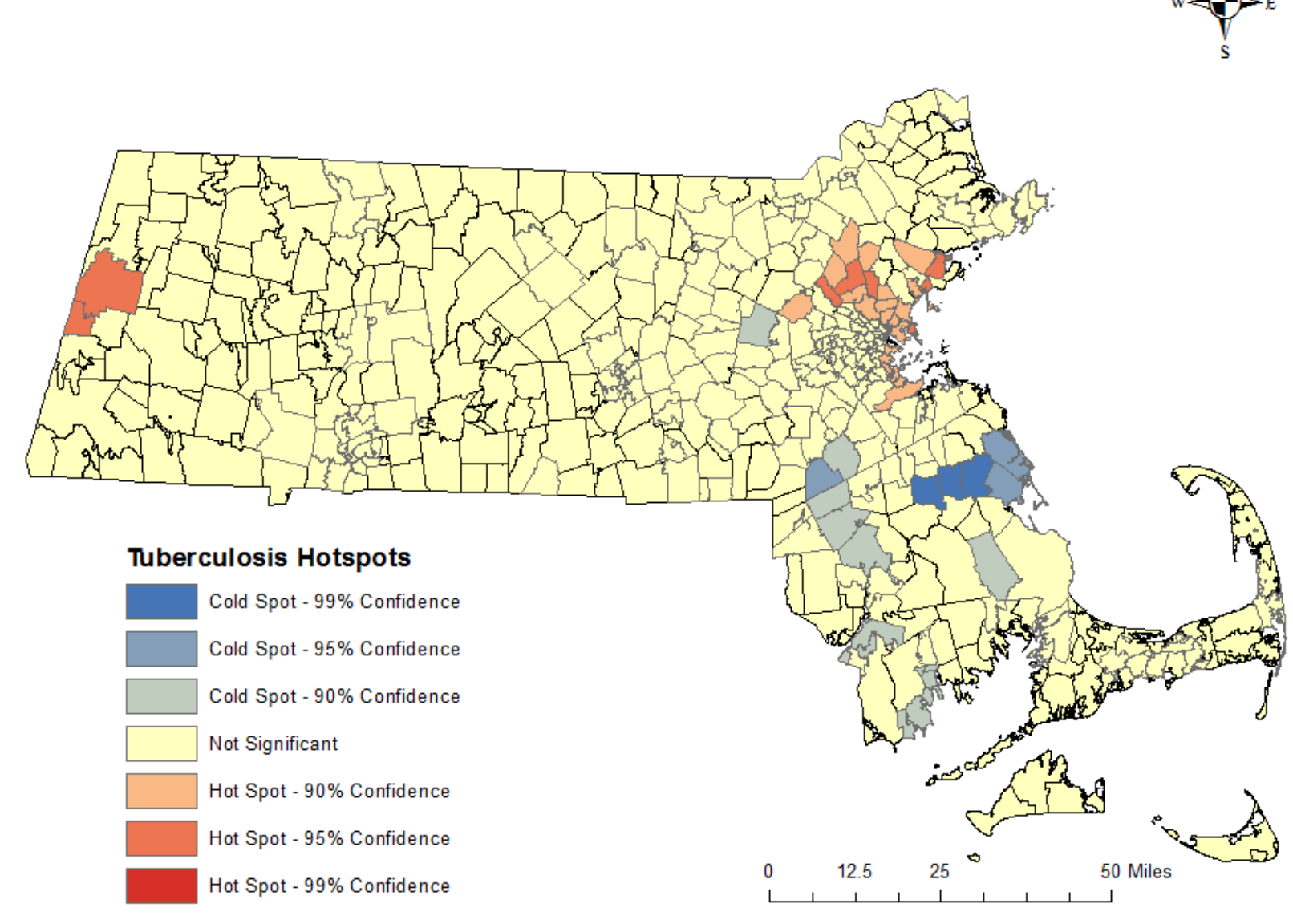
Tuberculosis Clusters, MA, 2012-2015



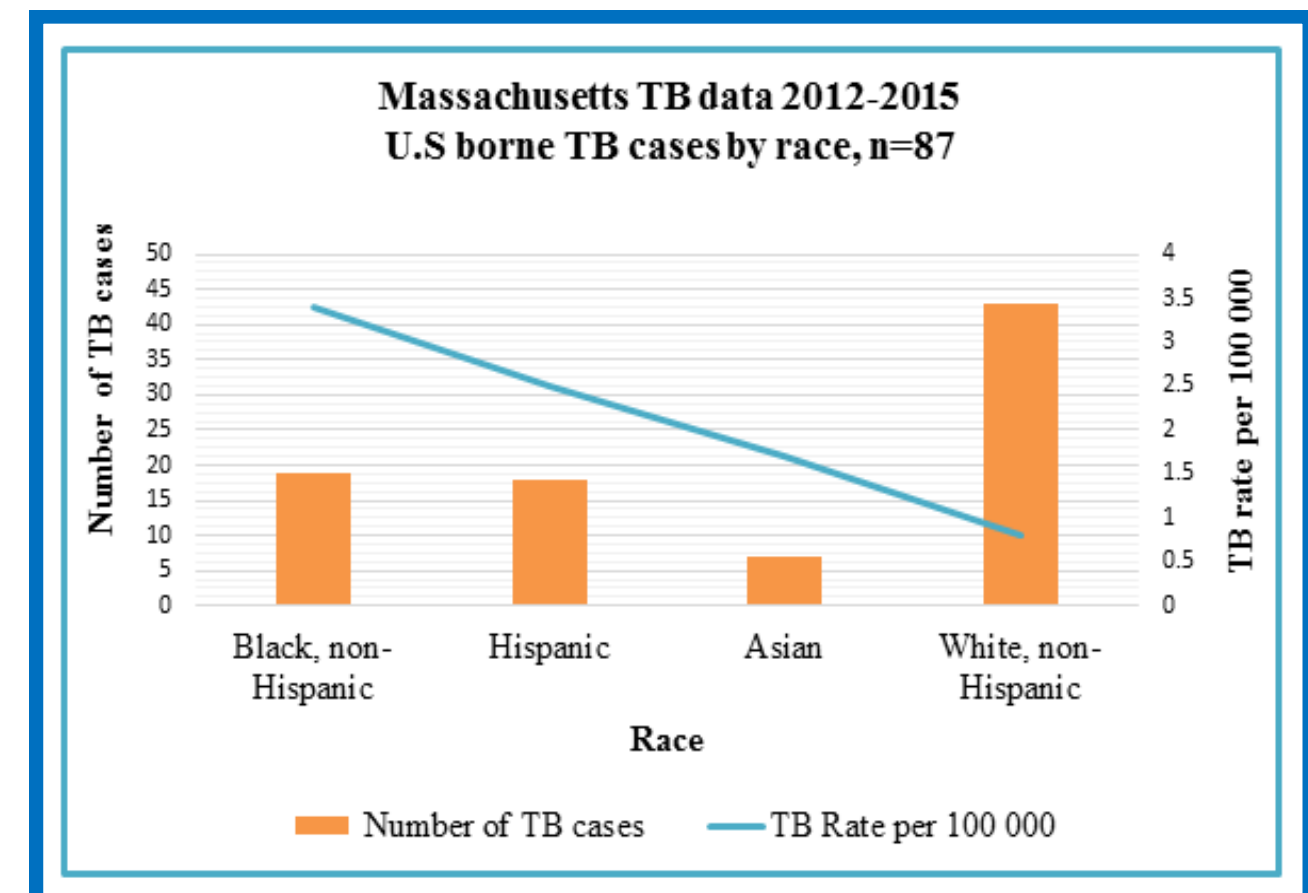
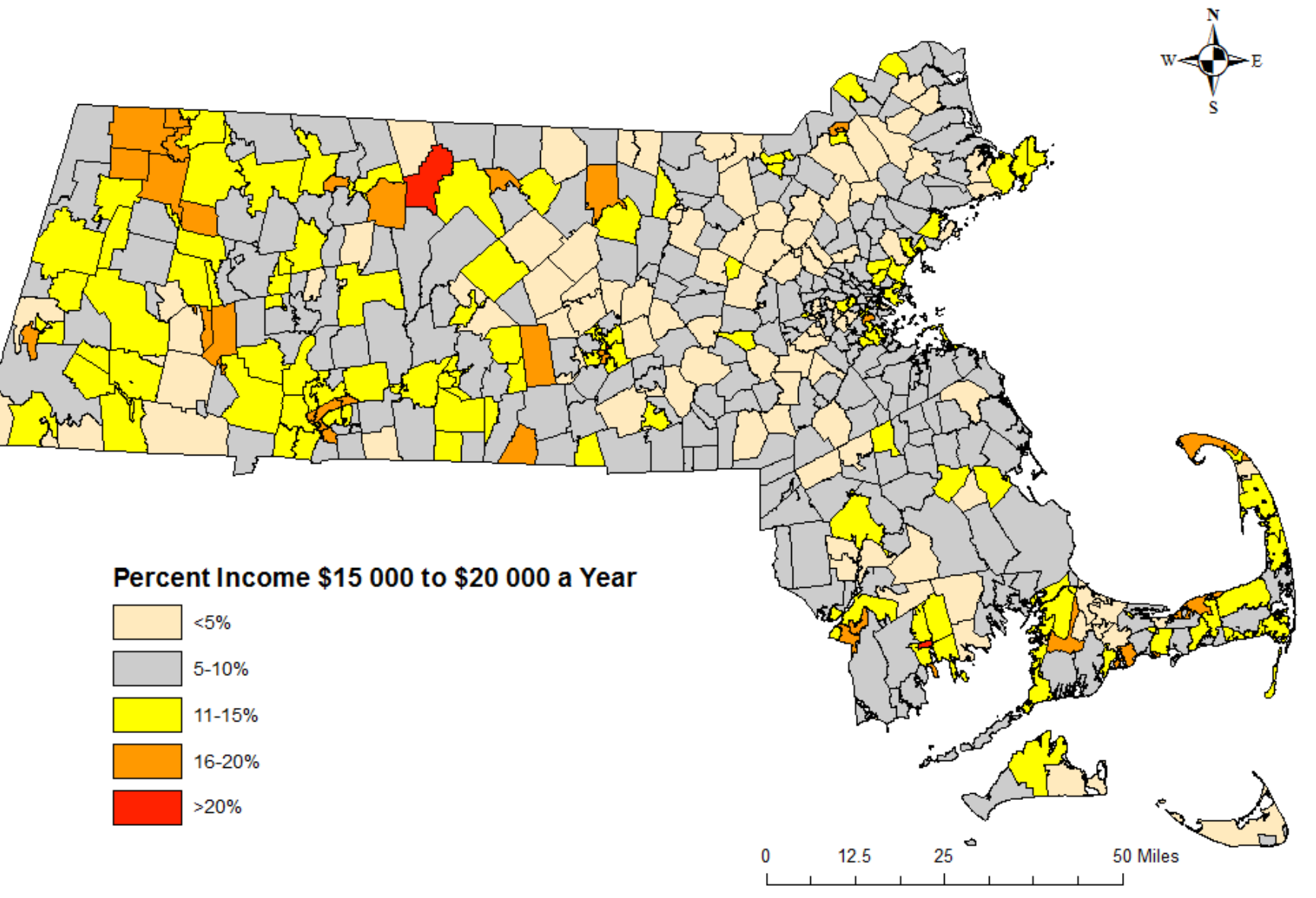
Percent Income \$10,000 to \$15,000 a Year, by Zip Code, MA, 2014



Tuberculosis Hotspots, MA, 2012-2015



Percent Income \$15,000 to \$20,000 a Year, by Zip Code, MA, 2014



RESULTS

The choropleth maps of TB incidence cases, TB clusters, and TB hot spots gives a spatial understanding of the distribution of TB cases in Massachusetts for targeted interventions. When the TB maps are reviewed in relation to the lowest income level brackets in Massachusetts we can note that zip codes with high TB incidence and hot spots are associated with zip codes with the highest percentage of low income. In addition, the study found that in Massachusetts a U.S. born Black is 4.2 times more likely to get tuberculosis compared to a non-Hispanic White. A Hispanic person is 3.1 times more likely to get TB compared to non-Hispanic White, and an Asian is 2.1 times as likely to get TB compared a non-Hispanic White person. A mapping of these data will be tested spatially in the future. These data highlight a major disparity.

DISCUSSION

Associations between low income zip codes and high TB incidence cases, delineated in these maps, are not necessarily causal, but are rather an observation in line with CDC's statement of TB disproportionately affecting the socio-economically disadvantaged and minorities. This study fills a knowledge gap of describing the geospatial distribution of TB incidence, hotspots and socio-demographic indicators associated with TB specific to Massachusetts. It is our hope that these data will assist TB prevention activities to ultimately reduce TB incidence in Massachusetts.

Cartographer: Tine Vindenes, M.D. May 6th 2016

Class: PH 262 Geographic Information System, Professor: T.Stopka
Sources: MDPH TB data 2012-2015, TB-GIMS, ACS 2014 (5yr data), U.S. Census Bureau, ArcGIS 10.3

References:

1. WHO. Global Tuberculosis Report 2015. (2015). Retrieved from http://apps.who.int/iris/bitstream/10665/191102/1/9789241565059_eng.pdf?ua=1
2. CDC. Leveling of Tuberculosis Incidence - United States, 2013-2015. (2015). *MMWR. Morbidity and Mortality Weekly Report*. 2016 Mar 25; 65 (11):273-8.
3. Massachusetts Department of Public Health Bureau of Infectious Disease. Division of Global Populations and Infectious Disease Prevention - Summary Tuberculosis Statistics for the Year 2015 Retrieved from <http://www.mass.gov/eohhs/docs/dph/cdc/tb/summary-data-2015.pdf>
4. CDC. National TB Program Objectives and Performance Targets for 2020 <http://www.cdc.gov/tb/programs/evaluation/indicators/default.htm>