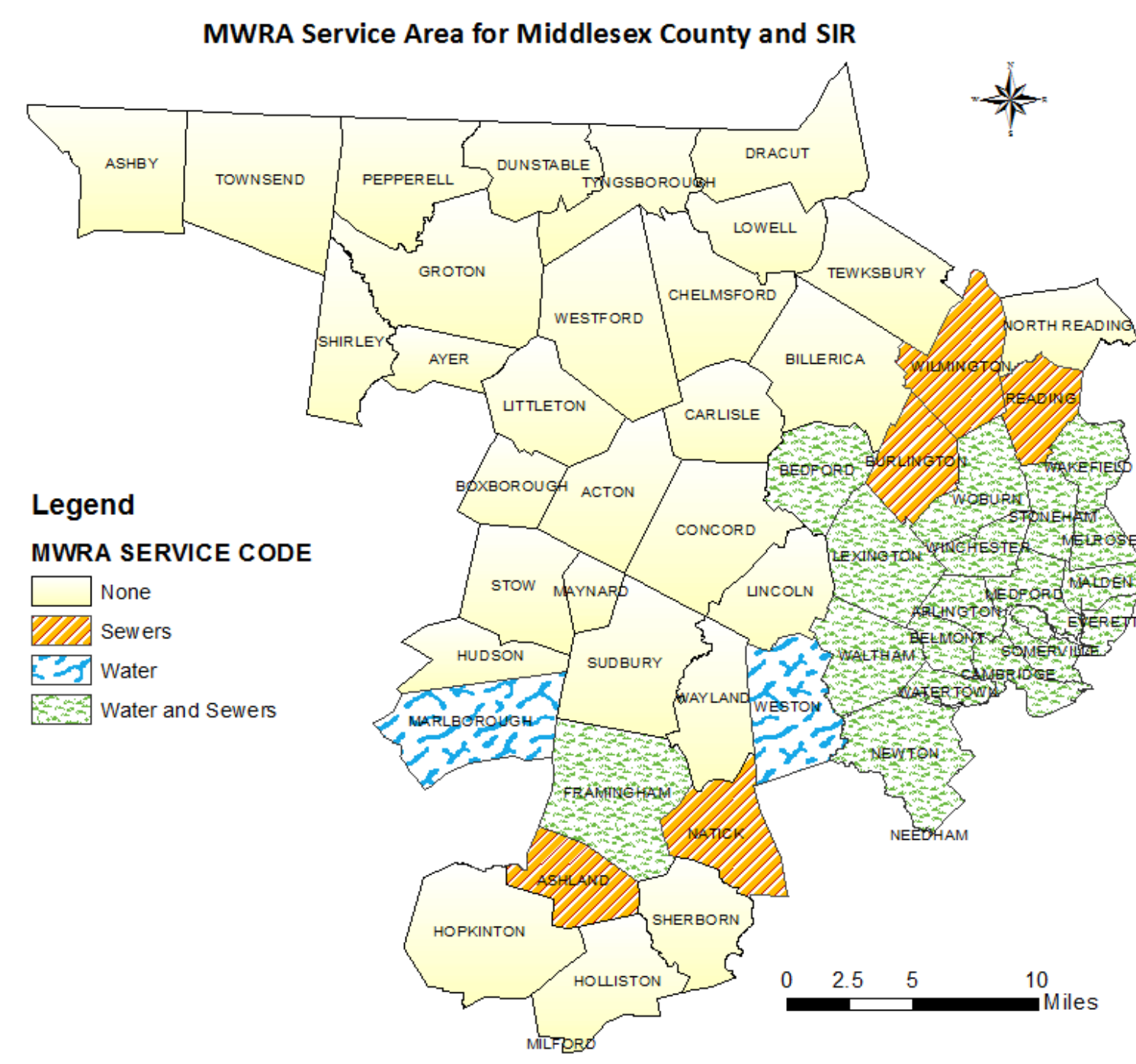


Ground Water Contamination by Septic Systems and Incidences of Hormonal Cancers on Cape Cod: A GIS Analysis

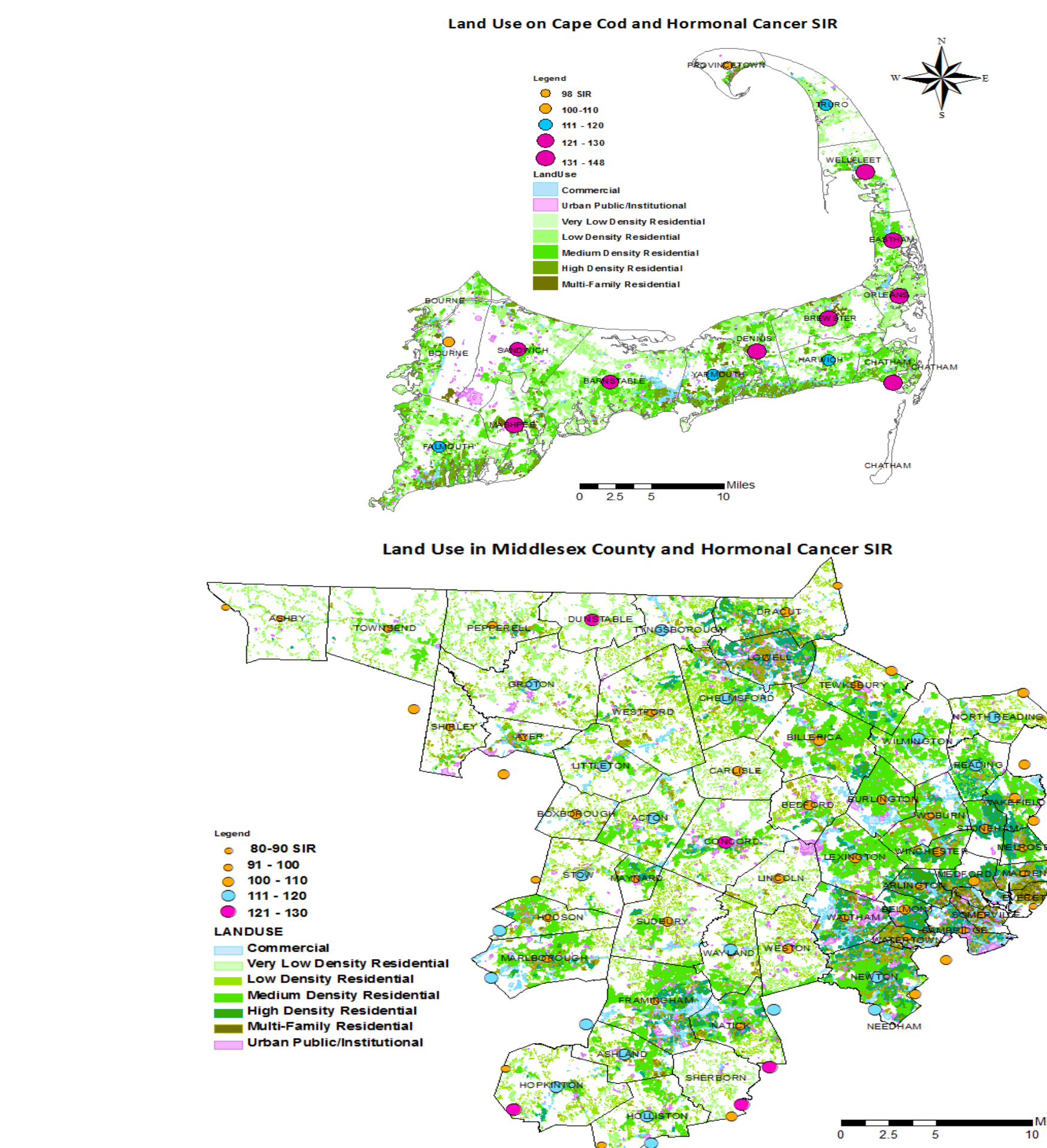
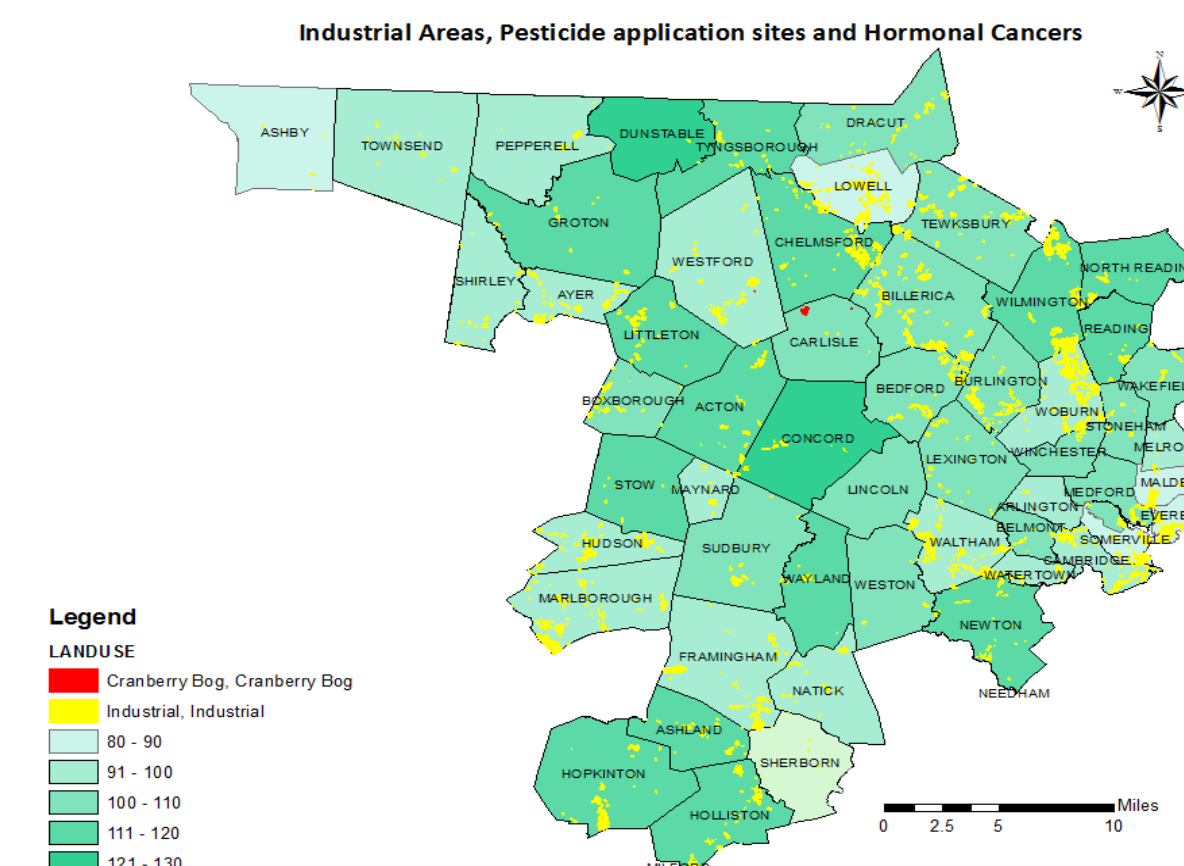
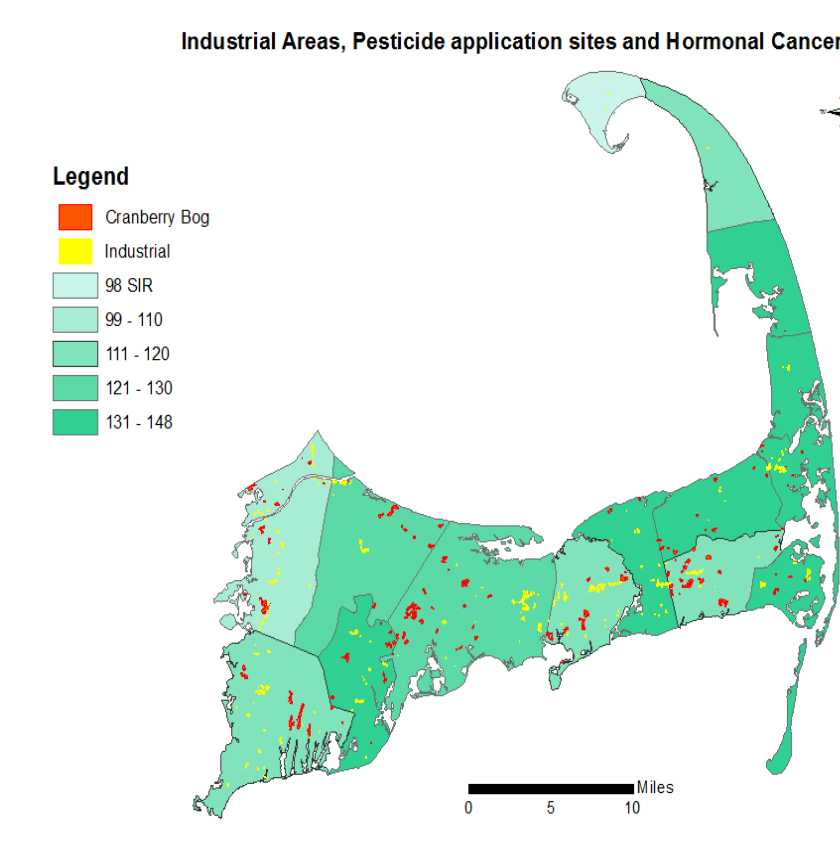
Objective

Use of septic systems as the only source of sewage treatment in a densely populated area could be an indicator of the risk of developing Hormonal Cancer due to groundwater contamination. This GIS analysis aims to study the correlation by comparing two counties, one that was primarily serviced by septic system and the other that was serviced by waste water treatment plants. The two counties used for comparison are the Cape and Middlesex County. Cape Cod is made up of coarse sand and gravels which makes it an extremely permeable ground water system. The sole Cape Cod aquifer is susceptible to contamination from various land uses. Fairly rigorous government regulations have been implemented and enforced for the treatment and disposal of industrial and commercial wastewater effluent to protect the ground water. The only major source of contamination that has not been adequately monitored is the residential septic system and since there are no public wastewater treatment plants on the Cape, it represents the study group. Middlesex County has a large population that is serviced by wastewater treatment plants but it also has several towns which have individual septic systems. Even though Middlesex County does not make an ideal control group, this is the best representation available at the time of this study and hence the data from this county is used for comparison.



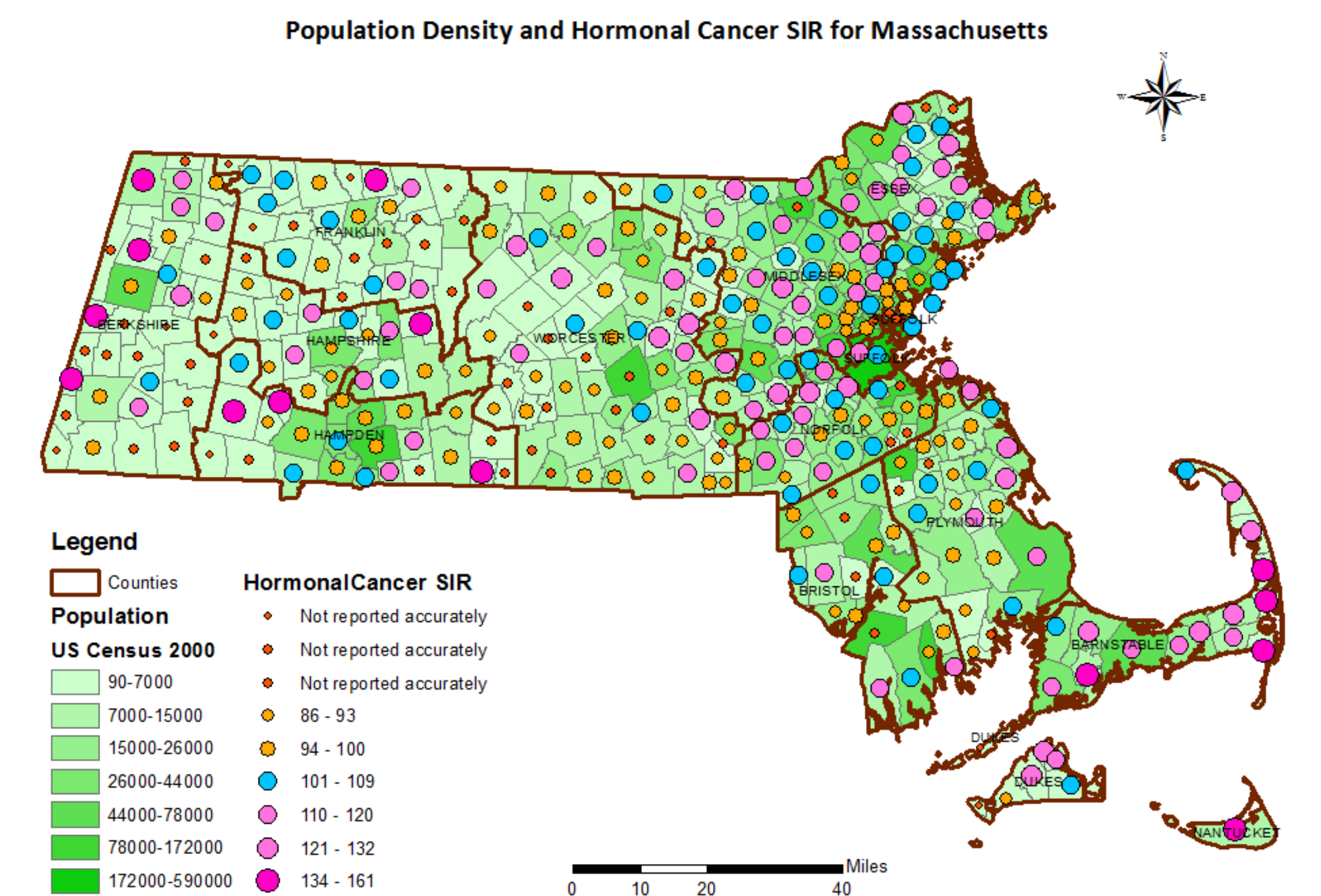
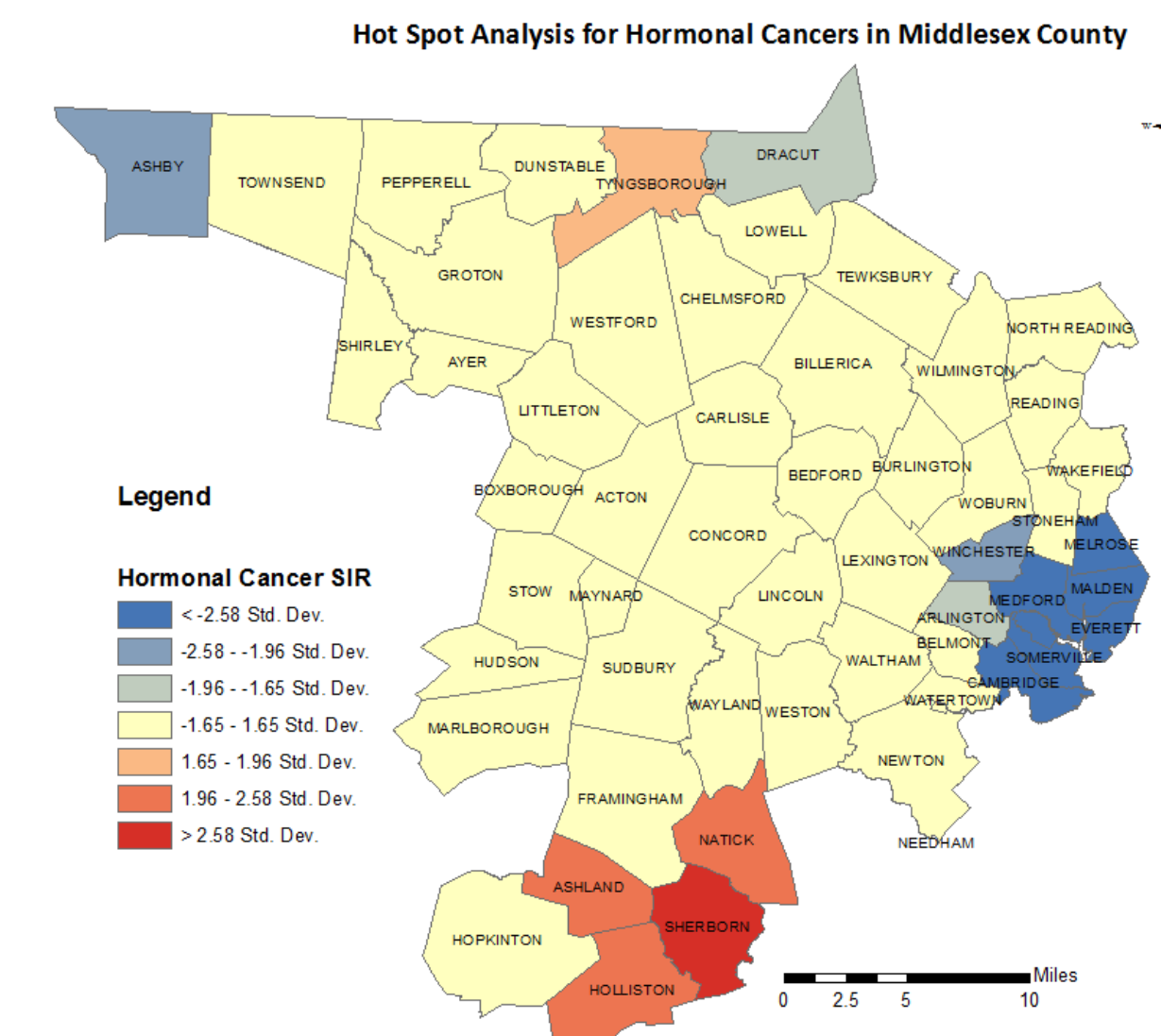
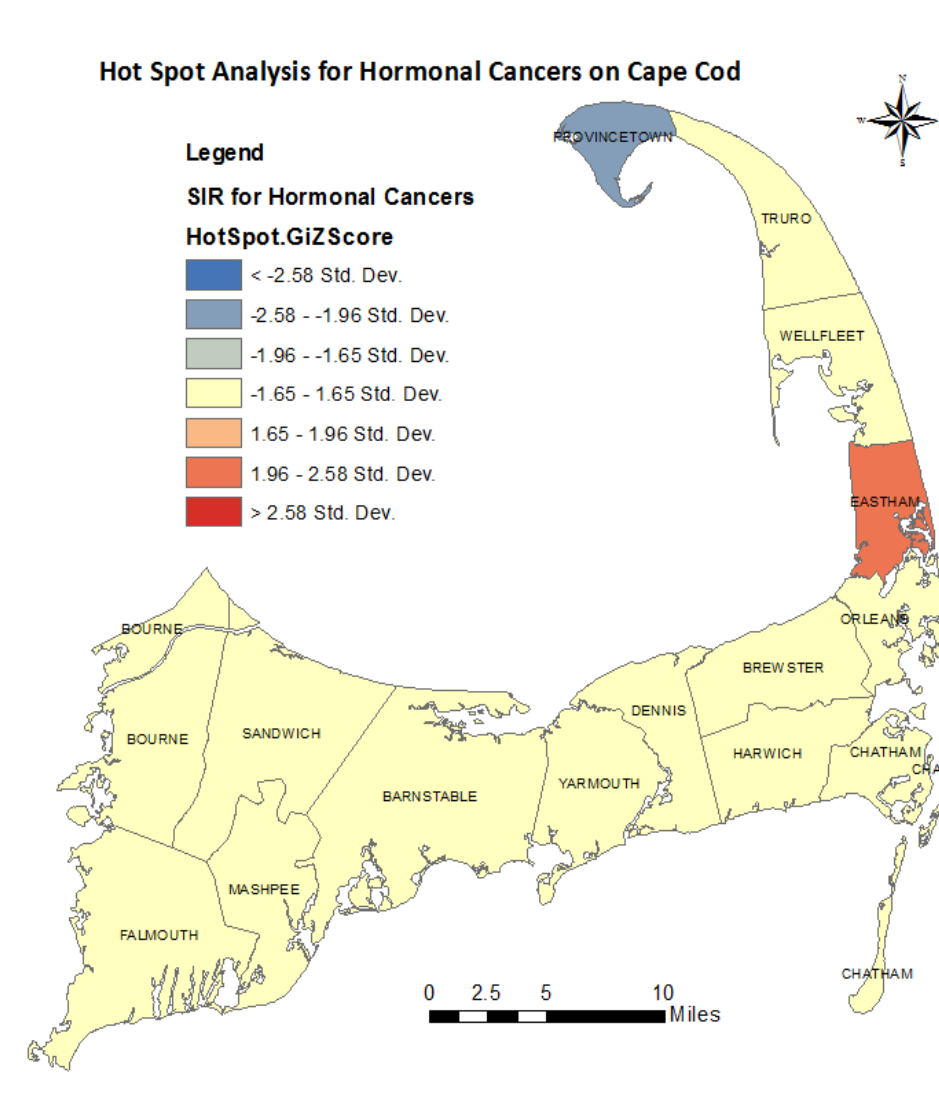
Data:

The data was obtained from Massachusetts Cancer Registry (MCR) with help of the Silent Spring Institute. The MCR collects its data from acute care hospitals, radiation/ oncology centers, surgical centers, physicians and from the death certificate clearance. The population and the environmental justice neighborhood data was obtained from the 2000 US Census. Spatial data on land use, towns serviced by Massachusetts Water Resources Authority (MWRA), physical boundaries for all the Massachusetts towns and counties and other features were obtained from the Office of Geographic Information (MassGIS), Commonwealth of Massachusetts Information Technology Division"



Methodology

Standardized Incidence Ratios were calculated to make adjustments for age and sex for the Hormonal Cancer Incidences for Middlesex County, Cape Cod and for the towns across Massachusetts. Tabulated data for SIR was joined with the spatial layer for the towns in the two counties to observe the distribution of Hormonal Cancer Incidences. Since Hormonal Cancers could be affected by septic tanks, industrial emissions and pesticides, - analysis of the correlation of Hormonal Cancer with Septic tanks, cranberry bogs and Industries was done using, overlays, and statistical queries. The same overlay technique was used for towns serviced by the Massachusetts Water Works Authorities for Middlesex County. A map overlay was also done for the Hormonal Cancer features and the Environmental Justice feature to analyze incidences in these neighborhoods. Hot spot Analysis was used to observe clusters of Hormonal Cancer SIR for Cape Cod and for Middlesex County. A Z-Score above a Standard Deviation of 2.58 was used for a Hot Spot and a Z-Score of Standard Deviation less than 2.58 was used for a Cold Spot.



Conclusion

Spatial analysis indicates a number of towns on the Cape to have a SIR of higher than 120. Falmouth, Yarmouth, Harwich and Truro have an SIR of 111 or higher. Provincetown and Bourne are the only towns to have an SIR of less than 110. The towns in Middlesex County to have an SIR higher than 120 are Dunstable, Concord, Sherborn and Hopkinton. All are primarily serviced by septic system. All the MWRA Towns serviced by water and wastewater treatment plants have a SIR of less than 100 except for Newton. Towns that are more densely populated on the Cape show a higher SIR. The densely populated towns in Middlesex County have public water and wastewater system and also have lower SIR. The towns of Natick, Sherborn, Holliston and Ashland are the Hot Spots for Hormonal Cancers as per the Gettis-Ord GI* method for detecting Hot Spots. Eastham on the cape is found to be the Hot Spot. The towns that were serviced by MWRA are the Cold Spots. The study was inconclusive in determining if there was a correlation between the presence of septic tanks and the incidences of Hormonal Cancer. Environmental Justice Neighborhoods appear to have low SIR, not because of lower incidences but because of under-reporting and lack of finances to seek and gain medical attention. Further in-depth studies to determine the role of septic systems considering the groundwater recharge and topography need to be carried out. Confounders such as migrant population, proximity to the air force base and cranberry bogs need to be evaluated to further explore a causal theory.

