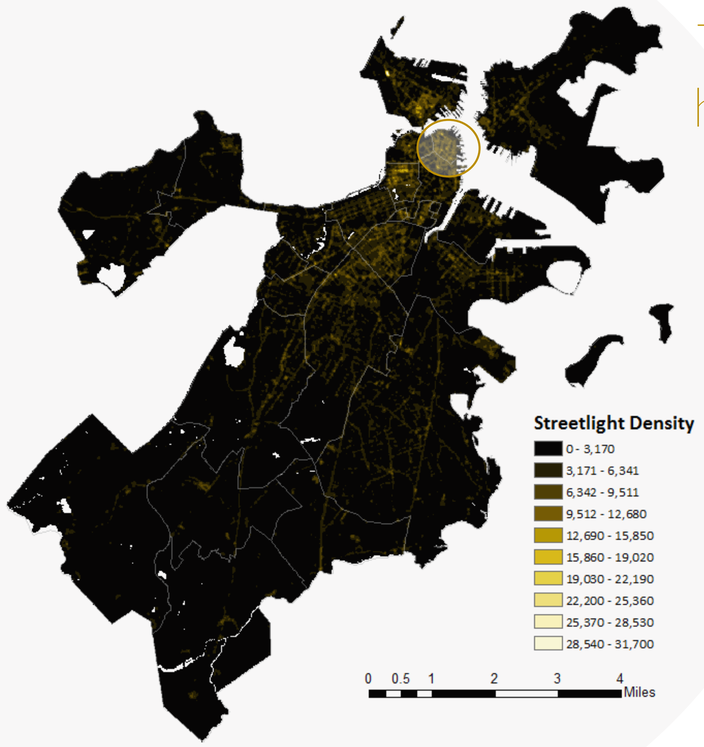
Measuring Streetlight Redundancy in Boston's North End

Austen Sharpe | SOC 1340 | December 2017

Background

Streetlights are commonplace, but they have a significant impact on urban life and their surrounding environments. Along with aesthetic benefits, **night lighting reduces crime rate and improves perceived safety** among pedestrians. The financial losses associated with high levels of crime are likewise diminished. Furthermore, people are more likely to walk or engage in recreational physical activity when in an area with sufficient outdoor lighting.

On the other hand, while lights are a critical facet of urban safely, consistent exposure to artificial night lighting is known to have **negative effects on both human and environmental health**. Streetlights contribute to the phenomenon known as light pollution—the artificial and excessive illumination of the night sky—which has in turn been shown to interfere with organisms' behavior and circadian rhythms. Optimized streetlights systems are a key means to mitigating concerns while preserving the benefits of outdoor lighting. Not only will more efficient lighting systems aid in the reduction of light pollution, but they will save energy while reducing financial load and greenhouse gas emissions.



The North End has the highest density of streetlights in Boston

Boston Streetlights

Boston has upwards of 67,000 streetlights, of which–thanks to a recent intervention—the majority are powered by LEDs. However, the streetlight division of the city's Department of Public Works **continues to operate according to decades-old efficiency standards** with forgotten explanations. Office protocol standardizes the distance between gas lights to 50ft and the distance between LEDs to between 75 and 80ft.

Streetlight Optimization

Studies show that in order to properly configure streetlights, **one must consider a myriad of factors** including but not limited to light type, light strength, light direction, fixture height, road size, road reflectivity, whether there is an intersection, and overall location safety. Another technique for maximizing system efficiency is staggering lights on either side of the road. Standards set by the illuminating Engineer Society of North America suggest that single-sided LED streetlights average approximately 150ft apart while staggered LEDs extend as far as 250ft.

Methodology

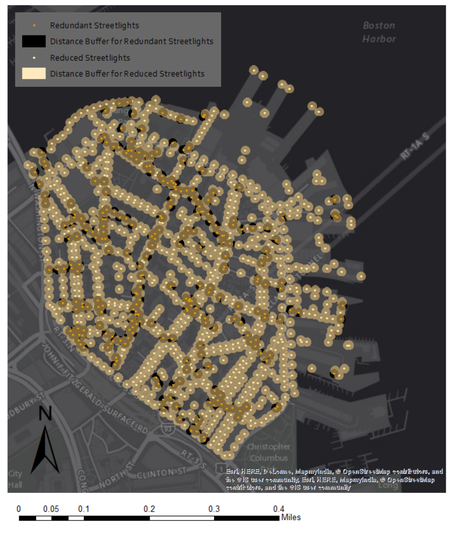
Taking these factors into account, I wanted to test Boston's most densely lit neighborhood for redundancies. I built a kernel density raster measuring the frequency of streetlights per neighborhood and determined that the North End had the highest magnitude per unit-area. I subsequently, mapped the streetlights of the North End and gave them a conservative buffer radius of 37.5ft—half of Boston's lower LED standard and far tighter than industry standard. **Even with strict guidelines, the results show significant room for improvement:**

A **21%** reduction of streetlights in the North End will only cause a **3%** loss of coverage.

Results

- Boston has highly redundant outdoor lighting systems, especially in the North End.
- A reduction in number of streetlights in the North End will not result in a significantly reduced coverage area.

Streetlights and spacing in the North End



Redundancy in North End Streetlight coverage

Literature

*See paper for background citations

Murray, Alan T., and Xin Feng. (2016). "Public Street Lighting Service Standard Assessment and Achievement." Socio-Economic Planning Sciences. 53, 14-22.

Troped, Philip J. PhD, M.S. et al. (2003). "Correlates of recreational and transportation physical activity among adults in a New England Community." Preventive Medicine. 37:4, 304-310.

Data Sources: Boston Department of Innovation and Technology: "Streetlight Locations;" U.S. Census Bureau 2010 Data for Blocks and Tracts. Provided by MassGIS at Mass.gov; Neighborhoods based on U.S. Census Bureau 2010 Data. Provided by the Boston Department of Innovation and Technology; Boundary by Boston Department of Innovation and Technology: "City of Boston Boundary," 2014