Shrinking Sinks: Searching for Forests in the Boston Metropolitan Area

Background

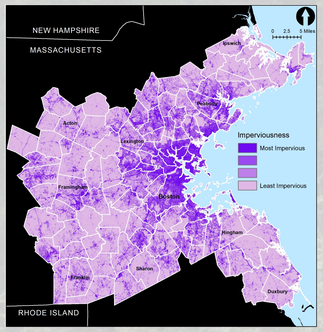
Forests play an important role in climate change mitigation given their ability to act as a carbon sink and sequester large amounts of carbon compared to other land covers and land uses. Understanding where carbon sinks exist in a region and how much carbon they have the potential to absorb from the atmosphere can be an especially important tool for climate change mitigation and adaptation planning. The goal of this project is to show where the Boston metropolitan region's carbon sinks are and how they have changed over time. Specifically, I looked at the change in forested area, and tried to quantify the loss of potential carbon sequestration capacity in the area, as I assumed that the region has experienced an overall net loss of forest area. Additionally, I wanted to know where in the region there is potential for new carbon sinks, how many acres of forest could be replanted, and how much potential additional carbon sequestration could be possible.

Methodology

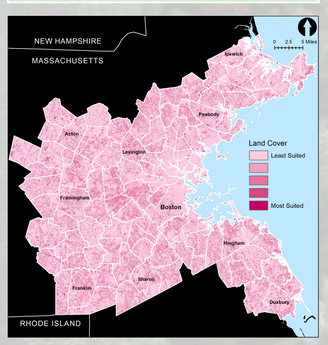
To answer these questions, I first calculated the loss of forest area in the Metropolitan Area Planning Council (MAPC) region for every year of land use or land cover data that I had available. I used land use data from MassGIS for 1971 (earliest available data), 1985, and 1999, and land cover data from the Multi-Resolution Land Characteristics Consortium for 2001 and 2011 (latest available data). I then multiplied the amount of lost acres by a factor (115.17 metric tons of carbon/acre) used by Davies et al. (2011) to very roughly estimate the amount of carbon sequestration capacity that had been lost. I also calculated the total forest area in 1971 and 2011 for references purposes, and determined the area's current carbon sequestration capacity using the aforementioned factor.

To determine where suitable areas for future forest growth are in the region, I used two suitability factors: current land cover and percent imperviousness of land based on the 2011 land cover data. Of the land cover categories available, I chose to rank the following land covers from least suitable to most suitable as follows: developed open space, low-intensity development, grassland, shrub. All other land uses, including open water, were classified as not suitable. I ranked percent imperviousness of land from least suitable to most suitable as follows: 76-100%, 50-75%, 26-50%, 0-25%.

Suitability Based on Imperviousness 2011

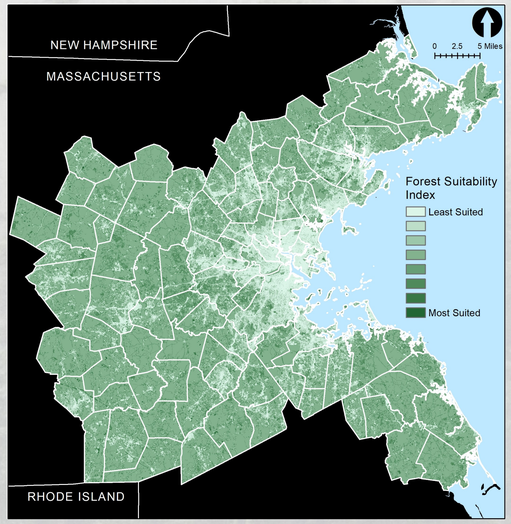


Suitability Based on Land Cover 2011

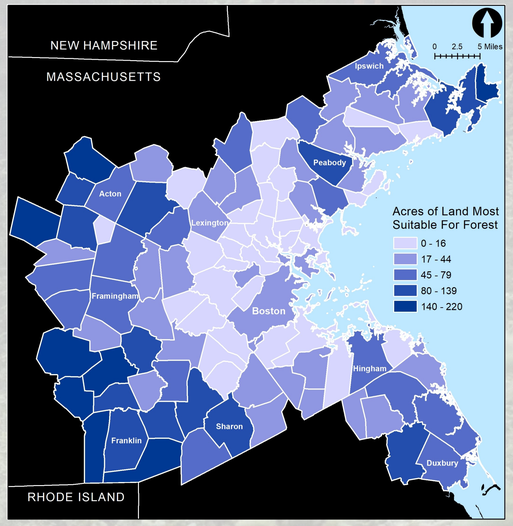


This ultimately excluded roads from being counted as suitable. I then overlaid these two layers to find the most suitable forest land (land rated a 7 were most suitable, land rated a 0 were least suitable), and calculated the total area and potential carbon sequestration capacity. Lastly, I calculated the area of the most suitable forest land (i.e. areas that received the highest rating based on my criteria) in each municipality in the MAPC region to see which municipalities had the most suitable land available.

Suitable Forest Area



Municipalities with Most Suitable Forest Area



Results

Between 1971 and 2011, the MAPC region lost 179,807 acres of forest area and the ability to sequester 20,708,372 metric tons of carbon. As of 2011, 28.9% of the MAPC region is covered by forest, which is able to sequester 30,657,678 metric tons of carbon. There are 4,734 acres in the region that are most suited (i.e. scored a 7) for new forest area based on my criteria. This is equivalent to the sequestration of 545,215 metric tons of carbon. Unsurprisingly, there are more suitable acres the father from Boston you travel. The top ten municipalities with the largest number of most suitable acres, in order, are Bolton, Wrentham, Milford, Hopkinton, Bellingham, Holliston, Littleton, Rockport, Sharon, and Franklin. The bottom ten municipalities that have no suitable acres (i.e. none that scored a 7) are Malden, Arlington, Revere, Everett, Watertown, Brookline, Winthrop, Cambridge, Norwood, and Somerville. It is important to note that although these towns had no suitable acres, this does not mean that they do not already have existing forest area or tree cover.

	1971 - 1985	1985 - 1999	2001 - 2011
Forest Loss (acres)	29,871	41,154	16,708
Forest Gain (acres)	211	7,831	231
Net Forest Loss (acres)	29,660	33,323	16,477
Net Forest Loss (% of total forest area)	6.7%	8.0%	5.8%
Carbon Sequestration Loss (metric tons)	3,415,942	3,837,810	1,897,656

Limitations

The biggest limitation I encountered was that the land use and land cover data I used was from two different sources and measured in two different ways (i.e. one was a vector shapefile that did not specify how forest area was coded, where as the other was a raster shapefile that counted forest area as area with at least 20% of tree cover). Therefore, there are inaccuracies in the total forest loss that I calculated between 1971 and 2011. However, Table 1 should be more accurate given that it calculated forest loss within each data set as opposed to across the two data sets.

Additionally, the carbon sequestration factor that I used was taken from a study done on tree cover and carbon storage in England. I used this factor because it was derived from other studies done in North America and was the most easily translatable for my purposes. However, this means that my carbon sequestration estimates are very rough, and do not take into account other factors that could affect carbon sequestration capacity, such as forest density, canopy cover, tree type, etc.

Lastly, more suitability criteria could have made my analysis of future forest area stronger, such as soil type and elevation, and more recent data could have made my analysis more accurate. 2016 land cover data from the Multi-Resolution Land Characteristics Consortium will be coming out soon, but was not available at the time of this project.

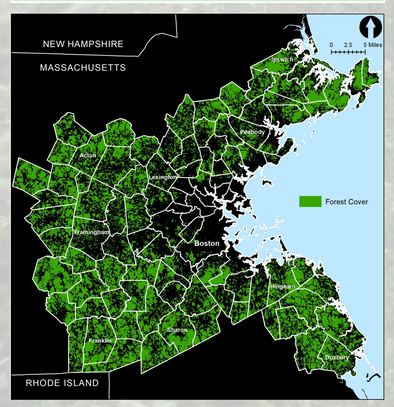
Emily Klotz
May 8, 2018
UEP 232: Intro to GIS

Data Sources: MassGIS, Multi-Resolution Land Characteristics Consortium (MRLC), Metropolitan Area Planning Council (MAPC)

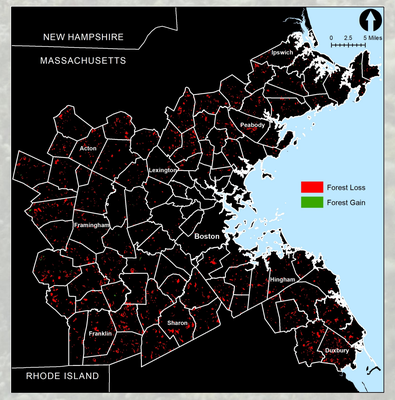
Projection: NAD 83 State Plane Massachusetts Mainland FIPS 2001 (meters)

Tufts UNIVERSITY

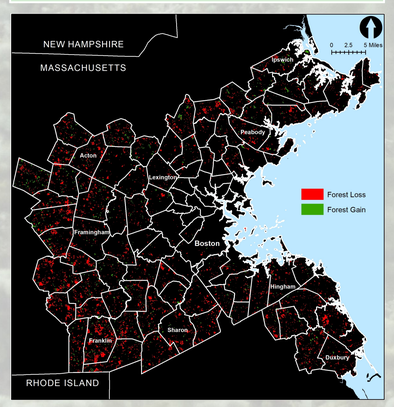
Total Forest Area 1971



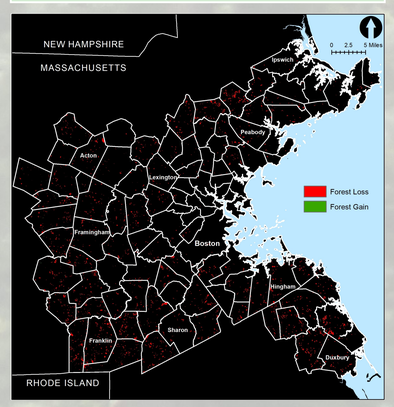
Change in Forest Area 1971-1985



Change in Forest Area 1985-1999



Change in Forest Area 2001-2011



Total Forest Area 2011