Blinking Out:

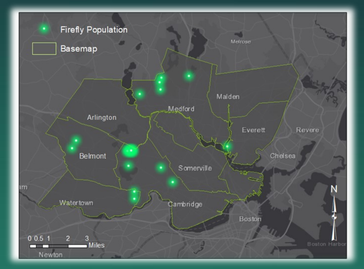
Establishing Firefly Habitat Suitability and Identifying Potential Wildlife Corridors in Northern Boston Metro Areas

Introduction

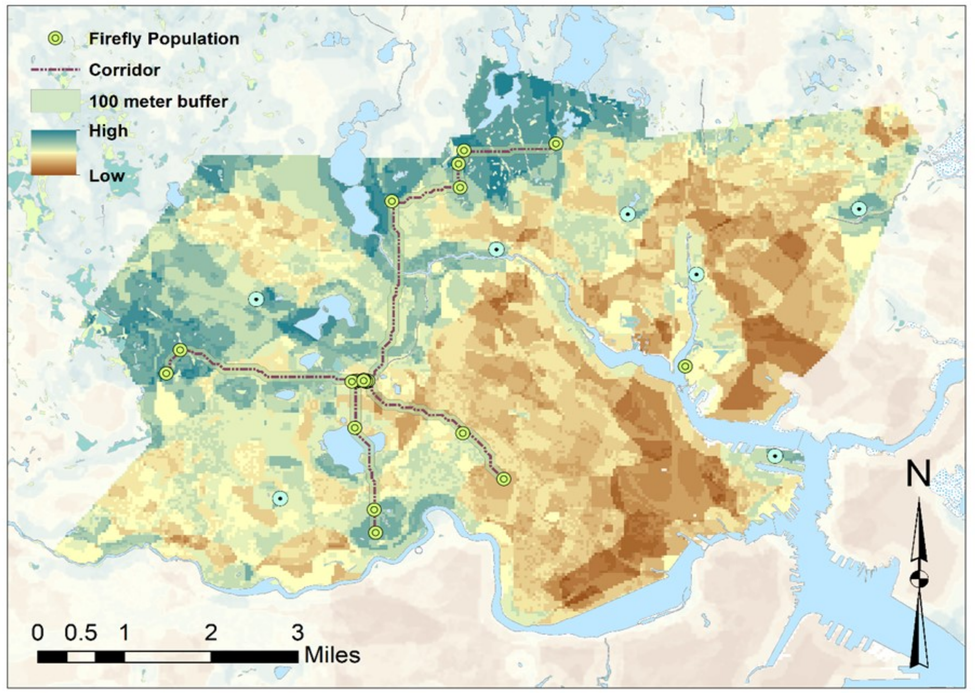
One of the greatest joys during the summertime in New England is seeing tiny firefly lights illuminate the evening sky. Not only are they a spectacle to behold with their chemical luminescence, they provide benefits to local ecosystems. Fireflies are important as bioindicators of many different aspects such as soil, air quality, and vegetation. Many firefly species spend most of their lives as larvae, living underground and feeding. Ergo, they rely heavily on soil health, thriving under conditions where the soil is loamy, has high porosity, and has a stable pH[1]. As adults, when they emerge to mate with conspecifics, their preferences shift to good air quality, undisturbed vegetation, and dark conditions[2].

However, there have been many anecdotal accounts about the decline of fireflies.[3] This decline can be attributed to the growing urbanization of communities that entail destruction of wildlife habitat, light pollution, and use of pesticides, all factors that would prove detrimental to a firefly's survival.

Firefly populations still exist, even in one of the most urbanized and light polluted areas in the country— the Metro Area. In the face of development and urbanization, fireflies are able to survive and live in this typically unideal environment. This project focuses on identifying the factors that would allow these populations to continue to thrive in urban areas and to focus conservation on areas that could still provide a home for fireflies.



Firefly populations in North Boston Metro



Methods

Firefly Population Data: Using citizen science data[4] of firefly sightings, I digitized these point features on a base map of the Northern Boston Metro Area. These sightings were treated as firefly populations. Generally fireflies stray not too far from the population, so sightings serve well as an indicator of a population.

Raster Data: The following factors were used to determine habitat suitability: soil type, population density, vegetation, land use, light data, wetlands areas.

Rasterization of soil, vegetation, land use: Suitable conditions were assumed to be areas where firefly populations have been found on and were given values of 1 (suitable) and 0 (unsuitable).

Rasterization of population density and light:
Suitability was rated on a scale of 1-4, 1 being the most unsuitable and 4 being the most suitable. High Light intensity and high population density were determined to be low suitability.

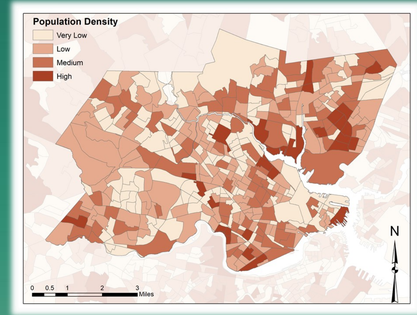
Wetland Buffer:
I created a 250 m buffer from any water source or wetland area since most of the firefly populations were not found beyond that distance from surrounding a water source. I rated the areas within this buffer to be suitable and anything outside of the buffer zone as less suitable.

Sustainability Index and Corridor Analysis
I then used a weighted sum on all of the above factors to create a suitability index on a scale of 1-9. The weights were given for each of the factors in order of importance:

Wetland buffer= 20%
Light Pollution= 20%
Soil = 20%
Population Density= 16%
Land use= 12%
Vegetation=12%

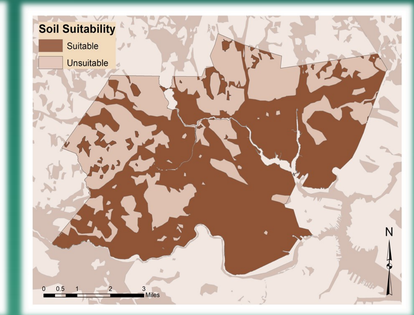
Using the **least-cost path analysis**[5] on ArcGIS, I determined which paths to link isolated populations are the most ideal and created 100 m buffers.

Population Density



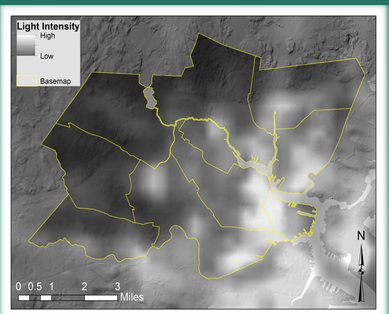
Most firefly populations were found on the areas where there population density was low.

Soil Suitability



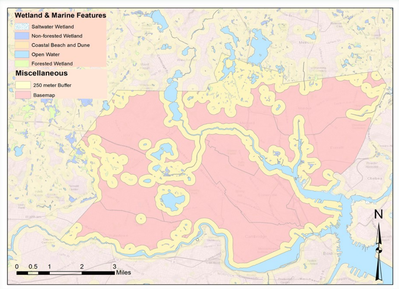
Most firefly populations were found on loose loamy soils.

Light Pollution



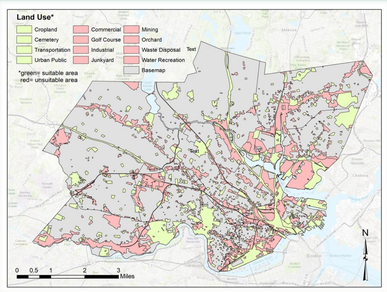
Most fireflies tend to hang out in low light areas, however, some did hang around areas where there was more light.

Wetland Areas



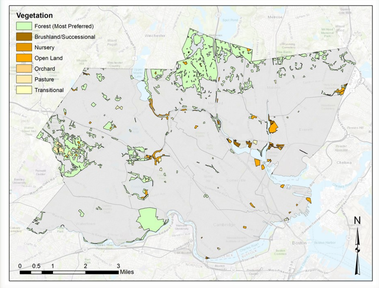
Most firefly populations spotted were not more than 250 meters away from natural water sources, which led me to create a 250 meter buffer zone.

Land Use



Suitable habitats were determined to be cropland, transportation, urban public areas, and cemeteries like Mt. Auburn Cemetery which is also considered as a forested area.

Vegetation



More fireflies were found in forests more than any other types of vegetation. Forests typically provide cover and darkness for the fireflies allowing them to see mating lights.

Results

The final map shows ideal firefly habitats in the Northern Boston Metro area in dark blue. Generally, areas closer to the Boston city area are highly unsuitable, but there are yellow areas where fireflies have been spotted. Firefly populations found further within the city are found within intermediate habitat. No firefly populations were found within the red/ low suitability areas. Areas that remain intermediate or highly suitable can be sites for conservation as it is shown that fireflies can still inhabit these areas.

I have also selected 7 suitable locations based on the suitability index in the Boston area that could better connect existing firefly populations and provide insight as to where to best focus and preserve the area. Along with the proposed corridors for preservation, areas indicated with a light blue point could pose as conservation areas for potential future firefly populations. Higher priority should be given to these areas and areas in yellow that are at risk for turning into unsuitable red areas.

Conclusions

Some of the inaccuracies that come with this data include the assumption that firefly sightings indicate firefly populations. Fireflies may sometime fly out of the normal range of their population, which can explain for some points that indicate fireflies located in lower suitability. Another limitation could be that since the data collected was collected by citizen scientists, there may be inaccuracies in correctly identifying the fireflies spotted. This is only partially accounted for by other experts' rating and confirmation of the sighting and photograph on iNaturalist[4], the source of the dataset.

Another problem is that there are many different firefly species. Although there are general trends in habitat preference among species (i.e. undisturbed vegetation or source of moisture), there may be some differences unaccounted for. For instance, some firefly species, such as the *Ellychnia corrusca* (Winter Firefly), emit no light and can attract each other by scents[6]. In which case, the light pollution data would be of less importance, and I would focus more on factors that would disturb olfactory cues.

This study attempts to address areas where fireflies are thriving in urban environments and try to capitalize on these factors to create more areas where habitats can be suitable not just for fireflies but to increase the overall ecosystem health. Conservation strategies could involve making a green space, preserving more wetland areas, or even reducing lighting in certain areas. Local governments can address areas where light can be turned off or reduced during certain times, or even be replaced with less harmful lights like red lights, that would not disturb a firefly vision during mating and courtship. Residents can also make an impact by reducing the use of pesticides in their lawns and growing some firefly- friendly plants like milkweed. By taking these steps in firefly conservation, we can bring back one of the most beloved insects to light up our skies once again.

Annie Nguyen | EOS 104, May 2018

All maps use NAD 1983 StatePlane Massachusetts Mainland Projection.

Data Sources: Vegetation and Land Use, Water Soures, Residential Density, Soil : MassGIS Data Layer, 2005; Night Data, National Oceanic and Atmospheric Administration, Basemap: Esri ArcOnline, Background and firefly image designed by Annie Nguyen

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