PLAN BEE

A suitability analysis of bee recolonization sites in New England

BACKGROUND

Throughout the past 10 years, pollinating bee populations have been steadily declining, without a clear reason.[1] Extensive research has been conducted in an attempt to determine the cause of this decline. Recently, “failure to thrive” in bees has been linked to the consequences of habitat loss and fragmentation, human disruption, the use of a particular class of insecticides called Neonicotinoids, and other factors.[2]

A potential conservation tactic could be the reintroduction of bee colonies to areas suffering from bee loss in order to encourage population growth. A suitability study of must be conducted to ensure the proper placement of recolonization sites..

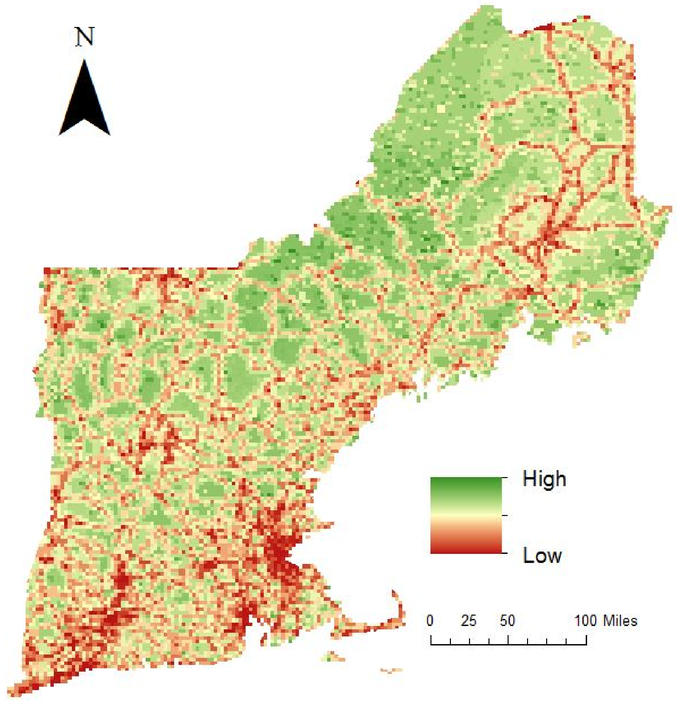
This study focuses on the northeastern United States, specifically New England. Potential reintroduction locations are ranked on a scale, based on how well they meet the criteria set forth (i.e. their suitability). Areas are ranked based on population density, land type, pesticide usage, elevation, and proximity to major roads.

METHODS

For each factor that could potentially be affecting bee success, data was gathered and spatially displayed in a raster format. The data for the insecticide imidacloprid was interpolated from county data. Road proximity was measured via euclidean distance methods, centered on major roads in New England.

In the production of the five maps below, each of which displaying a different factor affecting bee success, each 1000mx1000m* cell (pixel) was assigned a suitability value from 1 (low) to 5 (high) . Then, all of the map data was aggregated into one final map to display the locations with the highest and lowest combined suitability. The aggregated map is weighted, in that some factors have more of an impact on site suitability than others.

From the final suitability map, the best location for the reintroduction of pollinating bee colonies can be determined.



WEIGHTED SITE SUITABILITY

All of the factors hypothesized to affect bee colony success were combined via algebraic functions (the combination of the aforementioned suitability values) into a weighted suitability map. Each factor was weighted by the specified percentage. The easternmost points in Maine were excluded from this aggregated map, as no values were obtained for imidacloprid data, so an overall suitability value for those areas could not be calculated. The red areas on the map indicate low suitability, the beige moderate suitability, and the green high suitability.

ANALYSIS

While it does not indicate only a few specific sites as the “best choice”, the aggregated map can give insight into which broader locations in New England would be worth considering for recolonization efforts in the future, as well as which areas should be excluded from consideration. Most of eastern Massachusetts would likely be excluded from recolonization efforts, but there are several large areas in eastern Massachusetts, Vermont, New Hampshire, and Maine that would be worth examining.

The five factors that this project was based on are not the only factors that significantly impact the survival and success of bee colonies in New England. In future studies, factors such as climate, flower diversity, and toxic emissions should be explored in depth to ensure the highest likelihood of bee colony success. The locations most in need of bee recolonization could also be identified by examining existing bee populations in those areas. Unfortunately, data on existing bee populations organized by anything narrower than the state level are not currently available. This data is projected to be available by June 2016, and may be incorporated into future studies.

DATA AND REFERENCES

Projection: NAD US Contiguous Albers 1980 (2011)
Data Sources: Tufts GIS Data Server, US Geologic Survey Pesticide National Synthesis Project 2008-2012
All work done in ArcGIS and Microsoft Excel

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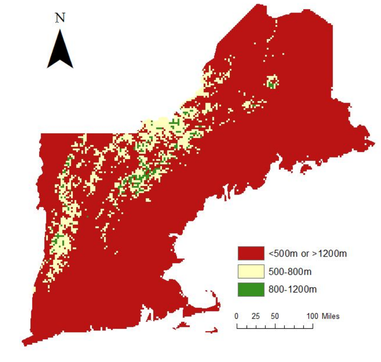
References:

1. Goulson, D., Lye, G., & Darvill, B. (2008). Decline and Conservation of Bumble Bees. *Annual Review of Entomology Annu. Rev. Entomol., 53*(1), 191-208
2 Goulson, D., Nicholls, E., Botias, C., & Rotheray, E. L. (2015). Bee declines driven by combined stress from parasites, pesticides, and lack of flowers. *Science, 347*(6229.
3. Kearns, Carol Ann. "Conservation Status and Population Structure Comparisons of Abundant and Declining Bumblebee Species."

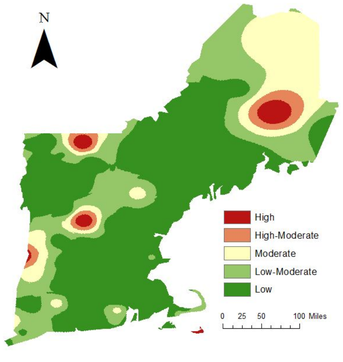
Tufts

SUITABILITY FACTORS



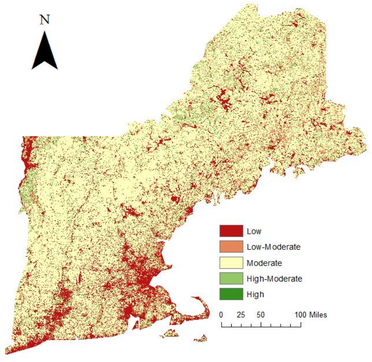
ELEVATION

It has been hypothesized that pollinating bees in low elevation are subject to a lower diversity of flowers and thus a more restricted food supply.[3] On the other hand, the flowering season in the very high elevations is shorter than in lower elevations, restricting feed time. It is possible that the most ideal habitats for pollinating bees may be located in mid-range elevations. This factor is not critical to bee survival, so it was weighted by only 5%.
*The minimum cell size for this raster was 3000m.



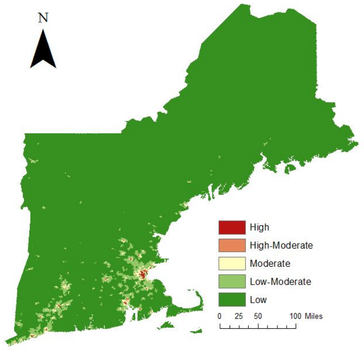
INSECTICIDE USE

In recent years, research has been conducted on the use of a class of insecticide called Neonicotinoids. They are believed to cause nerve damage and failure to thrive in bees. [2] One type of Neonicotinoid is Imidacloprid. Imidacloprid usage data was gathered from the USGS, and was gathered as total weight per county (in kg). County data was then interpolated to form a full-coverage raster. Due to the uncertainty of this factor’s effect, it was weighted by 15%.
**Data would not project to the easternmost points in Maine



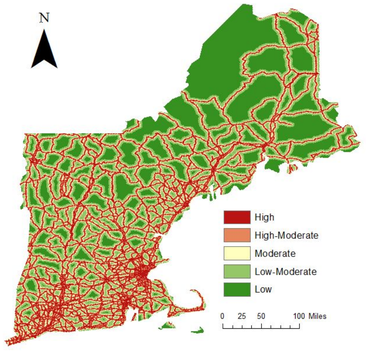
LAND USE

Land cover data was used to locate the most ideal pollinating bee habitats. Locations of low suitability are defined as areas with a high water cover, high urbanization, and low vegetation. Locations of high suitability are defined as areas of high vegetation and low urbanization, mainly pastures and fields. In this classification, low suitability was effectively defined as unsuitable, so this factor was weighted by 30%.



POPULATION DENSITY

Areas of high population density are unsuitable for bees, as these are areas of low habitat suitability and high human interference, as well as a number of other factors. This factor was deemed to have more of an effect that insecticide use and elevation, and was weighted by 20%.



PROXIMITY TO MAJOR ROADS

Habitat fragmentation and loss are two significant factors affecting bee loss. Bee colonies cannot be reintroduced to areas of high fragmentation. Euclidean distance categories of 500m, 1000m, 5000m, and 10000m were calculated to determine the areas most suited to recolonization. Areas greater than 10000m away from a major road were classified as highly suitable, while areas less than 500m away from a road were classified as having low suitability, which, in effect, makes them unsuitable. This factor was weighted by 30%.