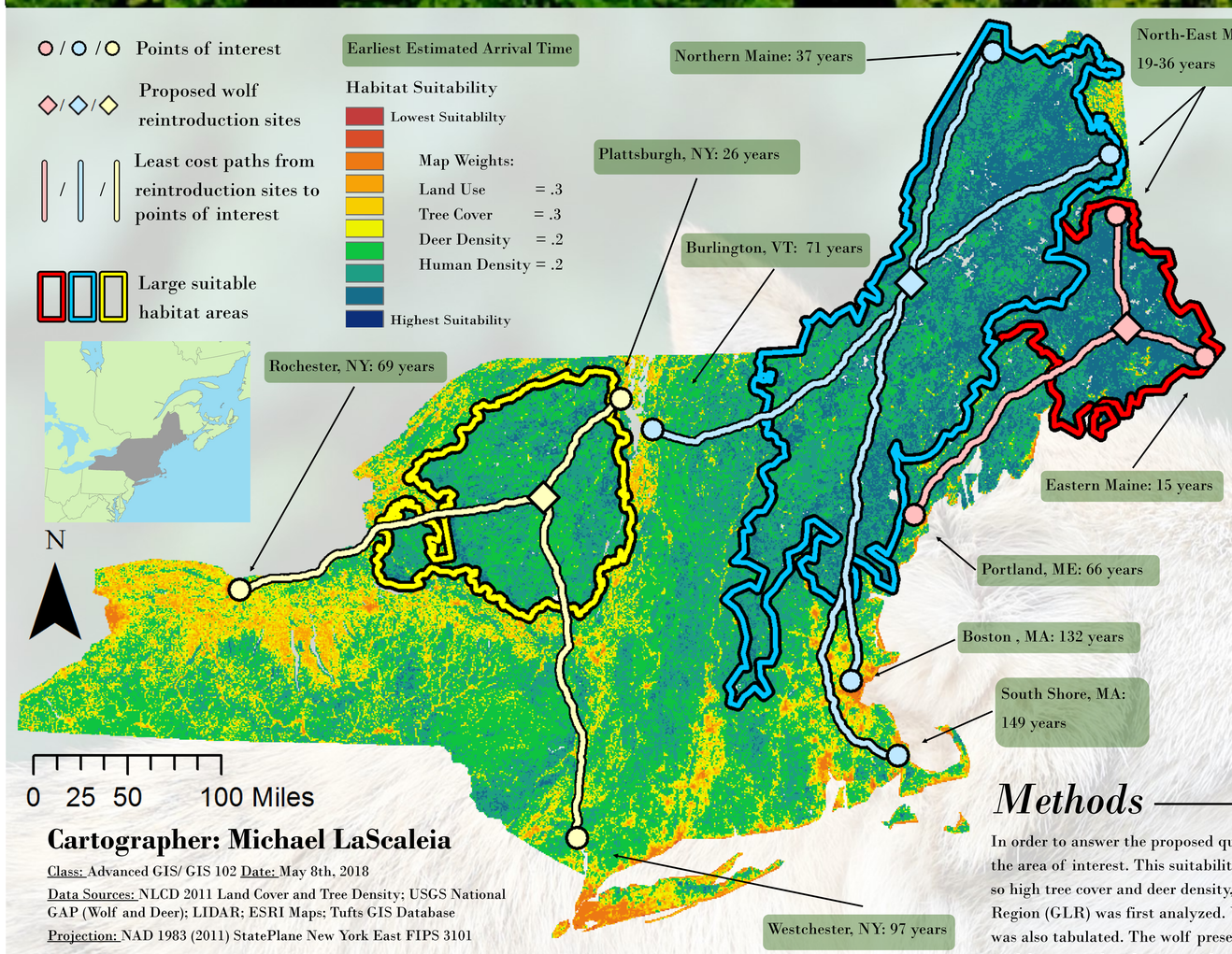
Going Gray: *Following Gray Wolves through a Reintroduction Scenario in New York and New England*



Cartographer: Michael LaScaleia

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Data Sources: NLCD 2011 Land Cover and Tree Density; USGS National GAP (Wolf and Deer); LIDAR; ESRI Maps; Tufts GIS Database

Projection: NAD 1983 (2011) StatePlane New York East FIPS 3101

Introduction

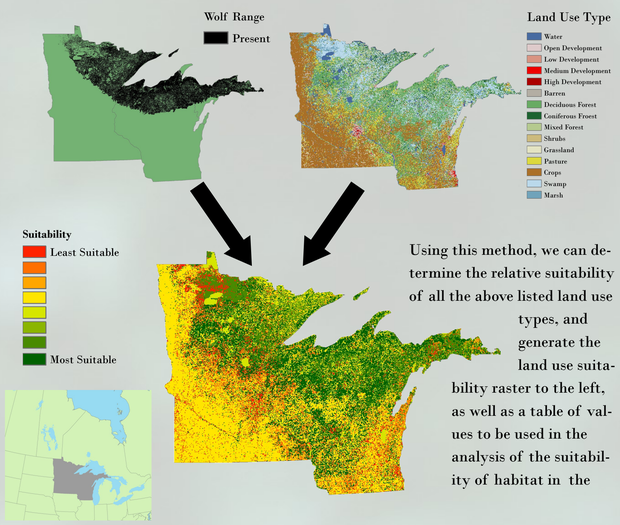
In the year 1630, only ten years after the establishment of the Plymouth Colony, the governing body of the Massachusetts Bay Colony set a bounty any gray wolf killed by settlers. By the year 1840, the gray wolf was extinct in New England. By that time, New England was less than 20% forest cover total, and nearly every square mile that sheep didn't graze had woodcutters aggressively removing lumber. There was no place for the wolves.

One-hundred and fifty years later, New England is now pushing 80% forest cover and is finally feeling the strain from the lack of predators. White-tailed deer have come back to the area in droves. In fact, due to the lack of wolves, there are more white-tailed deer in New York and New England than at any other time in history. As the deer population continues to increase, they will continue to cause a dramatic negative shift in the ecosystems of the area, including eliminating understory brush, increasing human-wildlife conflict through collisions with vehicles, and spreading diseases such as Lyme.

In 1995, as these same problems plagued Yellowstone National Park, a plan was implemented: reintroduce wolves to control the deer population. Despite a fear-based pushback from locals, the wolf reintroduction to Yellowstone has been incredibly successful in restoring the ecosystem back to its pre-wolf extinction baseline. A similar phenomenon has been displayed at other reintroduction sites in the Contiguous US, such as Northern California and the Great Lakes Region. By looking at the current ranges of wolves in the ecosystem most similar to New York and New England, the Great Lakes Reintroduction Area, we will be able to tell whether there is suitable area in New England for wolves (See *The Wolves of the Great Lakes*).

Wolves are also well known for their ability to both colonize new areas incredibly quickly, and travel great distances in search of suitable habitat. This can be a great boon to a small and struggling wolf population but is also one of the main reasons why wolves can be such a pest. While traveling through pasture wolves will often attack and kill livestock. People also tend to fear for their own safety around wolves, though wolf attacks on people are incredibly rare (Only two people have been killed by wolves in North America in recorded history). For this reason, it will be important to document how quickly wolves distribute to the edge of their ideal habitat, and to large cities like Boston and Burlington.

The Wolves of the Great Lakes



Using this method, we can determine the relative suitability of all the above listed land use types, and generate the land use suitability raster to the left, as well as a table of values to be used in the analysis of the suitability of habitat in the

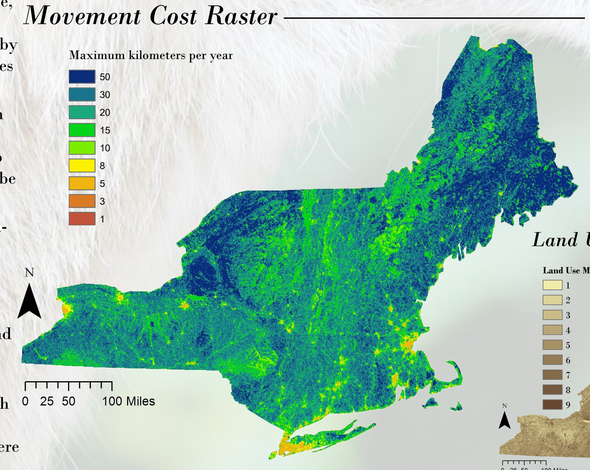
Methods

In order to answer the proposed questions, two aggregate rasters were required. The first raster was the suitability raster, which showed whether there was a large area of suitable wolf habitat in the area of interest. This suitability map required four layers: 1.) population density, 2.) tree cover, 3.) deer density/presence and 4.) land use suitability. Rasters 1-3 were produced and reclassified so high tree cover and deer density, plus low population, each had the highest suitability. For the land use raster, data from the Great Lakes Region (GLR) was first analyzed. Wolf data from the GLR a was aggregated with a fishnet raster of 1500mx1500m. In this fishnet, land use was also tabulated. The wolf presence of each fishnet square was then fit to a glm in R against each land type, and the coefficients from each model were used to determine the ranked suitability for wolves in each land type (See *Land Use Suitability*). These raster were then combined with weights population density = .2, tree cover = .3, deer density = .2, and land use type = .3, to produce the Habitat Suitability map (top left). From this map, the large suitable area polygons were drawn along the borders of slightly suitable areas and slightly unsuitable areas. Finally, the reintroduction points were placed near the center of each polygon.

Land Use Suitability

Land Use Type	Suitability
Water and Cropland	1
Med/High Development and Pasture	3
Barren	4
Low Development and Deciduous	5
Swamp and Marsh	6
Coniferous Forest	8
Grassland	9
Mixed Forest and Shrubs	10

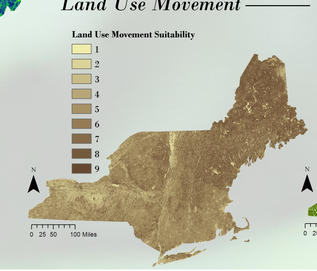
Movement Cost Raster



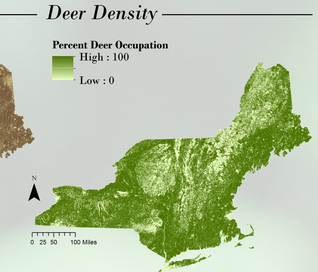
The second raster created was *Movement Cost Raster* (Left). This raster was created from the four layers shown below (*Land Use Movement*, *Deer Density*, *Roads*, and *Slope*). All rasters were weighted evenly after reclassification. The following raster was then reclassified based on the colonization speeds of wolves. In their lifetime, a wolf might travel up to 500 km away from their birthplace. The movement cost raster was reclassified to reflect the colonization under the assumptions this distribution is in ideal conditions, and a wolf lives for 10 years.

To create and measure the paths of wolves to major cities, backlink rasters were created from each point of interest (POI) based on the movement cost raster. After paths were created from the reintroduction sites to their respective closest POIs, the total cost across each path was individually aggregated to determine the total time for wolves to reach a each POI.

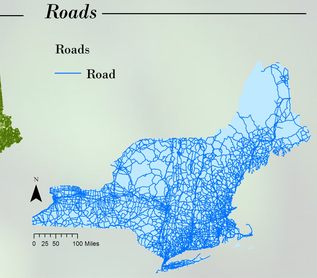
Land Use Movement



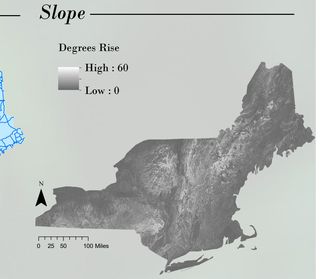
Deer Density



Roads



Slope



Conclusion

There are three areas in New York and New England that have an acceptable amount of suitable habitat to support a wolf population. They are outlined in red, blue and yellow above. The red area consists of the most suitable area: Eastern Maine, where there is dense forest, many deer, and few people. Northern and Northwestern Maine, outlines in blue, is similar in quality and has acceptable habitat that stretches all the way south to Quabbin Reservoir in Massachusetts. Finally, and somewhat predictably, Adirondack Park in New York offers a sparsely populated have surrounded by pasture and agriculture. All three of these areas offer the possibility of movement between wolves in the United States and in Canada, which would promote genetic diversity and prevent inbreeding depressions.

Despite their general suitability, it must be noted that there are people and livestock who live within these areas, such as the cattle farmers in Plattsburg, NY, for whom wolves might have a negative effect. Wolves will likely reach the farming communities around Lake Champlain in under 40 years, though in the best case scenario they would move to the other more suitable areas in the west. No matter where wolves are introduced and where they move to, there will be human-wildlife conflict that must be mitigated as a result.

If the wolves are reintroduced near the center of each habitat zone, they will likely colonize most of the nearby suitable area very quickly. While the times listed above may seem like wolves will eventually colonize all of New England, it is important to remember that those are the *fastest possible* times a wolf might arrive there. For the shorter times, these estimates are more likely. The conditions in Eastern Maine are so optimal that wolves might start venturing there in under 10 years (but will likely not colonize before 15 years). For the farther areas, like Boston, Westchester and the South Shore (all ~100+ years), it is highly unlikely wolves will ever reach here, simply because the habitat and movement is so sub-optimal. It is even doubtable they will colonize closer areas like Portland and Rochester in near their fastest estimated time due to the ample more-suitable habitat elsewhere.

Based on this map, an argument can be made for wolf reintroduction to New York and New England. There is enough suitable habitat to support large populations of wolves. Additionally, wolves will likely stay away from large population centers and will reduce deer populations. Ultimately, there will be conflict between people and wolves, though these can be kept to a minimum if wolves are reintroduced to the areas shown in the map above.

Tufts