Bogs or Wetlands?

A Suitability Analysis for Wetland Restoration of Cranberry Bogs in S.E. Massachusetts

Background

The Problem: Southeastern Massachusetts is well-known for its historic cranberry industry, and produces nearly one-quarter of the country's cranberries. Recently, however, the industry has not been faring well—production went down 16% between 2016 and 2017, and average price per barrel dropped as well. Production has been moving away from New England to Canada and the Midwest, where they are able to grow more productive cultivars. At the same time, S.E. Massachusetts has been experiencing severe water pollution. Most of this pollution is excess nitrogen in ground and surface water, primarily caused by the high number of septic systems. When the nitrogen makes its way into lakes and bays, it causes algae blooms and hypoxia, which is a hazard for humans and wildlife, alike. Many lakes and rivers in the area of interest have federal mandates to reduce the amount of nitrogen and pathogens that reach the water.

The Solution: Luckily, there's potential for a "win-win" situation. Farmers could sell their land to a conservation organization, or place their land into an easement through the U.S. Natural Resource Conservation Service. This would allow farmers to leave the industry with money in their pockets. Additionally, restoring the cranberry bogs to naturalized wetlands would remove nitrogen and other contaminants from the water in a natural and cost-efficient way, and also provide wildlife habitat and scenic areas.

Research Question: Which cranberry bogs located in Southeastern Massachusetts are the most suitable to be restored to naturalized wetlands?

Methods

In order to conduct the suitability analysis, I used five layers of data. All of the layers except for Hydric Soils were originally polygons, and were rasterized into 30x30 meter cells.

Cranberry Bogs: This layer, from Mass GIS, shows all of the state's cranberry bogs. The suitability analysis is limited to the area of these bogs.

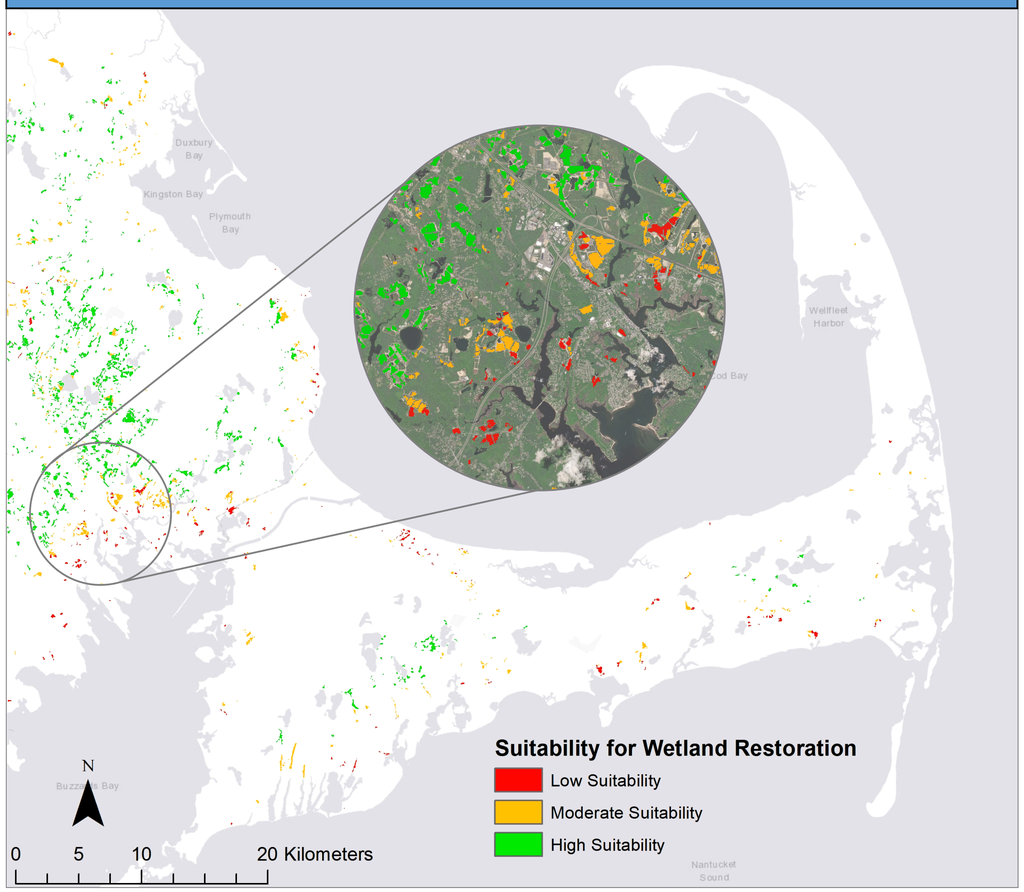
Sea Level Rise: This layer, from NOAA, shows a prediction for 3-foot sea level rise. I chose 3 feet because it's high enough to have an impact on the suitability analysis, but not so high that the timeline is impractically distant. Freshwater wetlands are sensitive to salinity, so I prioritized bogs further from the sea—it doesn't make sense to restore a wetland if it will soon be submerged.

Conserved Land: This layer, from Mass GIS, shows all land classified as Conservation and Conservation/Recreation, which contains beaches, forests, etc. I prioritized bogs that are further from conserved land, because conserved land could perform some of the same habitat and nitrogen attenuation functions to an area.

Hydric Soils: This layer, from ESRI, shows the percentage of the map unit that is classified as hydric. Hydric soils are very poorly drained, and are a requirement for a functional wetland. Most cranberry bogs are located on primarily hydric soils. I prioritized bogs on more hydric soils.

Impaired Water: This layer, from Mass GIS, shows all rivers and water bodies that are nutrient or pathogen-impaired. I prioritized bogs that were closer to impaired waters, because of the water quality benefits they provide

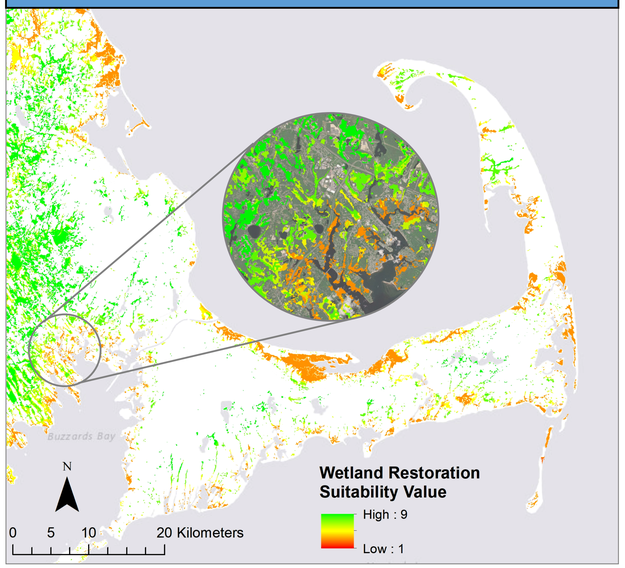
Most Suitable Bogs for Wetland Restoration



Analysis: Using Model Builder, I used Euclidean Distance on the Sea Level Rise, Conservation Land, and Impaired Water layers to find the distance from each factor. Then I Reclassified the distances into a 1-9 scale, with 9 as the most suitable. Then I used Fuzzy Membership (large membership) to change distance into a continuous (0-1), rather than classified, raster. Next I used Raster Calculator to add up the values for each raster cell in the Sea Level Rise, Conservation Land, Impaired Water, and Hydric Soil layers. I used BPMSG online to calculate weights for the four criteria, and multiplied the values of each layer by the suggested weights. Because Hydric Soil was on a 0-2 scale, I also multiplied the other three layers by 2, so they were equivalently weighted. The output is the Wetland Restoration Suitability Value, which is classified from 1-9. Finally, I used Zonal Statistics to calculate the majority value of the Suitability Value, to determine which were the most suitable bogs for restoration. I then manually Reclassified it into three categories: 3-6.5 (low suitability), 6.5-8.5 (moderate), and 8.5-9 (high).

Factor Weights	%
Distance to SLR	28.9%
Distance to Conservation Land	17.5%
Distance to Impaired Water	24.6%
Hydric Soil	28.9%

Wetland Restoration Suitability Value



Results

Results: According to this suitability analysis, 1,538 cranberry bogs in the area of interest were classified as "High Suitability" based on the included criteria. This means that they should be prioritized for wetland restoration. The general pattern appears to be that the most suitable bogs are located inland, which makes sense considering that Sea Level Rise was a factor.

Suitability Value	Reclassified	# of Bogs	Acres
3-6.5	1	302	957
6.5-8.5	2	776	2,465
8.5-9	3	1,538	5,521

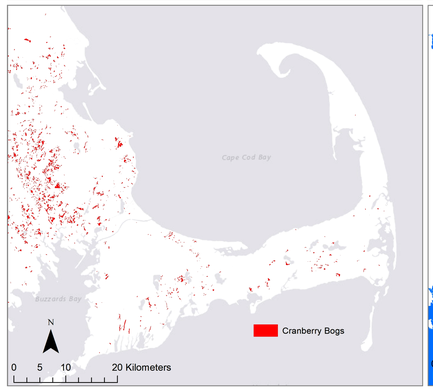
Limitations: There are several important limitations on this analysis.

Age of Data: Most of the data have been updated within the last 2 years, with the exception of the Impaired Waters layer, which was last updated in 2014. It is likely that there are changes that have not been accounted for.

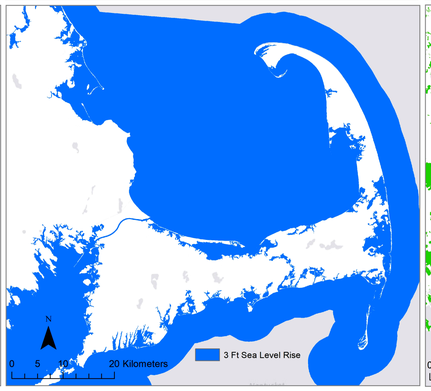
Granularity: The Hydric Soils layer had a raster size of 30x30 meters, so I rasterized the three polygon layers to match. It is possible that some areas were not accounted for because of the cell size.

Missing Data: Wetland Restoration suitability often takes many more factors into account, such as groundwater movement, and presence of wetland vegetation. Adding more factors to this analysis would have strengthened the results, but I was unable to find appropriate data.

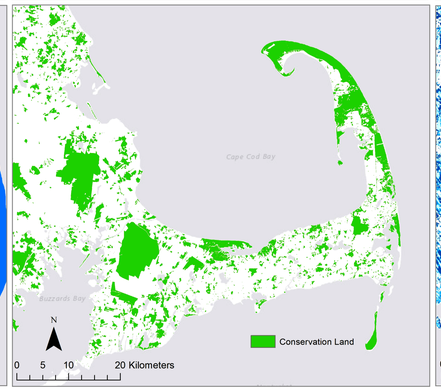
Cranberry Bogs



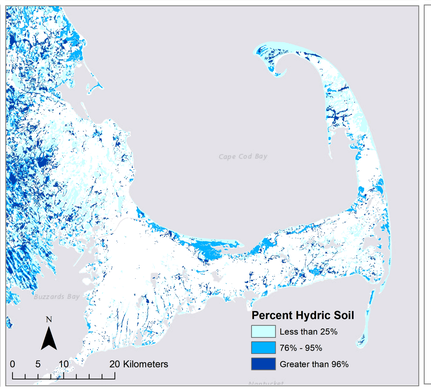
Sea Level Rise



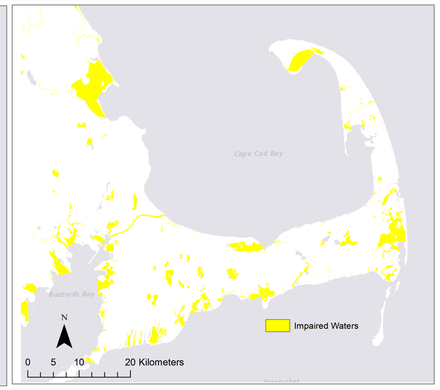
Conservation Land



Hydric Soils



Impaired water



References

Cranberry Data: MassDEP Hydrography, MassGIS, 2017

Sea Level Rise: NOAA, 2018

Conservation Land: Protected Open Space, MassGIS, 2019

Hydric Soils: USA Soils Hydric Class, ESRI (Originally from Natural Resources Cons. Service), 2017

Impaired Waters: Integrated List of Waters, MassGIS 2014

Images: Pexels.Com and Wikimedia.Org

Coordinate System: NAD 1983 State Plane Massachusetts Mainland FIPS 2001

Projection: Lambert Conformal Conic

Map Created by Emily Liss
Tufts University
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