Introduction

The Three Bays Watershed is a complex estuary located in the Town of Barnstable on Cape Cod. The watershed has been deemed an area of high concern by the Massachusetts Estuary Project report (2006). The main ecological threat to the watershed is degradation from excessive nitrogen loading. The primary sources of nitrogen include waste disposal, fertilizers, and changes to freshwater hydrology as a result of development. One solution for increasing nitrogen attenuation is through the restoration of wetlands. Wetlands provide crucial ecosystem services and habitat that contributes to the health of the watershed.

The purpose of this project is to develop a watershed-level, site-suitability model using GIS techniques to assess the potential for wetland restoration in the Three Bays Watershed. Existing sites were identified and integrated with the proposed restoration locations to maximize the potential area for nutrient mitigation and increased available wetland habitat. Other factors used in the analysis, included current land use, slope, and hydric soils criteria. In addition, the analysis provides a recommendation of a location of a possible wetland restoration pilot project based on the results of the study.

Methodology

Wetland restoration is a complex process and requires many different indicators to evaluate the restoration suitability. A suitability modeling approach is taken, using a multi-criteria evaluation. To identify suitable sites for wetland restoration, this analysis used the MaxGIS 2005 Land Use data, existing wetlands data from the Department of Environmental Protection, and NRCS soils data to identify slope and hydric soils. A normalized value system was assigned for each raster from 0 (not suitable) to 4 (high suitability).

For land use preference I gave wetlands a ranking of 4. Beaches, vacant land and open land were given a ranking of 3. Cropland, pasture, and other grassy areas were given a ranking of 2. Shrubland was given a ranking of 1. The urban areas, residential areas, forested, and open water areas (including reservoirs) were ranked as 0, because they are considered to be unsuitable for wetlands.

For the slope layer, I ranked 0% as 4, 0-3% as 3, 3-8% as 2, 8-15% as 1, and anything above 15% as 0. The hydric soils criteria is defined by the NRCS in four categories: 1 are hydric soils and 2, 3, and 4 are hydric inclusions. For the hydric soils criteria, I ranked “1” as 4, “1.13” as a 3, “1.2” as a 2, and all other soils as not suitable. To evaluate riparian habitat I used a euclidean distance tool to show distance, in meters, from each cell to the nearest existing wetlands. The wetland distance was reclassified from 0 (not critical) to 4 (most critical). For the distance from existing wetlands layer, I ranked 0-50 meters as a 4, 50-100 meters as a 3, 100-200 meters as a 2, 200-500 meters as a 1, and everything beyond 500 meters as not critical. A simple weighted summation was used to create a new suitability map. Using a raster calculator, a map algebra statement was created 

Suitability Factors

Land use is one of the major factors of determining a location suitable for wetland restoration. The most optimal locations in terms of land use are areas, such as wetlands, dunes, and cranberry bogs. Areas are classified as hydric soils (high suitability), hydric inclusions (somewhat suitable), and all other soil types are considered not suitable.

Slope is an important factor in identifying lands that could be susceptible to erosion. Wetlands are best located on lands with low slope. Areas with slope less than 3% are considered highly suitable. Areas with a slope above 15% are considered unsuitable.

Hydric soils are those that are formed under conditions of saturation, flooding, or ponding. Hydric soils are used to determine wetlands Soils are classified as hydric soils (high suitability), hydric inclusions (somewhat suitable), and all other soil types are considered not suitable.

The distance from existing wetlands is used as a suitability factor to take into account riparian habitats. Areas between 0 and 100 meters are classified as critical. Areas more than 500 meters from the existing wetlands are considered as not critical.

Results

According to this map, there are very few areas that would be considered to be highly suitable for wetland restoration. Most of the area considered to be suitable for wetland restoration are along existing wetways or cranberry bogs. Much of the surrounding area is residential or densely forested, so that land was deemed unsuitable for this analysis. The map shows where the best areas that were not suitable for wetlands. The limited amount of areas that resulted in a high suitability score does provide a relatively strong model for a assessing suitable land for wetland restoration.

Conclusion

Based on the results of this suitability analysis, I provide a possible wetland restoration site. At the headwaters is the Three Bays Watershed is the Hamblin Cranberry Bogs. These bogs have been in production for hundreds of years and has overtime contributed to the excessive nitrogen levels in the watershed. Highly fertilized commercial and residential landscapes are estimated to account for 10% of excessive nitrogen in the watershed. With the decline in cranberry production in Cape Cod, landowners are searching for new alternatives for their bogs. At the Hamblin Cranberry Bogs, there is an inactive bog that is naturally being restored back into a wetland. This wetland is also located next to two ponds, which have been recognized for high nitrogen attenuation. To initiate a pilot project for wetland restoration, the proposed restore the natural hydrology and re-establish the wetland on the retired cranberry bog. This will allow for testing of actual nitrogen attenuation rates.

This model provides a useful tool to set goals for wetland restoration. It is limited in that it does not address individual sites or what type of wetland would be most suitable for that location. There are also limitations to the data sets themselves. Using a more updated land use, rather than the 2005 data set, could provide varied results. I would expect levels of development, especially residential, forested land, and cranberry bogs in production would be significantly different from today. An increase in residential land could decrease the amount of suitable land for wetland restoration, whereas higher levels of retired cranberry bogs could provide higher levels of potential wetland restoration sites.

Moving forward, there are many variations that can be developed from this model. Evaluating multiple alternatives is important for decision makers to determine suitable lands for wetland reclamation that take into account local conditions and regional priorities.