Locating Potential Vernal Pools in Westford, MA Using a GIS Model

Brielle Kissel, CE 194GIS, June 27, 2008

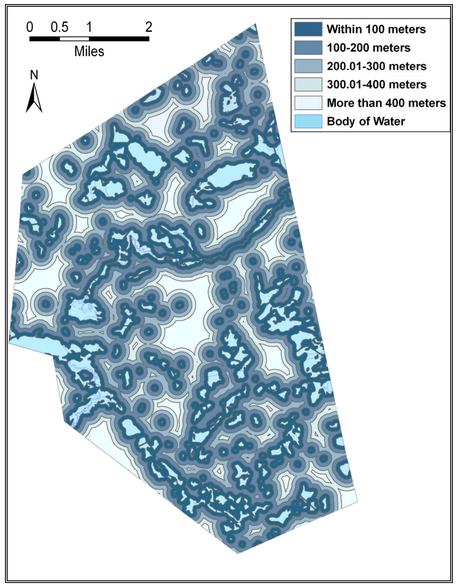


Figure 1. Proximity to water in Westford, MA. Map includes 4 buffer rings of 100m each around bodies of water.

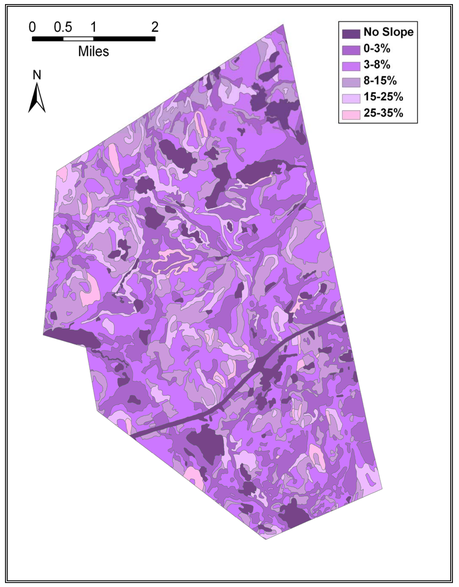


Figure 2. Slope of land in Westford, MA. Map is based on soil data that included slope.

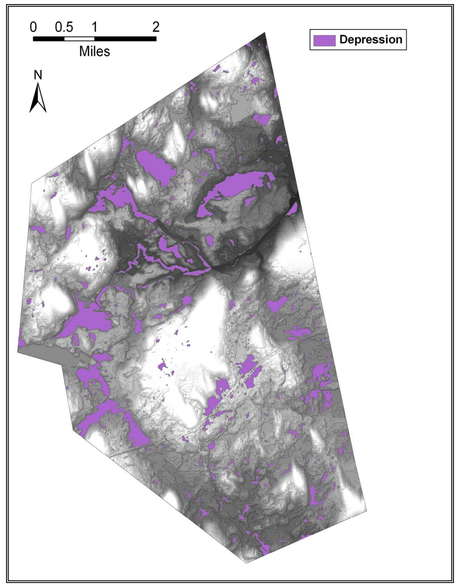


Figure 3. Depressions in Westford, MA. Depressions are calculated from elevation data.

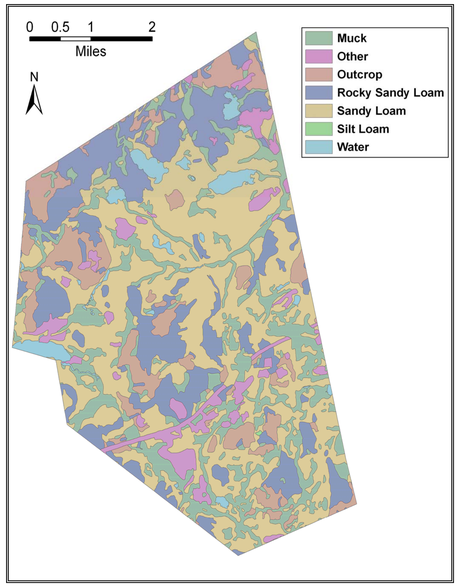


Figure 4. Soil Reclassification in Westford, MA. MassGIS soil data included over 80 unique soil types; this figure reclassifies the data into 7 unique categories.

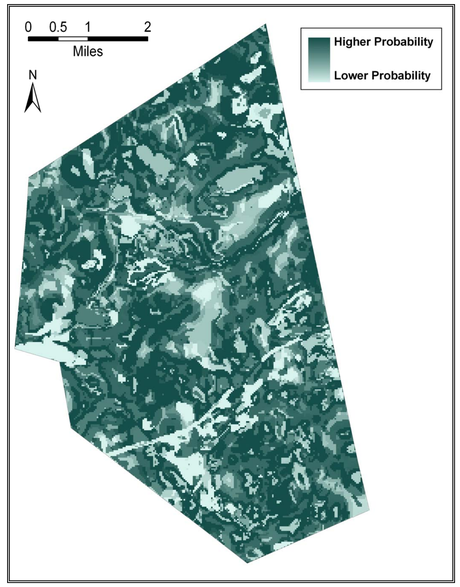
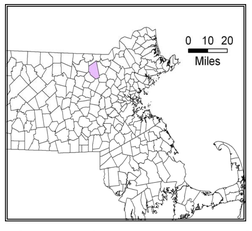


Figure 5. Location of potential vernal pools in Westford, MA. Probability was calculated using multivariate regression and represents the log odds of each location being a vernal pool.



Background

Vernal pools are temporary pools of water that typically form in the spring from melting snow and rain runoff. Vernal pools provide unique breeding habitat for many invertebrate animals and amphibians, some of which are dependent on vernal pools for their survival. Besides providing homes for many species (as well as sanctuary to migrating birds), vernal pools help moderate seasonal flooding and maintain water quality.

In Massachusetts, vernal pools may be certified by the Natural Heritage & Endangered Species Program. Certification provides protection to vernal pools and boundary habitat granted by the Wetlands Protection Act.

Objectives

Certifying vernal pools ensures that these fragile ecosystems are not impacted negatively by human activity. In order to certify vernal pools, one must be able to find and document a pool. This can be a difficult task, as the pools run dry for part of the year.

The goal of this project is to use a GIS model to predict the location of vernal pools in Westford, MA based on environmental factors of known pool locations.

Source: MassGIS
Projection: Massachusetts State Plane Mainland, NAD 1983, meters

Methods

GIS was used to map four selected environmental factors that could have potential effects on the location of vernal pools.
Proximity to Water. Many known vernal pools appear to be close to other bodies of water. Four buffer rings of 100m were created around bodies of water in Westford (see Figure 1).
Land Slope. Figure 2 presents the slope of land in Westford.
Land Depression. Westford elevation data was used to locate depressions in the land (i.e. areas with lower elevation than surrounding land). Depressions seem like likely spots for water to accumulate, possibly forming vernal pools (see Figure 3).
Soil Type. Available soil data included over 80 unique soil types. These were reclassified in GIS to 7 unique soil categories (see Figure 4).

The four maps created were used to determine the environmental factors present at the 102 certified vernal pools in Westford, MA. The same environmental factors were determined at 770 points in Westford known *not* to be vernal pools. This allowed a standard multivariate regression technique to be used to identify the actual relationships between the known vernal pool sites and the four environmental factors.

Results

Table 1 provides results of the regression analysis used to determine the relationships between the factors and the probability that a certain location would be a vernal pool or not. The coefficient values in column 2 represent the relationship for each factor: holding all things constant, if the factor in column 1 is true, the (log of the) odds of this particular location being a vernal pool go up by the coefficient value.

The regression also suggests, however, that the observed results can be attributed to chance alone and that the factors analyzed do not affect the location of vernal pools in a discernable manner (see the p-values in the 'P>z' column of Table 1).

Despite the shortcomings of this model, in order to demonstrate how it would be applied if the results were statistically significant, the coefficient values were added together to create a raster map of Westford showing the locations that are likely to contain vernal pools (see Figure 5). This map could be used by professionals or citizens to target their search for vernal pools.

Follow-up for this project should include an analogous analysis of a broader range of potential factors that may influence the location of vernal pools. Once factors that are statistically significant are determined, a map similar to Figure 5 could be created to target vernal pools.

Independent Variable	Coefficient	Std. Err.	z value	P>z	[95% Conf. Intvl]	
In Depression	0.5790	0.379	1.53	0.126	-0.163	1.321
Within 100 m of water	1.0830	0.390	2.78	0.005	0.319	1.847
100-200 m to water	0.7431	0.421	1.77	0.077	-0.081	1.568
200.01-300 m to water	0.7347	0.436	1.69	0.092	-0.119	1.589
300.01-400 m to water	0.1713	0.543	0.32	0.752	-0.892	1.235
Soil: Other	-1.3052	0.995	-1.31	0.19	-3.256	0.645
Soil: Outcrop	0.7565	0.664	1.14	0.255	-0.546	2.059
Soil: Rocky Sandy Loam	0.7399	0.630	1.18	0.24	-0.494	1.974
Soil: Sandy Loam	0.0477	0.546	0.09	0.93	-1.023	1.118
Soil: Water	-0.3270	1.165	-0.28	0.779	-2.610	1.956
0-3% Slope	0.1878	0.836	0.22	0.822	-1.452	1.827
3-8% Slope	0.1566	0.725	0.22	0.829	-1.263	1.577
8-15% Slope	-0.1011	0.760	-0.13	0.894	-1.591	1.389
15-25% Slope	-0.6666	0.825	-0.81	0.419	-2.283	0.949
25-35% Slope	-1.3086	1.265	-1.03	0.301	-3.788	1.170
Constant	-3.0099	0.943	-3.19	0.001	-4.858	-1.162

note: 'Soil: Muck' variable, 'Soil: Silt Loam' variable, and 'No Slope' variable dropped due to colinearity

Table 1. Logit regression results for four environmental factors' (proximity to water, soil type, slope, in depression) relationships to probability of a location being a vernal pool.