Maximizing the Environmental and Social Benefits of Land Conservation

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Introduction

The goal of the project is to identify land available for conservation in the Ipswich River Basin in Massachusetts (Figure 1) and to prioritize land acquisition to maximize environmental and social benefits. Unprotected land is prioritized based on a set of criteria including type of land use, proximity to permanently protected areas, location of critical habitat, proximity to surface water, current level of protection, projected level of development, area fragmentation and public access. Areas with the five highest priority rankings are compiled in decreasing size and a price indicator based on median owner occupied housing value is provided for comparison.

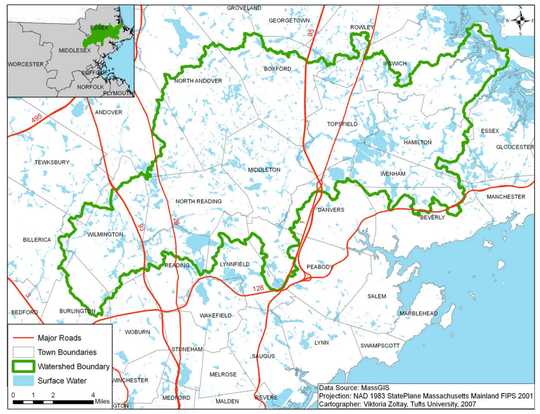


Figure 1. Context map for the Ipswich River Watershed.

Methodology

The criteria, rationale, data source and ranking scheme used in the analysis are summarized in Table 1. The elements of such a table may be determined by the land conservation organization with public input. The values in Table 1. were assigned for the purpose of demonstrating the geographic information system analysis technique.

The analysis was performed using MassGIS data layers and ESRI ArcMap 9.1 software. The data layers in Table 1. were converted to raster format and reclassified according to the ranking scheme. The weighted overlay tool in spatial analyst was used to combine all the criteria into one composite priority indicator. With this tool each criterion's relative influence on the final indicator may be specified.

In the first analysis, all criteria were equally weighted. In the second, it was assumed that residential access to the potential conservation areas was important in order to facilitate recreational use and continued support for land protection and as a potential source of revenue. The ranking scheme for proximity to roads (Criterion 8, Table 1.) was reversed as easy access is more desirable. In addition, the influence of proximity to roads and proximity to residential land use (Criterion 9, Table 1.) were both set at 15 % and all other layers were set at ~8.6% to total 100%.

The resulting priority layer was converted to polygons and their areas were calculated using Hawth's table tool. Due to the lack of other data, the 2000 United States Census data on owner occupied median housing values were used as a relative price indicator for land value. This data table was joined to the polygons and the five largest of the highest ranking areas were selected for each analy-

Table 1. Criteria for Suitability Analysis

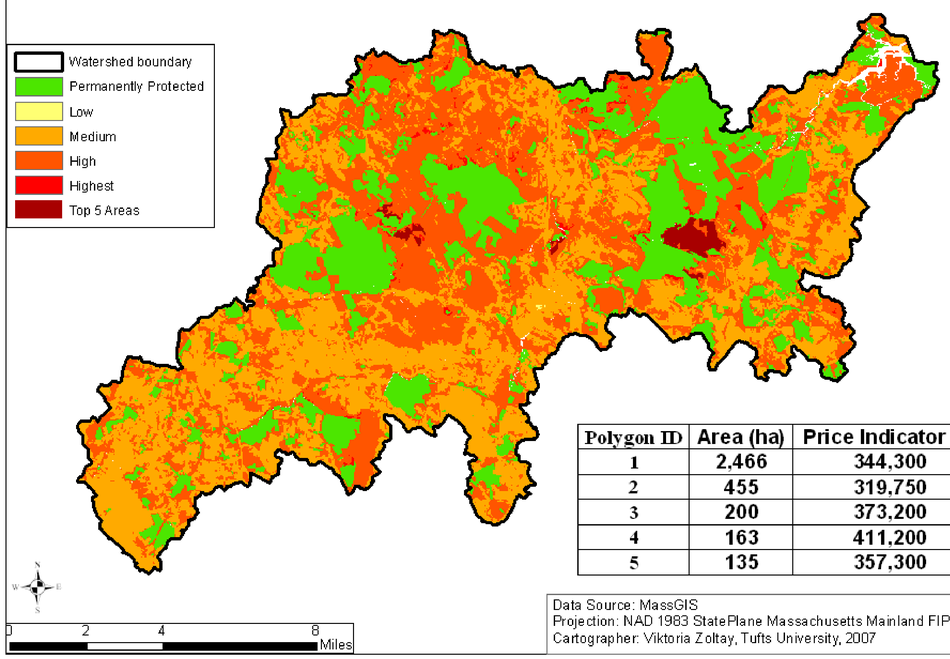
Criterion		*Rationale*	*GIS Data**	*Ranking Scheme*	
1	Land Use	Certain land use and land covers such as wetlands and forest are more important to natural communities and do not require restoration effort or time as pasture or cropland land uses may.	The Massachusetts Executive Office of Environmental Affairs funded the acquisition of 1999 land use data using 1:25,000 aerial color infrared photography.Photointerpretation and digitizing were completed by the UMASS Department of Forestry Resource Mapping Project.	5	Forest, Wetlands
				4	Open, Woody Perennial
				3	Pasture, Cropland
				2	Urban Open
				1	Waste Disposal
				0	Residential, Commercial, Industrial, Transportation, Recreational, Mining, Water
2	Proximity to Protected Lands	Larger parcels of protected lands offer a greater ecological value that similar size but discontious areas.	The Protected and Recreational Open Space layer represents parklands, forests, golf courses, playgrounds, wildlife sanctuaries, conservation lands, water supply areas, cemeteries, school ball fields, and other open land that may be classified as protected and/or recreational in use as compiled by MassGIS at 1:25,000 scale.	5	0-5 m
				4	5-100 m
				3	100-400 m
				2	400-800 m
				1	>800 m
3	Critical Land Habitat	The most viable habitat for rare species and natural communities are a priority for conservation.	Natural Heritage and Endangered Species Program scientists delineated habitat polygons at a scale of 1:25,000 or larger using digital boundaries of base feautres and "heads up" digitizing.**	5	Core Habitat
				4	Supporting Landscape
				0	All other
4	Critical Water Habitat	Lakes, ponds, rivers, and streams important for the protection of freshwater biodiversity are priority for conservation.	Natural Heritage and Endangered Species Program biologists delineated habitat polygons at a scale of 1:25,000 or larger using field data sets of species occurances and "heads up" digitizing.	5	Core Habitat
				4	Supporting Landscape
				0	All other
5	Proximity to Surface Water	Undeveloped land can help protect surface waters from nonpoint source pollution.	The data includes surface water (lakes, ponds, reservoirs), wetlands, bogs, flats, rivers, streams, and others. It is based on USGS Digital Line Graphs and digitized from paper USGS 1:25,000 Topographic Quadrangle maps by MassGIS.	5	0-5 m
				4	5-100 m
				3	100-400 m
				2	400-800 m
				1	>800 m
6	Previously Identified Protected and Recreational Open Space	Areas already identified as land important for conservation and/or recreation but are not permanently protected are higher priority.	The Protected and Recreational Open Space layer (same as in Criteria 2) includes the level of protection as one of the fields in the attribute table.	5	No protection
				4	Limited or Temporary
				3	Unknown
				0	Permanently protected
7	Zoning	Lands zoned for more intense level of development are more important to protect.	Executive Office of Environmental Affairs' Community Preservation Initiative sponsored buildout projections including digital zoning for each municipality in Massachusetts. The zoning shows the highest density of development permitted as a matter of right.	5	Industrial
				4	Commercial
				3	Residential
				2	Other
				1	Conservation/Passive Recreation
8	Proximity to Roads	Proximity to roads is used as a measure of land area fragmentation. As in criteria 2, larger contigous areas are of greater ecological value.	Official state-maintained street transportation dataset depicting local and major roadways. Road and rail centerlines at 1:5,000 scale were interpreted from black and white digital orthophotos.	5	>800 m
				4	400-800 m
				3	100-400 m
				2	5-100 m
				1	0-5 m
9	Proximity to Residential Land Use	Access for recreational use is important for appreciation and support of nature and land conservation and may serve as a revenue source.	This data was derived from the land use layer used in Criteria 1.	5	0-5 m
				4	5-100 m
				3	100-400 m
				2	400-800 m
				1	>800 m

* All data layers used in the analysis and information in this table was accessed from MassGIS. This column indentifies the original data sources.
** "Heads up" digitizing is drawing on the screen using digital technology.

Results

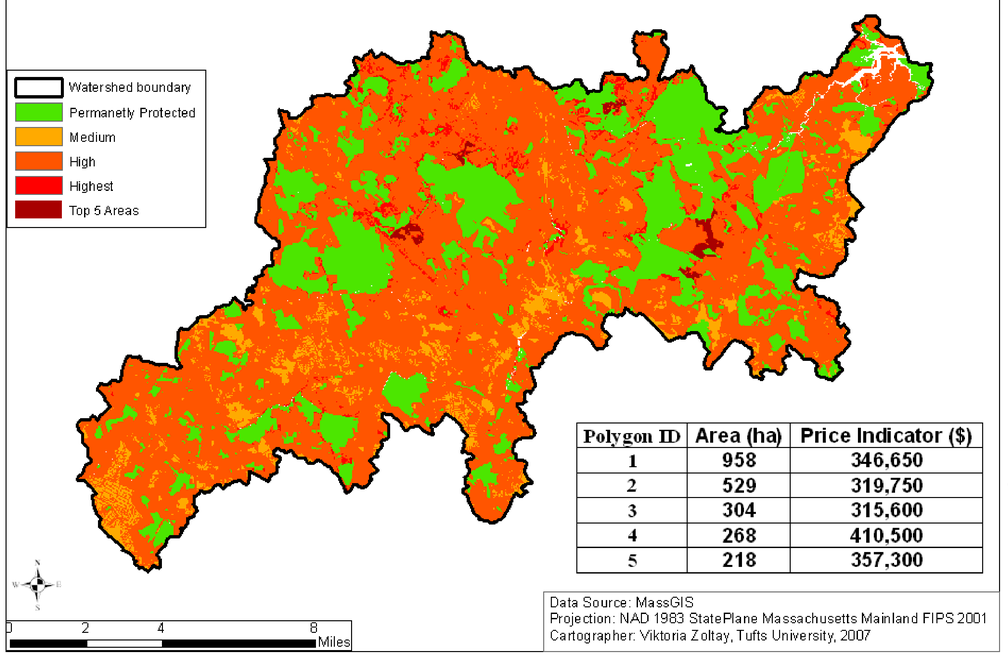
The resulting priority maps for the equally and recreational criteria weighted analyses are shown in Figure 2 and 3, respectively. The recreational criteria weighted figure visibly has higher rankings overall. This is due to the weight on residential land use and proximity to roads. Both of these are abundant in this mostly developed watershed resulting in higher rankings overall for conservation priority. The top five highest ranking areas are shown in both maps and are also different. This demonstrates the importance of the development of an appropriate weighting scheme. The recommendation is to conduct several analyses with different weights to test the sensitivity of the highest ranking areas to the weighting scheme. This may show which areas are the best both for the environmental and recreational objectives. In this study, there are two areas in common between these maps suggesting that those areas should be investigated for acquisition first.

Figure 2. Equally Weighted Criteria Priority Map



Polygon ID	Area (ha)	Price Indicator ($)
1	2,466	344,300
2	455	319,750
3	200	373,200
4	163	411,200
5	135	357,300

Figure 3. Recreational Criteria Weighted Priority Map



Polygon ID	Area (ha)	Price Indicator ($)
1	958	346,650
2	529	319,750
3	304	315,600
4	268	410,500
5	218	357,300

References
Amundsen III, Ole, et al. (2006). "Tug Hill Tomorrow Land Trust Strategic Land Conservation Plan." http://hdl.handle.net/1813/5285.