THE SHUTESBURY MODEL—A COMPARATIVE LANDSCAPE PATTERN ANALYSIS OF SUBDIVISION ZONING PATTERNS IN MASSACHUSETTS

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INTRODUCTION

BACKGROUND

In 2008, the Town of Shutesbury, Massachusetts passed an innovative Open Space Design zoning bylaw that supports cluster subdivision development. The North Quabbin Regional Landscape Partnership (NQRLP) requested conclusive research concerning the ecological significance of such residential patterns. This study and GIS analysis aims to provide such evidence. This paper discusses a study from the fall of 2009, though it is actually the result of two years of project design and research begun by Brian Hall and Bill Labich of Harvard Forest. In 2008, they were able to develop a model for applying the Town of Shutesbury (Shutesbury) zoning to a forested parcel based on acreage and areas that were constrained from development (e.g. steep slopes, wetlands). In this more recent phase of the project, Laura Hammett, with Highstead, helped identify developed sites that had been forested in the 1980s. Ms. Hammett then used GIS tools to measure the ecological values of three conditions: pre-development, existing conventional large-lot residential subdivision development and development based on the Shutesbury bylaw.

GOAL

The goal of this project is to provide the NQRLP with conclusive information about the ecological value of forested landscapes developed using Shutesbury's recently passed open space residential development bylaw as compared to conventional subdivision design common in Massachusetts.

METHODOLOGY

DETERMINE POTENTIAL STUDY SITES

Using the current land use data and forest land cover data from 1985, provided by MassGIS and simplified by Brian Hall, we determined areas in Massachusetts that were developed in large-lot residential uses but that prior to 1985, were contiguous forest blocks of at least 750 acres in size. We chose 1985 as a benchmark for this study because it is a year in which two conditions are met: data is available and development that occurred in that year still exhibits patterns similar to today--large-lot residential subdivisions. We first identified all forest blocks in Massachusetts over 750 acres in size in 1985, and then overlaid the areas of new residential development that took place between 1985 and 2005. We then were able to visually analyze the data layers. We selected 16 unique blocks spread throughout the state that had new development of the pattern and magnitude necessary for our analysis. We looked for developments that were of a size and pattern that showed significant protrusion into the center of a forest block (non-ANR lots). For the purposes of testing our methodology in this, our initial, study during the fall of 2009, we decided to focus on one study site located in Wilbraham, Massachusetts.

DESIGN AND PERFORM GIS ANALYSIS OF LANDSCAPE METRICS FOR PRE-DEVELOPMENT AND POST-DEVELOPMENT STATES

Based on current theories of landscape ecology set forth by scientists such as Richard T. T. Forman, K. H. Riiters and Harbin Li, we selected a set of four metrics for this project that would seek to quantify the ecological significance of differing development patterns on forest blocks or "patches". The metrics chosen for this study were: 1) the length of edge between forest and developed land, 2) the amount of interior forest, 3) forest area or raw acreage, and 4) the perimeter–to-area ratio of the patch. Using the tool modelbuilder in ArcGIS, we were able to design models for how these metrics could be measured. We calculated interior forest based on a 100-meter buffer zone. The forest/development edge calculation required use of a polygons-to-lines tool available for free download from ET Geotools (www.ian-ko.com). We then ran these tools to calculate the landscape metrics based on the shape of the forested area pre and post-development.

RE-DRAW DEVELOPMENT ACCORDING TO SHUTESBURY ZONING MODEL AND CONTINUE ECOLOGICAL METRICS ANALYSIS

After measuring the ecological metrics for both pre and post-development conditions, we applied a hypothetical Shutesbury-style development design to the forest block. In order to re-draw the development according to the Shutesbury model, we first had to determine pre-development and post-development (existing) parcel information for the site. This information was digitized and the specifics of environmental development constraints (slope > 20%, wetlands, etc.) were gathered. We then used the Open Space Design Worksheet created by Shutesbury residents/town officials to determine the number of development lots and amount of open space allowed if the original parcel were developed using the Shutesbury zoning. From these numbers we were able to re-draw the development and determine a third forest block shape for ecological metrics analysis. The parcel was subjectively "redeveloped" according to the Shutesbury Zoning model. We calculated the same four indices for the pre-development, actual development, and potential Shutesbury Zoning model-based development for comparison.

RESULTS FROM THE WILBRAHAM STUDY SITE

*Numbers in red are percent change from pre-development condition

FOREST BLOCK	FOREST ACREAGE	INTERIOR FOREST	PERIMETER/AREA RATIO	FOREST/DEV. EDGE
PRE-DEVELOPMENT	1,102 ACRES	624 ACRES	1: 574 0.00174 FT/SQ.FT.	43% OF TOTAL EDGE OR 35,576 FEET
POST-DEVELOPMENT	1,027 ACRES 6.8% DECREASE	499.5 ACRES 20% DECREASE	1: 434 0.00208 FT/SQ.FT.	52% OF TOTAL EDGE OR 52,178 FEET 46.7% INCREASE
SHUTESBURY MODEL	1,068 ACRES 3.1% DECREASE	600 ACRES 3.9% DECREASE	1: 554 0.00181FT/SQ.FT.	46% OF TOTAL EDGE OR 38,486 FEET 8.2% INCREASE

ORIGINAL PARCEL: 129 ACRES

SHUTESBURY MODEL

- 26 acres developed (including roads)
- Remaining acres in preserved open space
- 26 dwelling units permitted
- No minimum lot size

EXISTING DEVELOPMENT

- 129 + acres developed (original lot plus additional planned extension to the north)
- 57 housing lots
- Average lot size approx. 2 acres

CONCLUSIONS

Because this project relies heavily on the hypothetical, many of the decisions made throughout the methodology were naturally subjective. If this study were repeated by others, slightly different numerical results would likely occur. Despite this fact, the outcomes of the study still have the potential to show significant differences in the ecological effects of various development patterns. The study results show that the Shutesbury model has a different impact on the forested environment. However, what does "different" mean, exactly? In order to read these results and come to any conclusion about whether it is best to support the adoption of the Shutesbury style of zoning, it is necessary to take into account a myriad of other externalities. For example, what kind of ecological condition does the locality wish to promote? A conventional subdivision may disrupt the amount of core forest in a patch but it also, through an elongated perimeter, provides greater habitat for species that thrive in edge conditions. As it stands, with this particular application of the Shutesbury model, there were less than half the dwelling units as in the existing development. Also, the four metrics used for this study are in no way exhaustive indicators of a landscape's ecological status. In Richard Forman's book Land Mosaics, he speaks at length about the importance of patch shape in providing certain kinds of habitat and promoting species movement patterns. The changing shape of the forest block due to Shutesbury's or conventional zoning should perhaps be taken into account in addition to the conditions already measured.

Though this study relies on information that is in places incomplete and subjective, the real value of our work is in the developed and tested methodology outlined above. Hopefully the methods tested here can be applied to other study sites and, if necessary, on a case-by-case basis to parcels contained in forest blocks being considered for development in the future.

RESOURCES CONSULTED

Forman, Richard T. T. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge: Cambridge University Press, 1995.

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