

BASELINE GREENSPACE INVENTORY & ASSESSMENT: MONROE COUNTY, INDIANA 1998 / 1999

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for

the City of Bloomington Environmental Commission

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Introduction

In 2003 and 2007, the City of Bloomington Environmental Commission (EC), with the support of the city's Information and Technology Services, Engineering, Planning, and Parks and Recreation Departments, and the EC's intern program, conducted greenspace assessments of vegetated cover within the City Planning Jurisdiction. The 2003 report, titled "Greenspace Trends in Bloomington, Indiana 1993-2003"¹ provided a valuable examination of city greenspace changes over a ten year period. A subsequent piece of research, "Greenspace Trends in Bloomington, Indiana 1993-2007"² extended the survey of greenspace over an additional four years.

In 2008, the EC began research to conduct an inventory of all greenspace within Monroe County, Indiana. Previous greenspace studies concerning land within the city planning jurisdiction were aimed at quantifying trends in greenspace gains and losses over time. In contrast, the aim of this first county-wide study is to establish a baseline upon which future trends analyses for the entire county can be based.

Aerial imagery obtained from April 1998 and November 1999 was utilized to construct geographic information systems (GIS) maps and determine areas of greenspace versus other land cover. In addition to quantifying area of greenspace, greenspace quality was investigated via examination of greenspace patch size, continuity, and proximity of patches to roadways.

Methodology

As with previous Environmental Commission research, greenspace was defined using the following criteria:

- **The area must be greater than one contiguous acre.**
- **The area must be more than ten feet from any manmade development, such as roads, parking lots, and buildings.**
- **The area must possess a permeable surface.**
E.g.: forested, shrub/grass covered areas, parks, golf courses, cemeteries, and agricultural land.

To provide future analyses with an adequate temporal duration to examine trends in greenspace cover and urban expansion, 1998 was selected as the baseline year. Aerial photography from 1998 provided coverage for the City of Bloomington. However, in 1998 incomplete aerial imagery existed for areas outside of the City of Bloomington. In 1999, flight-captured photography provided aerial images for land outside of Bloomington. The two aerial image sets were joined to provide county-wide coverage which was used to inventory greenspace. Environmental Systems Research Institute (ESRI) ArcGIS software was used as the principal tool to analyze, manipulate, and store the spatial and visual data. Because the 1998/1999 aerial images are in black and white, much of the remote sensing and spectral analysis capabilities of the software were not applicable. Therefore, manual digitizing was conducted to extract greenspace features from the raster images.

The 1998/1999 images served as a basemap for Monroe County. The Indiana Spatial Data Portal and Indiana Map, which function as publicly accessible GIS data clearinghouses, were accessed to gather necessary shapefiles/layers. In particular, geographic data and shapefiles from the Indiana Geological Survey, Indiana Department of Transportation, and Indiana Geographic Information Council enabled a deeper understanding of the county's built and natural environment. Multiple layers were also accessed from the City of Bloomington GIS. Layers were then overlaid to display topographic, hydrologic, biological, geological, and infrastructure features.

Once the inventory was complete, additional features were examined to provide a more robust description of greenspace quality in relation to its physiographic setting. Watershed boundaries were added and the county was divided into the following five sections to assist with delineating greenspace areas and improving visual navigation (Figure 1): northwest county quadrant, northeast county quadrant, southwest county quadrant, southeast county quadrant, and City of Bloomington land. In order to map topographic features, contour elevations were imported. The locations of current and former extraction sites (quarries) were also added to clarify large parcels of non-greenspace.

Continuity and road density indices were calculated as useful indicators of greenspace integrity. To calculate the continuity index, the greenspace map was grided into the five aforementioned sections. Continuity indices for individual sections were calculated based on Hurd et al. (2002) as follows:

$$\left[\frac{\text{Mean acreage of greenspace patch}}{\text{Acreage of total area} - \text{acreage of water area} - \text{acreage of non-greenspace area}} \right] \times 100\%$$

Where mean area of greenspace patch refers to the average size of contiguous areas of greenspace and is calculated by summing all contiguous areas of greenspace (greenspace patches) and dividing by the total number of such patches. Thus, an index score of 10% would indicate that the average patch size of greenspace in a given section of land (i.e. a particular quadrant) is 10% of that quadrant's total greenspace area. Similarly, a score of 100% would indicate that the quadrant is comprised of one contiguous piece of greenspace.

Since continuity decreases and fragmentation increases in the presence of roads and railways, a simplified road/rail density index was calculated as follows:

$$\left[\frac{\text{Acreage of roads and railways}}{\text{Acreage of total area} - \text{acreage of water area}} \right] \times 100\%$$

An index of 10% would indicate that a given quadrant has one unit of roadways for every ten unit areas of total land. Similarly, an index of 50% would indicate that half of a given quadrant's total land area is taken up by roads.

Results

County-Wide Greenspace:

In 1998, there were 224,925 acres of greenspace within Monroe County (Figure 2) composing 89% of the county's total land area (Table 1). Relatively large land areas of non-greenspace were frequently identified as former or current industrial mineral extraction sites/quarries (Figure 3).

Patch Size:

County-wide, the mean patch size of greenspace in 1998 was 263.57 acres (Figure 4). Mean greenspace patch size was highest in the northeast and southeast quadrants of the county, with averages of 500.83 and 425.78 acres, respectively. In contrast, mean greenspace patch size was more than two times lower in the southwest and northwest county quadrants, and lowest (~7 acres) in the City of Bloomington.

A multi-color map was designed to display patch size with the following incremental categories: 1-100 acres, 101-1000 acres, 1001-2500 acres, and larger than 2500 acres (Figure 5). This map assists in identifying wildlife corridors, as well as potential land holdings that could connect other high quality areas of greenspace, potentially strengthening existing green infrastructure. Watershed boundaries were overlaid to illustrate their location in relationship to greenspace patches (Figure 6) and contours (Figure 7) were overlaid to show topography (Figure 8).

Continuity:

County-wide, the mean greenspace continuity index in 1998 was 0.49%, indicating that the average size of a piece of greenspace in the county was roughly one half of one percent of the county's total greenspace area (Figure 9). Continuity indices for the northeast and southeast quadrants of the county were 0.88% and 0.75%, respectively. In contrast, the continuity indices of the southwest and northwest county quadrants were more than two times lower, and lowest (0.10%) in the City of Bloomington.

Road/Rail Density:

The county-wide road/rail density index was 7.72% in 1998, thus for every 7 acres of roads and rails there were about 100 acres of greenspace (Figure 10). The road/rail density indices for the northeast and southeast quadrants were 3.34% and 3.26% respectively. Road/rail indices were nearly one and a half times higher in the southwest and northwest quadrants, and roughly six times higher (21.39%) in the City of Bloomington.

Discussion and Recommendations

The previous Environmental Commission greenspace report noted a 24.4% loss in City of Bloomington greenspace from 1993-2007². The utility of these findings is maximized when one examines the broader trends of land use/land cover change occurring regionally. This current report serves as a necessary first step to achieving the goal of monitoring greenspace trends at the county-wide level.

This report demonstrates that, during the 1998 baseline period, Monroe County's most robust areas of greenspace were located in the northeast and southeast county quadrants. The fact that the eastern half of the county possesses larger contiguous areas of greenspace reflects the large quantities of land managed by the Indiana Department of Natural Resources (DNR) in this area, as well the Hoosier National Forest near Lake Monroe.

Lower continuity and higher road density figures were found in the Bloomington and Ellettsville areas, as was expected given their status as economic and population centers for the county. However, the county is fortunate to have large contiguous sections of greenspace only a short distance from primary urban areas. Two greenspace patches, each exceeding 2500 acres, were located only three miles northeast of Ellettsville. Similarly, three greenspace patches over 2500 acres were found only one mile northeast of Bloomington's eastern edge. In addition to the aesthetic value of being surrounded by a landscape with large sections of greenspace, these areas provide other social, economic, and ecological benefits, including opportunities for outdoor recreation, modulation of climate, purification of air and water, and provision of wildlife habitat. The Environmental Commission has published previous reports on the benefits of greenspace, which can be found at http://bloomington.in.gov/documents/viewDocument.php?document_id=506.

The EC recommends that follow up analyses of county-wide greenspace be conducted on five- to ten-year time frames in order to track patterns of greenspace change over time (e.g., 2008, 2018, etc.). While many cities and counties are becoming increasingly built out at the expense of their greenspace, regular greenspace inventories will assist Monroe County in protecting the integrity of its green infrastructure. Regular inventories and greenspace trends analyses will inform intelligent land use planning that preserves a balanced network of greenspace and associated benefits. In addition to ongoing greenspace monitoring by the City of Bloomington Environmental Commission, collaboration across stakeholders, both at the public, private, and not-for-profit sectors, is vital to ensuring the integrity of Monroe County's greenspace. The EC's 2003 report, titled "Greenspace Trends in Bloomington, Indiana 1993-2003"¹ provided a detailed examination of funding sources and existing greenspace programs. A subsequent EC report, "Greenspace Trends in Bloomington, Indiana 1993-2007"² outlined greenspace acquisition strategies and planning methods that could assist in greenspace preservation. The Environmental Commission renews its recommendation to establish a Greenspace Taskforce to establish and implement a county-wide greenspace acquisition and preservation plan.

Table 1. County-wide greenspace

Acres:	Land Type:
252,160	Total County-Wide Land Area
-18,173	County Non-Greenspace
-9062	City of Bloomington Non-Greenspace
224,925	Total County-Wide Greenspace

Figure 1. Monroe County in five sections (quadrants & City of Bloomington)

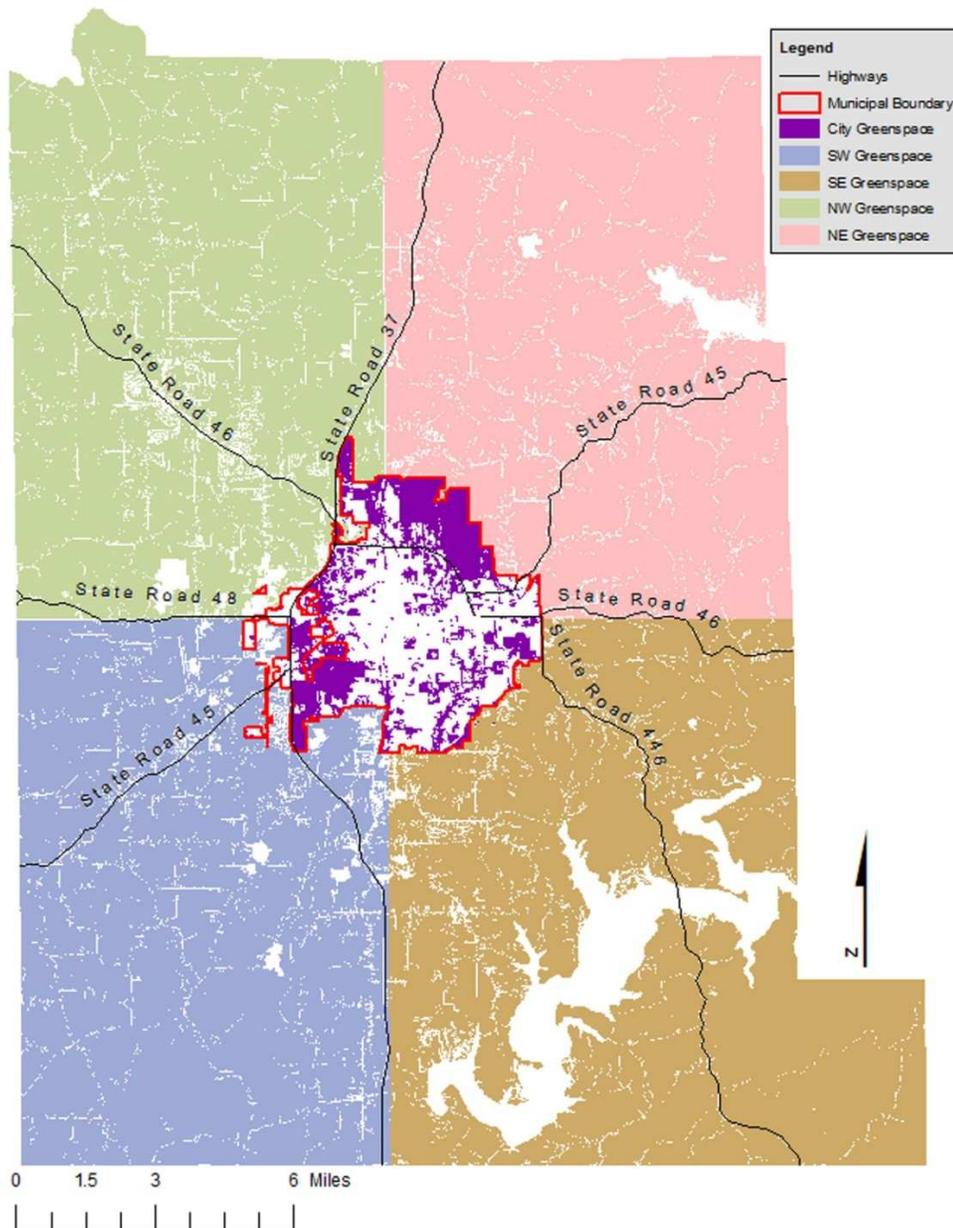


Figure 2. Extent and type of greenspace in Monroe County

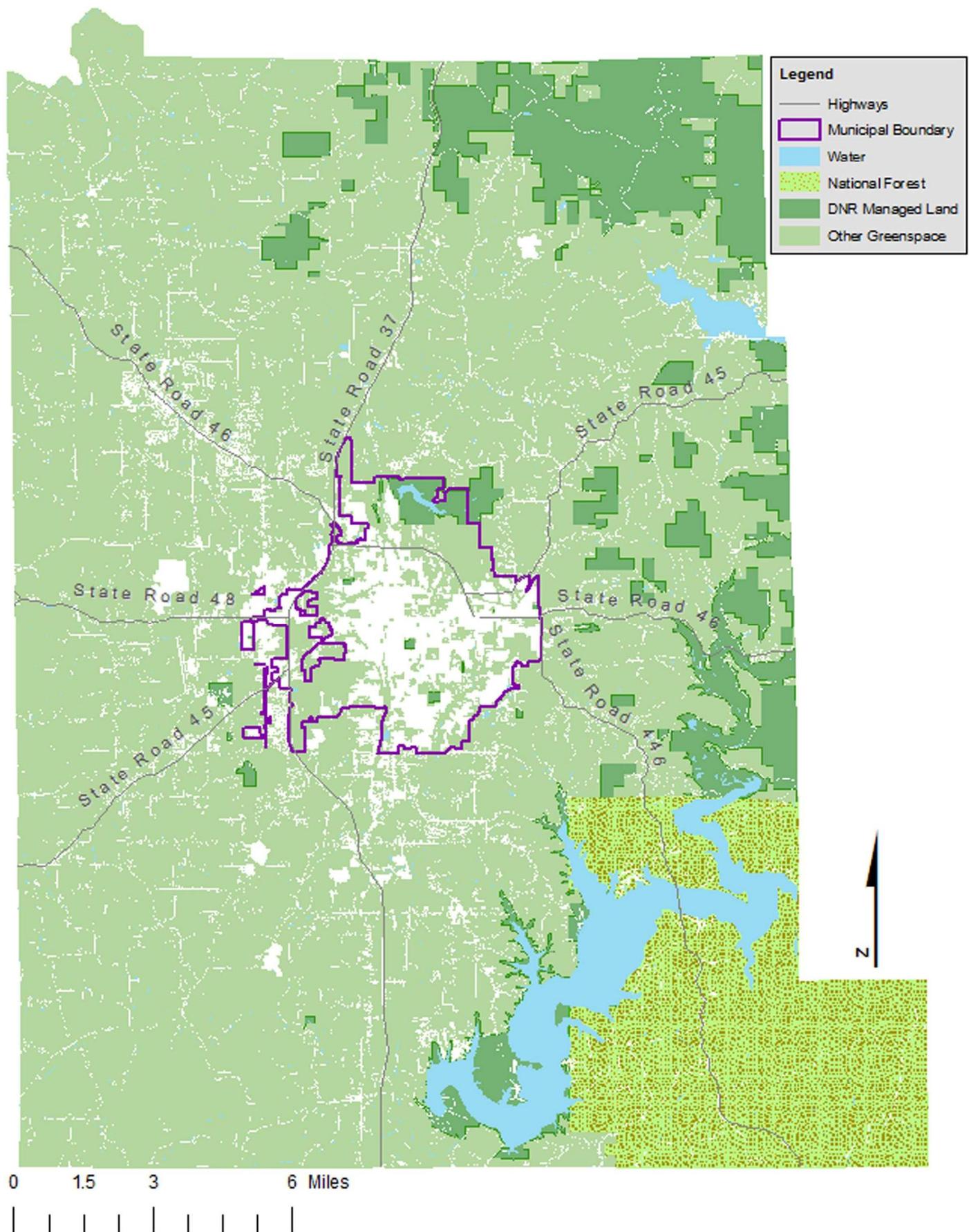


Figure 3. Location of mineral extraction sites/quarries

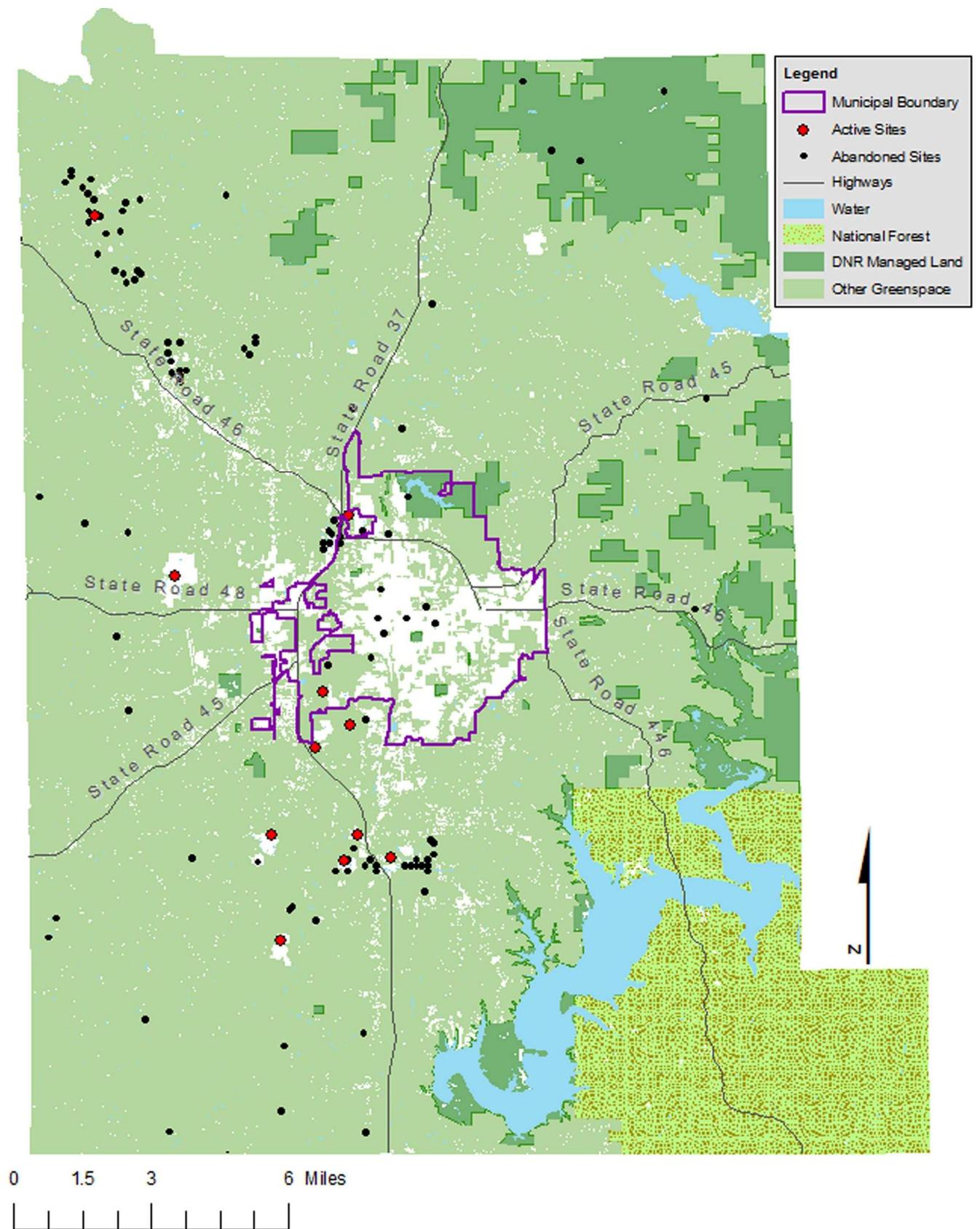


Figure 4. Mean patch size of greenspace

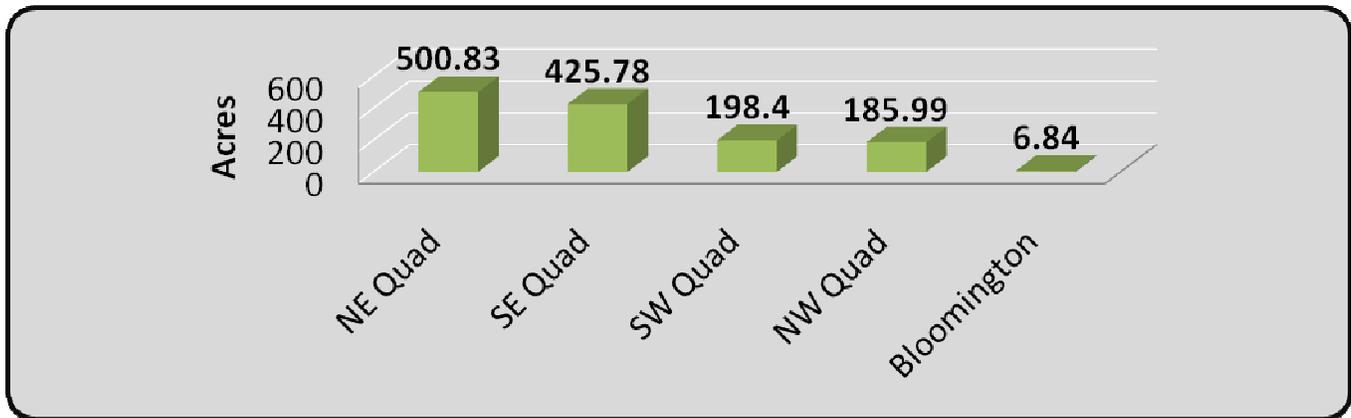


Figure 5. Location and size of greenspace patches

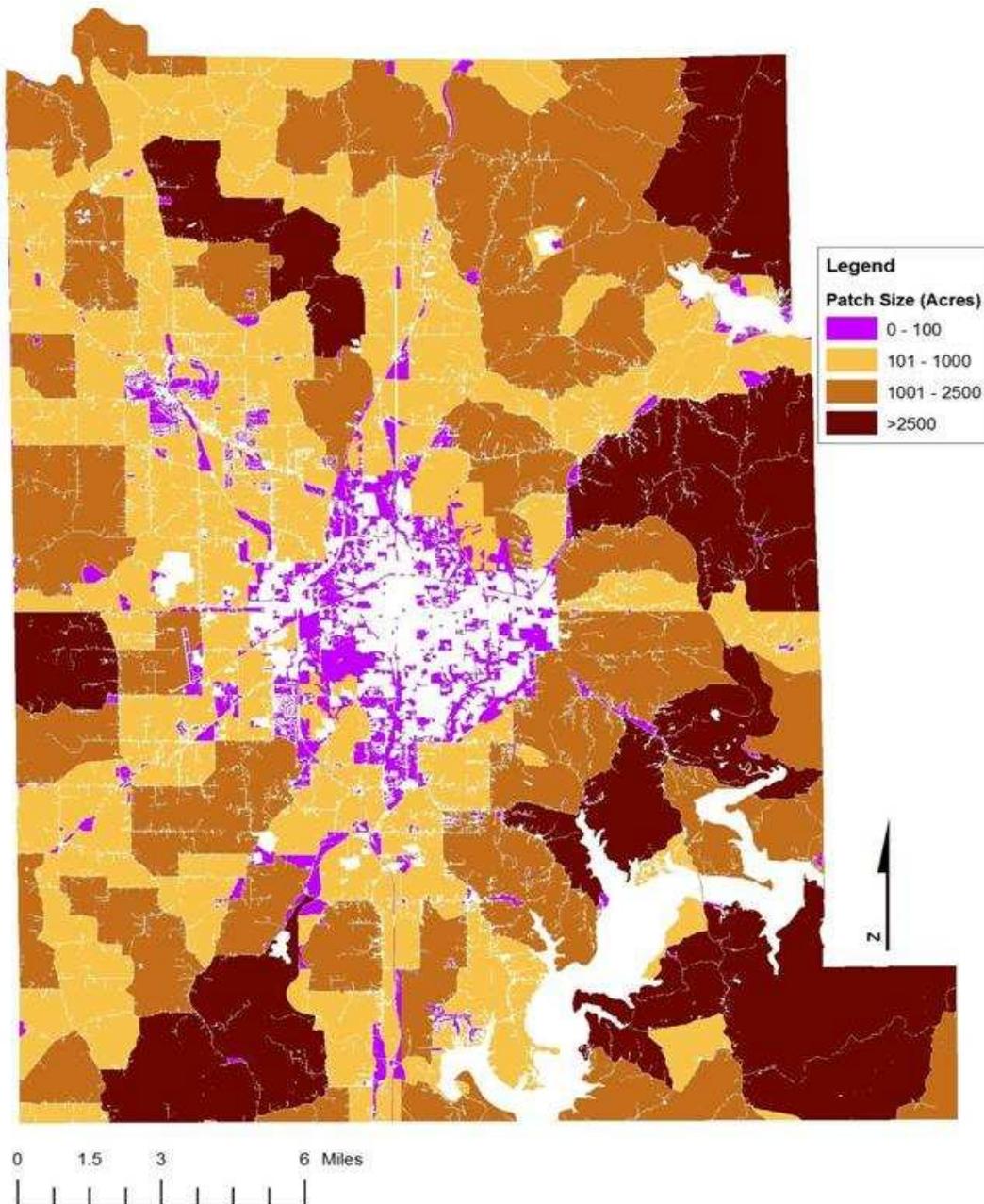


Figure 6. Location and size of greenspace patches overlaid by watershed boundaries

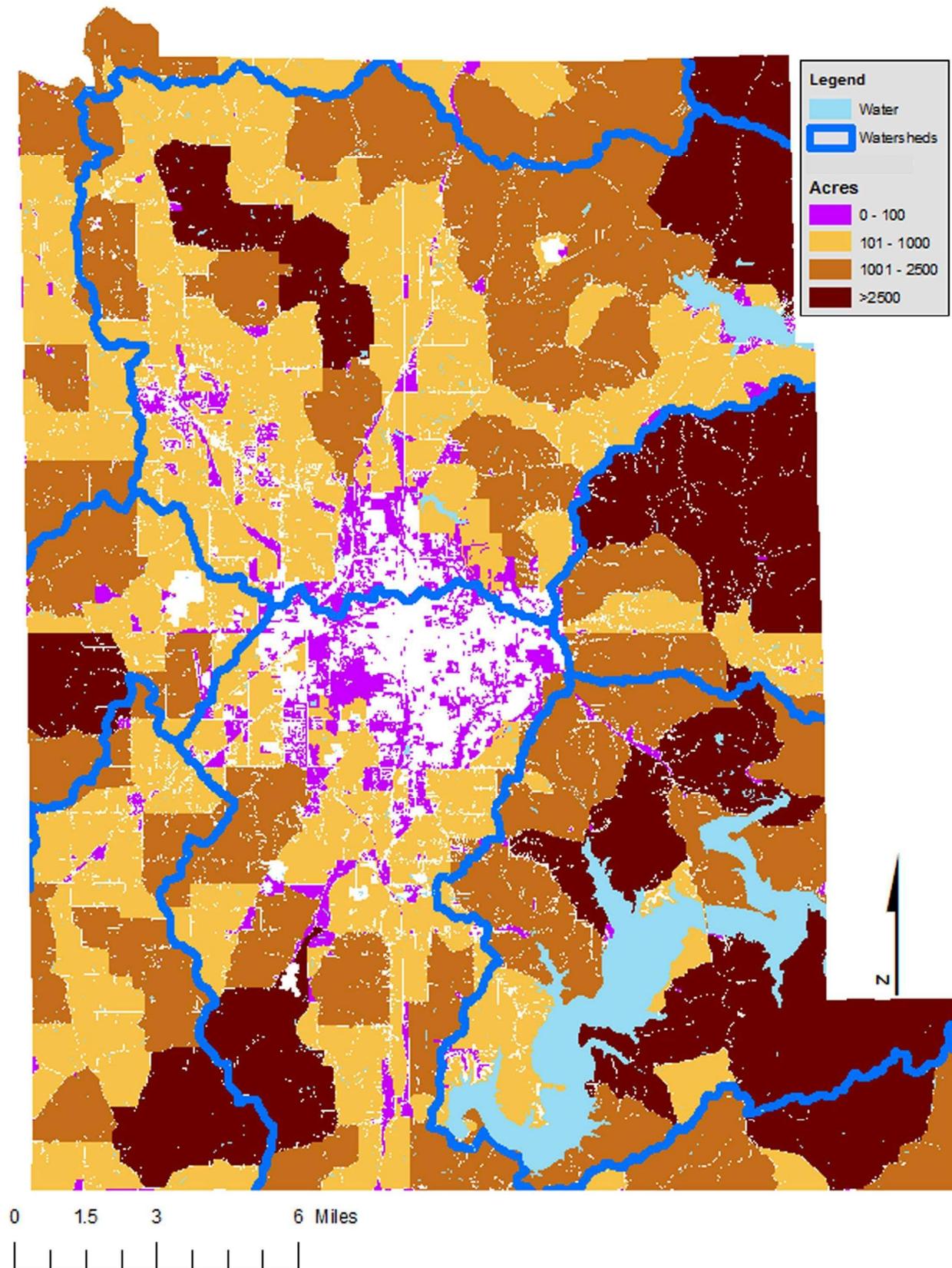


Figure 7. Contour lines showing topography/elevation

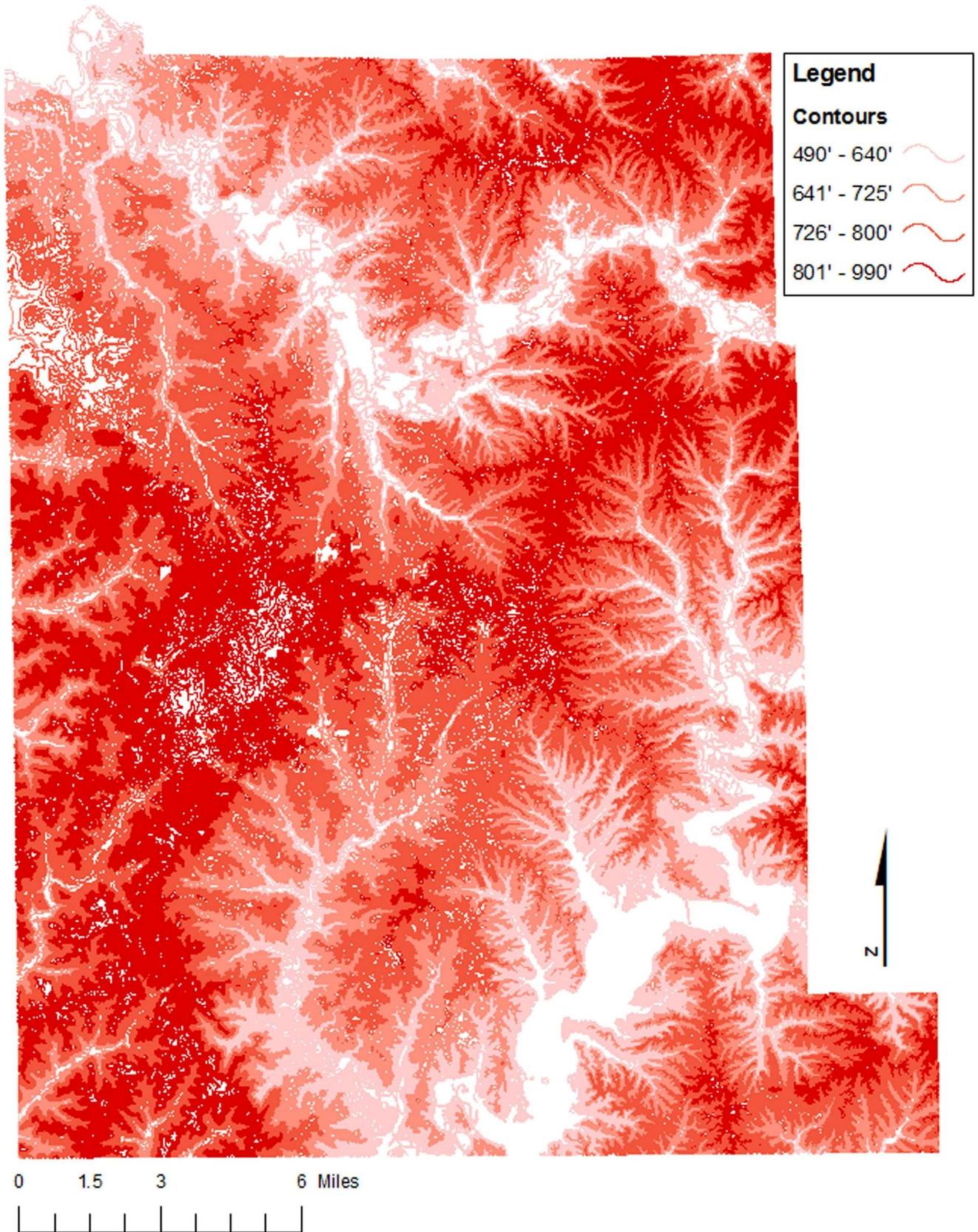


Figure 8. Location and size of greenspace patches overlaid by contour lines

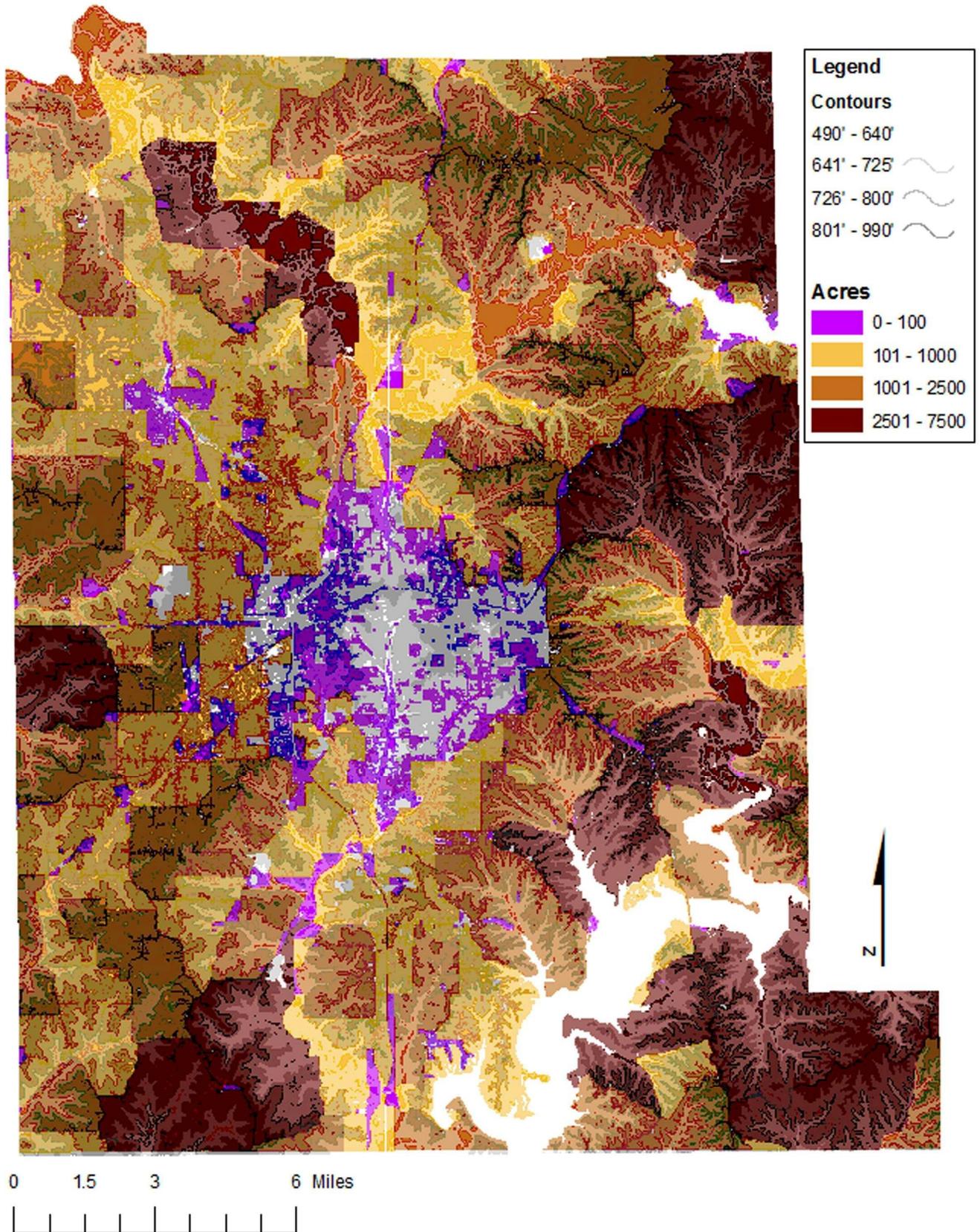


Figure 9. Greenspace continuity across Monroe County quadrants & the City of Bloomington

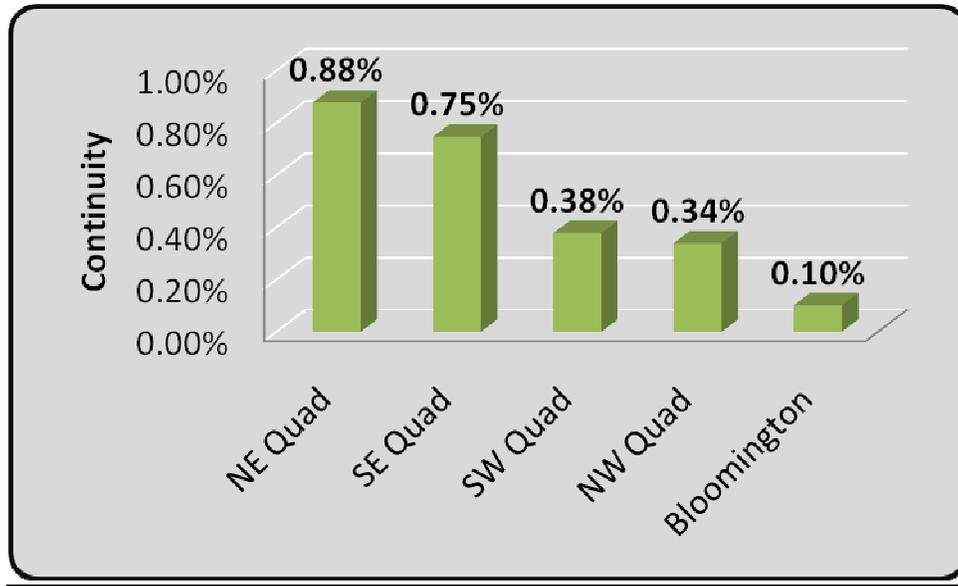
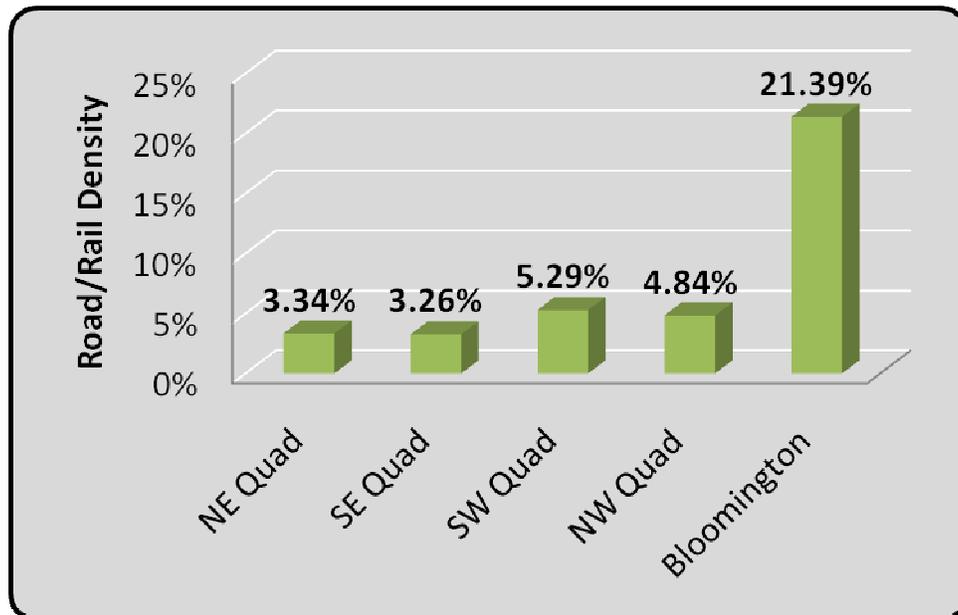


Figure 10. Road/Rail Density across Monroe County quadrants & the City of Bloomington



References

- ¹ City of Bloomington, Indiana, Environmental Commission, “Greenspace Trends in Bloomington, Indiana 1993-2003” 2002. Available at: <https://bloomington.in.gov/media/media/application/pdf/48.pdf>
- ² City of Bloomington, Indiana, Environmental Commission, “Greenspace Trends in Bloomington, Indiana 1993-2007” 2007. Available at: <https://bloomington.in.gov/media/media/application/pdf/2738.pdf>
- ³Hurd, J.D., E. Hoffhine Wilson and D.L. Civco. 2002. “A Forest Fragmentation Index to Quantify the Rate of Forest Change” Proc. 2002. ASPRS Annual Convention, Washington D.C.