

Human Appropriation of Net Primary Production (HANPP) Analysis of Rural to Urban Transition at the Watershed Scale in the Southeastern United States

Rachel Martin¹, C. Brannon Andersen¹, John E. Quinn²

¹Dept. Of Earth and Environmental Sciences and ²Biology Department, Furman University, Greenville, SC

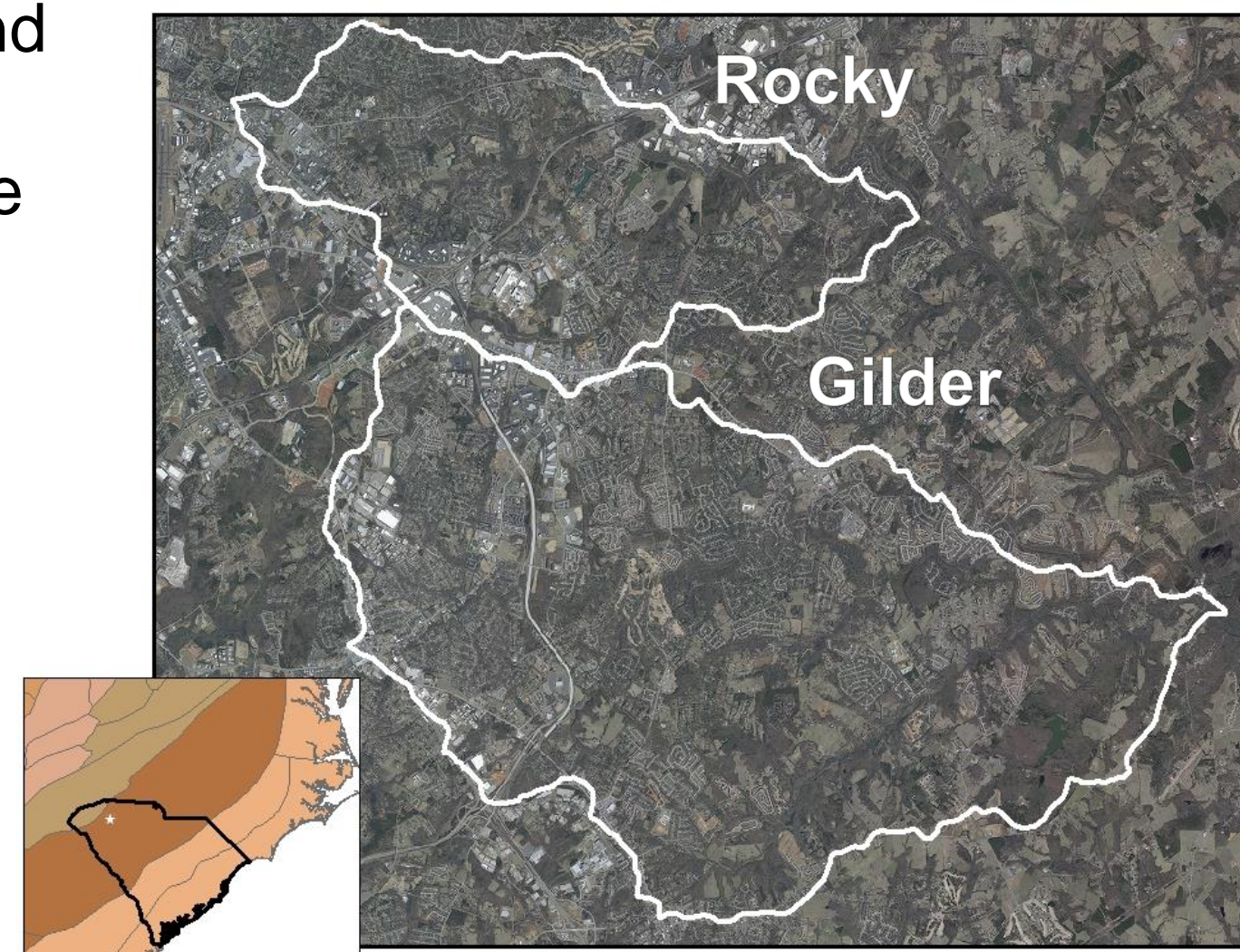


Introduction

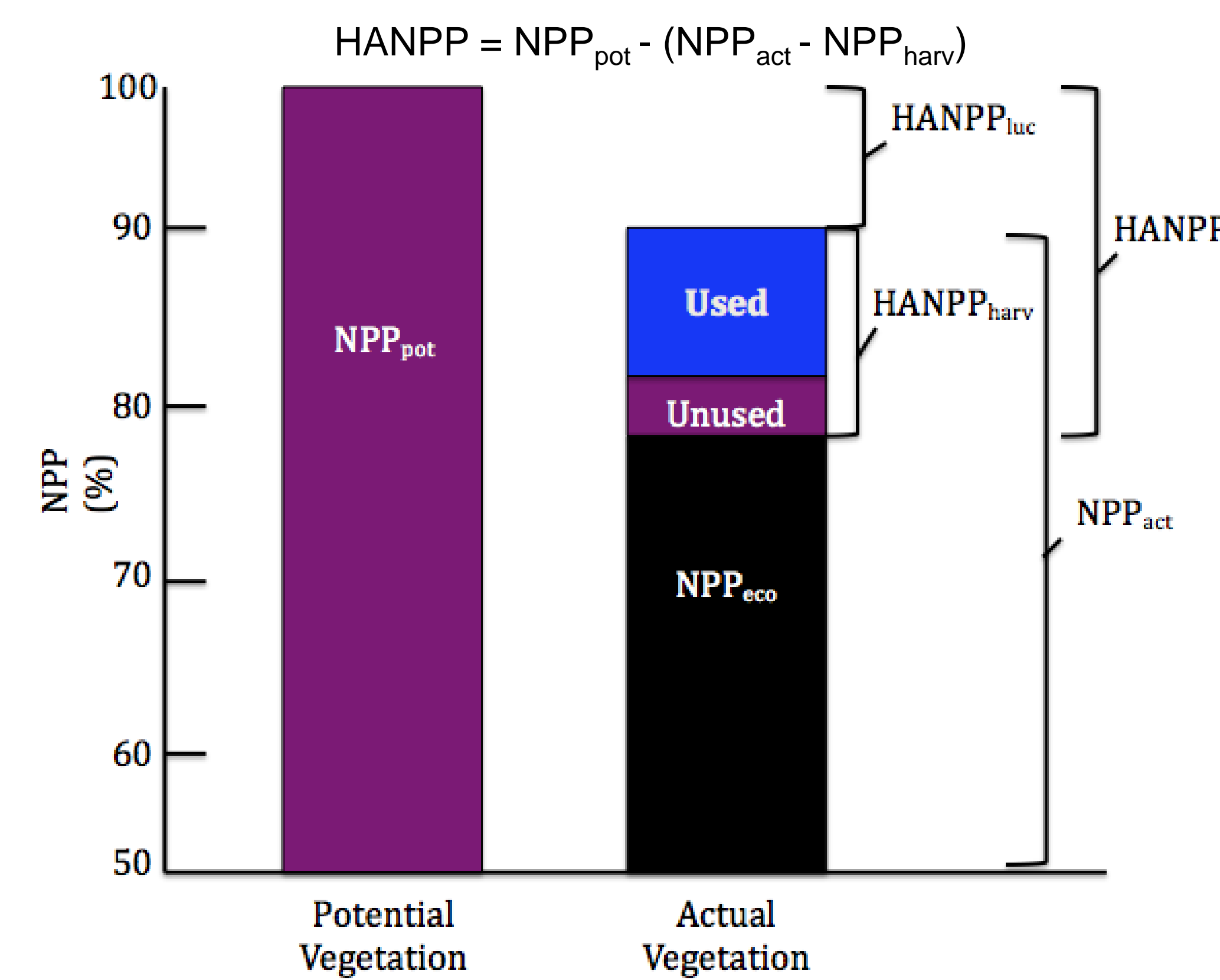
- The human appropriation of net primary productivity (HANPP) is a socio-ecological indicator that quantifies the effects of human-induced changes in biomass flows within ecosystems.
- Most HANPP research is done at the global, regional, or country scale.
- We examined HANPP at the watershed scale quantify the rural to urban transition currently shaping the Piedmont.
- High resolution analysis possible at the watershed scale allowed quantification of HANPP in urban environments that are characterized by complex and changing spatial heterogeneity.

Methodology

- Rocky Creek (36 km²) and Gilder Creek (82 km²) watersheds are located in the southeast United States, in a temperate forest biome and the southern Piedmont ecoregion.
- Land cover classification map from NLCD and previous land cover classifications in Andersen et al. (2015) were used to organize different land cover types for a comparable analysis.
- Land cover types were digitized from aerial photographs of 1965 and 2013 using ArcMap10.1.
- High resolution analysis of four low intensity and four medium intensity residential neighborhoods analyzed the land cover distribution in the urban mosaic.
- Estimates of agricultural harvest were based on data for Greenville County collected from 1964 and 2012 USDA Census of Agriculture. Estimates of forest harvest were based on data for Greenville County from the South Carolina Forestry Commission.
- HANPP calculations adapted from Andersen et al. (2015) and Haberl et al. (2007).



Aerial photo of watersheds. Inset map shows location of watersheds in upper left region of South Carolina in the Southern Piedmont.

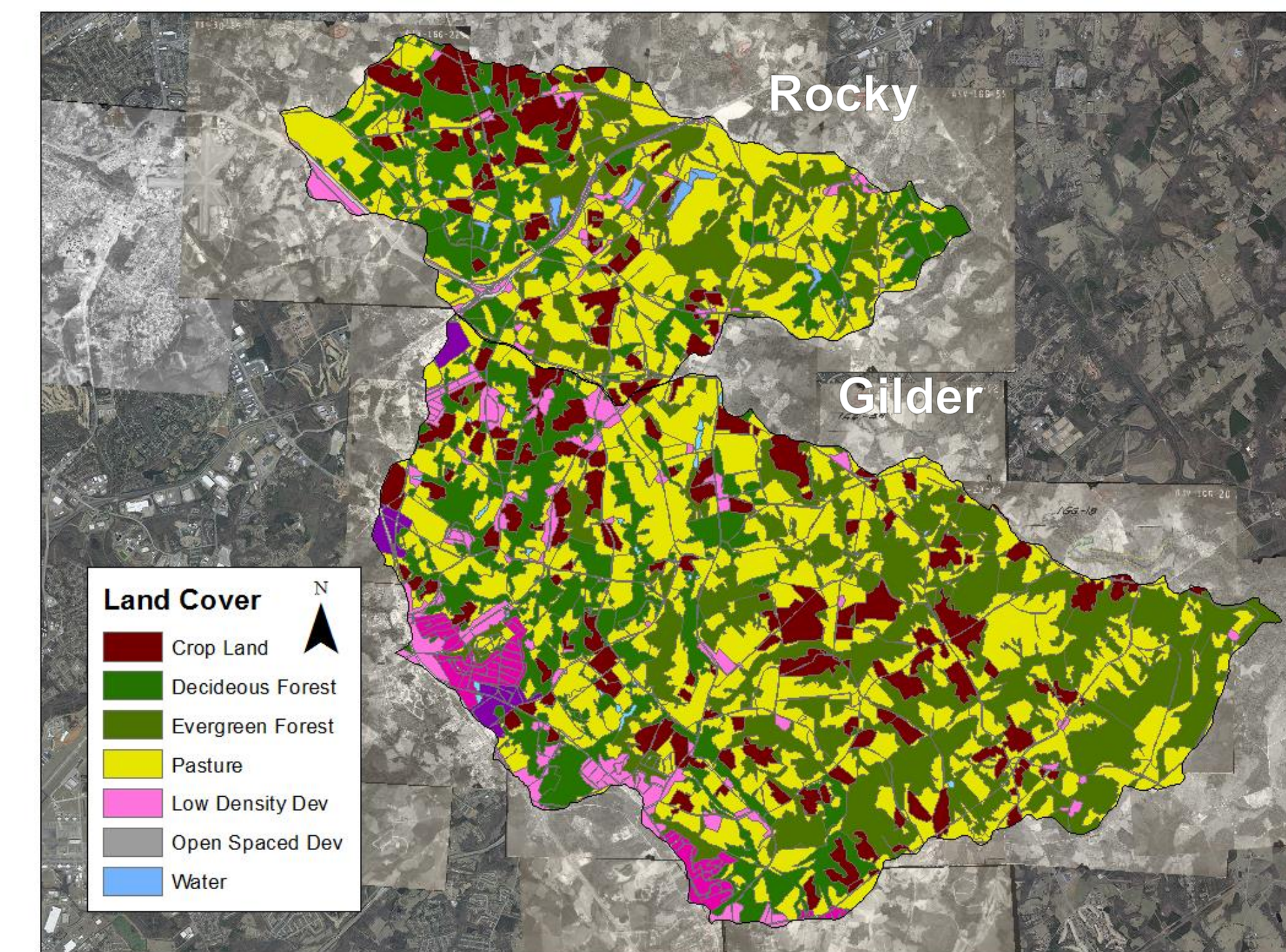


NPP_{pot} is the potential net primary production (NPP) vegetation assuming average climate conditions, NPP_{act} is the actual NPP in the area from quantitative analysis vegetation types, $HANPP_{luc}$ is NPP loss from land use changes, $HANPP_{harv}$ is NPP removed from the landscape via agricultural and timber harvest. $HANPP_{eco}$ is remaining NPP left in the ecosystem after harvest. Adapted of HANPP from Haberl et al. (2014).

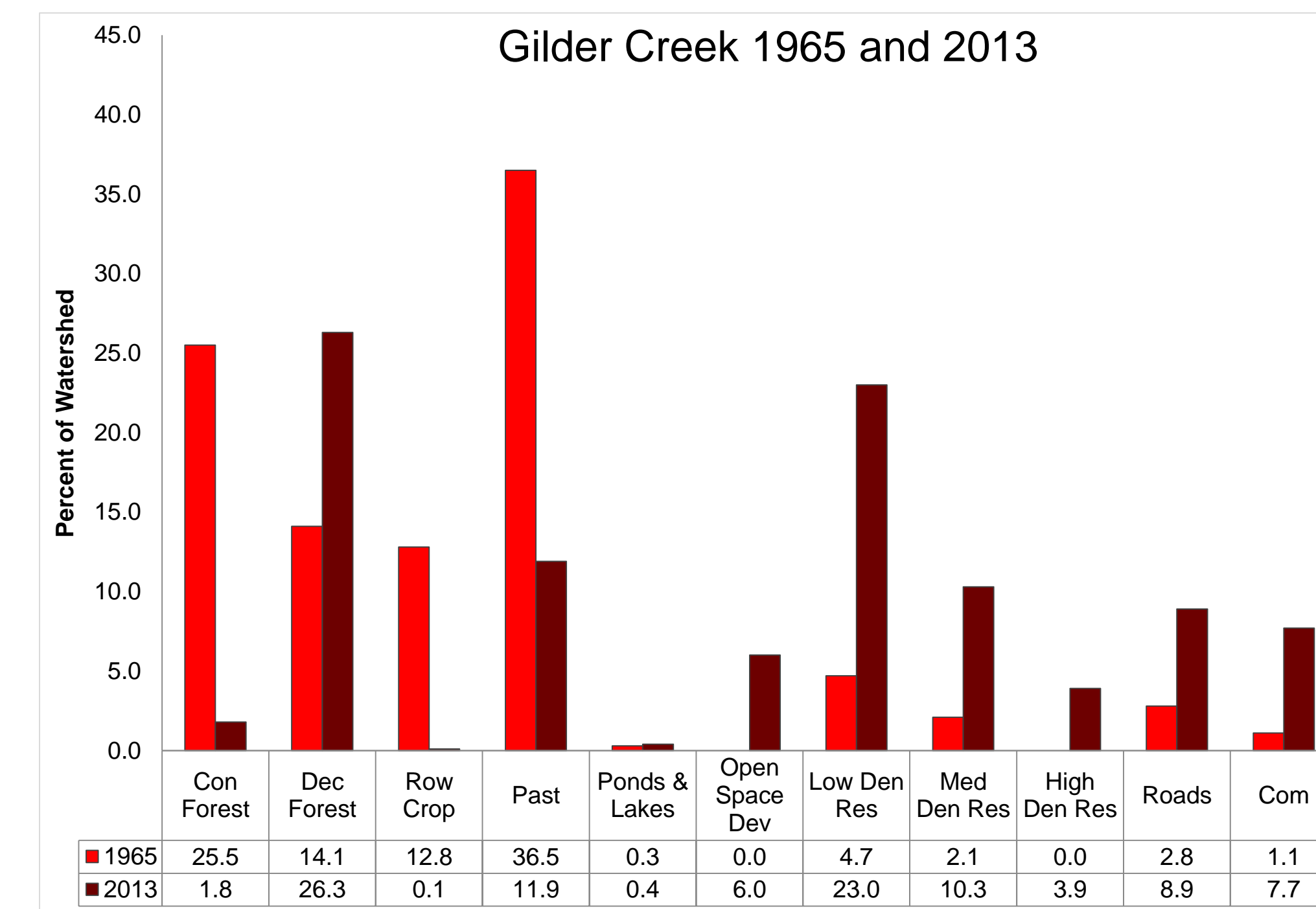
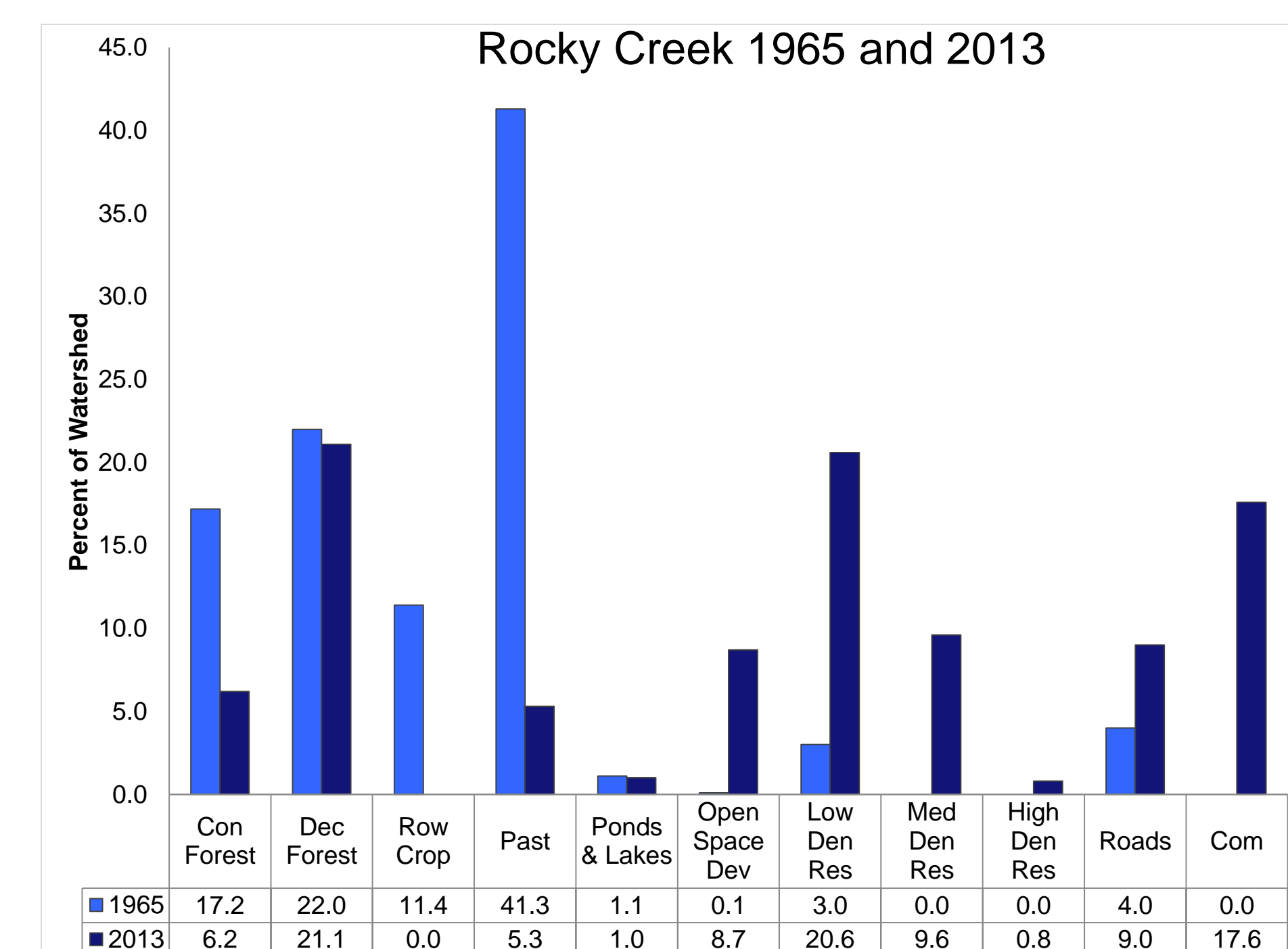
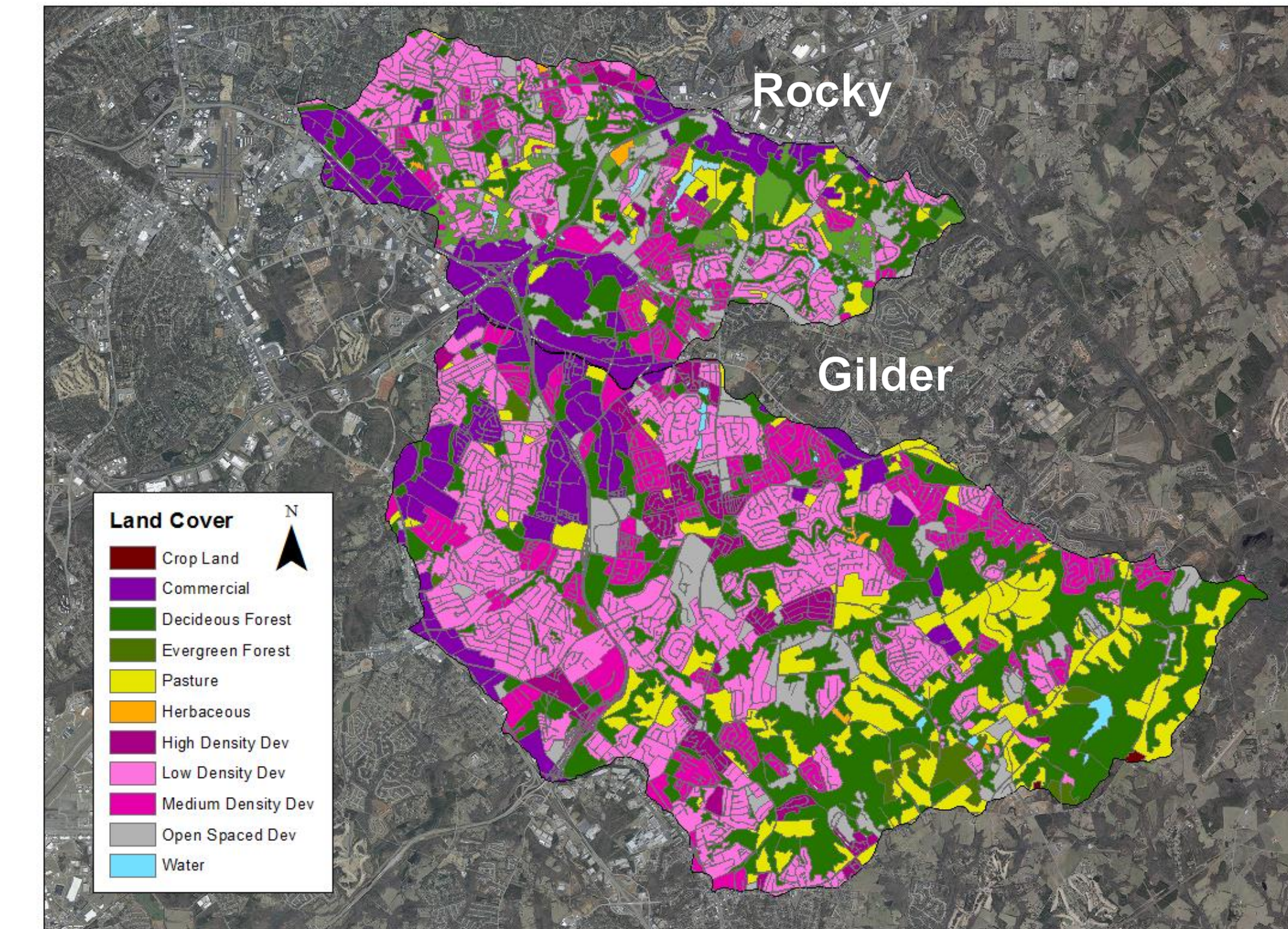
Results and Discussion

Land Cover Analysis

1965

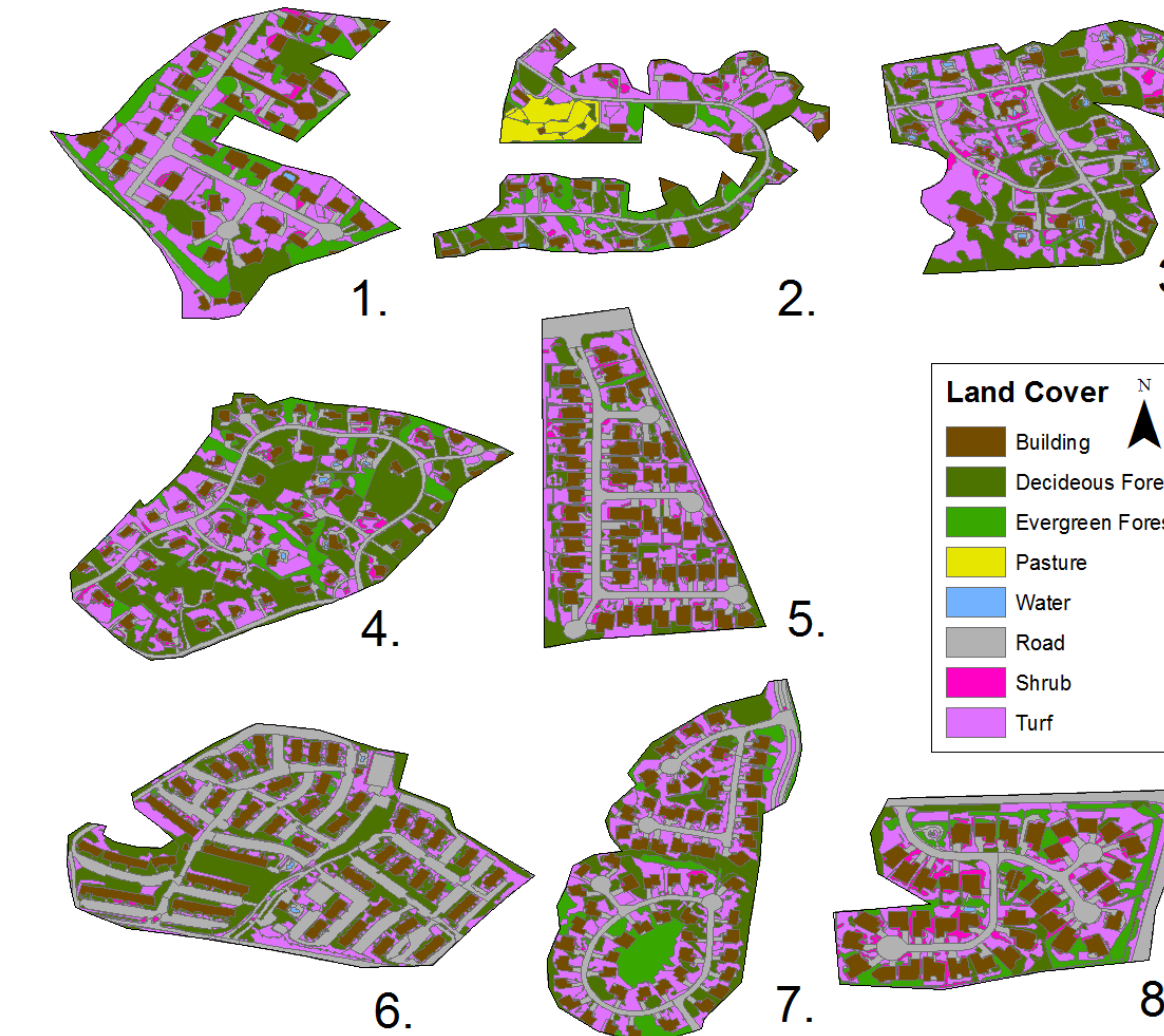
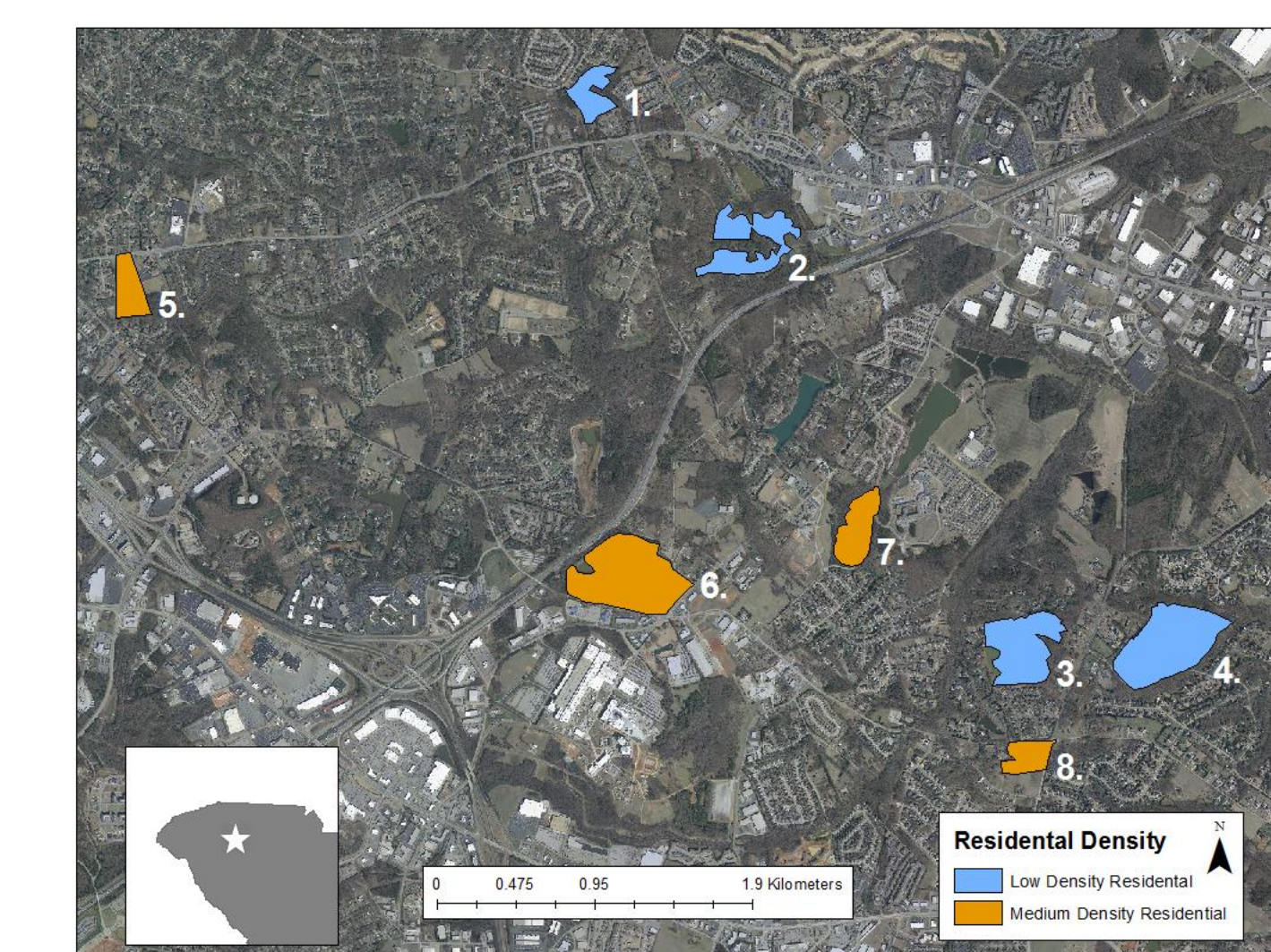


2013

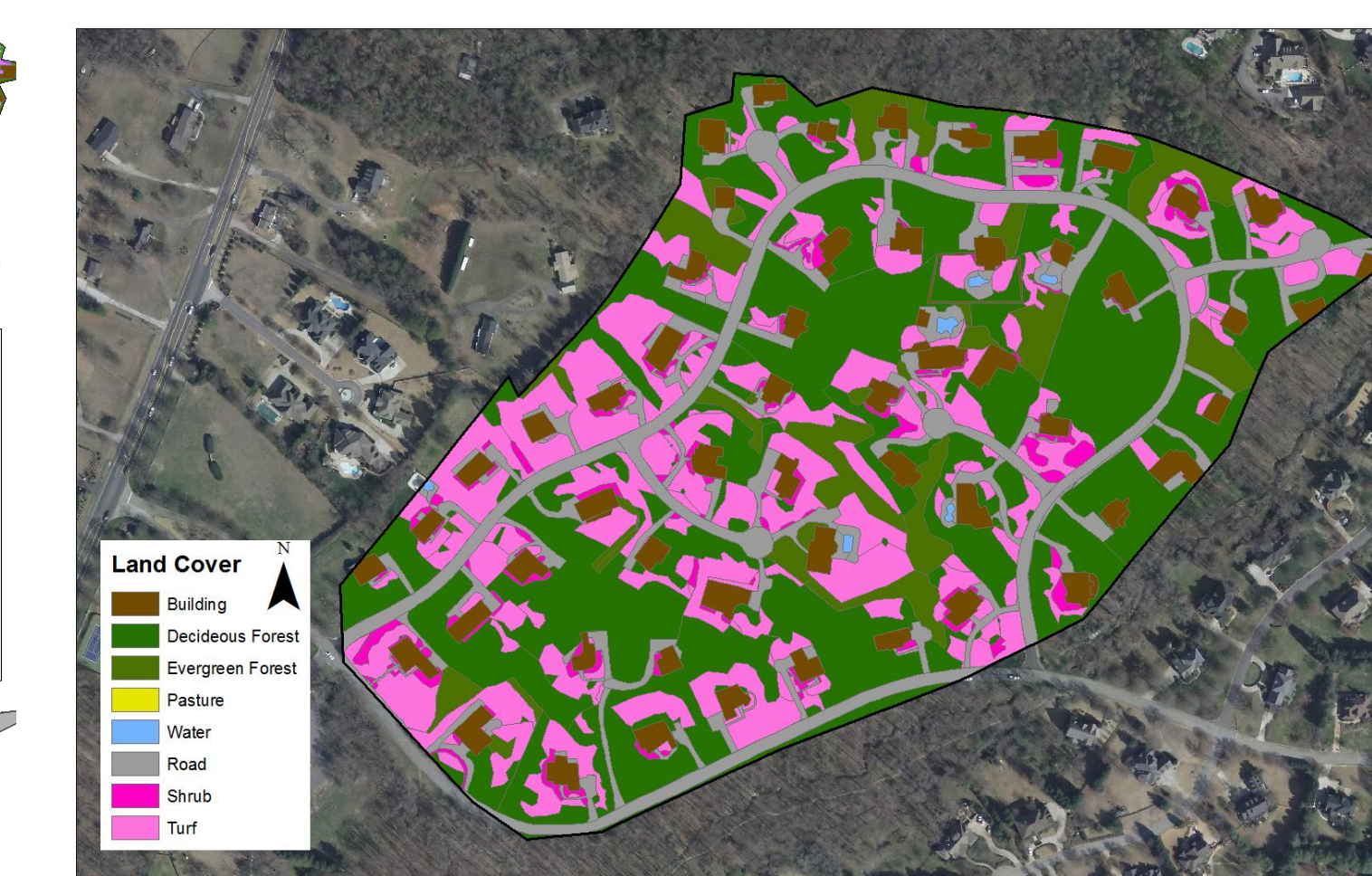


Between 1965 and 2013, forest cover and pasture decreased and row crop nearly disappeared. Urbanization led to the expansion of residential and commercial land cover at the expense of agriculture.

High Resolution Neighborhood Analysis



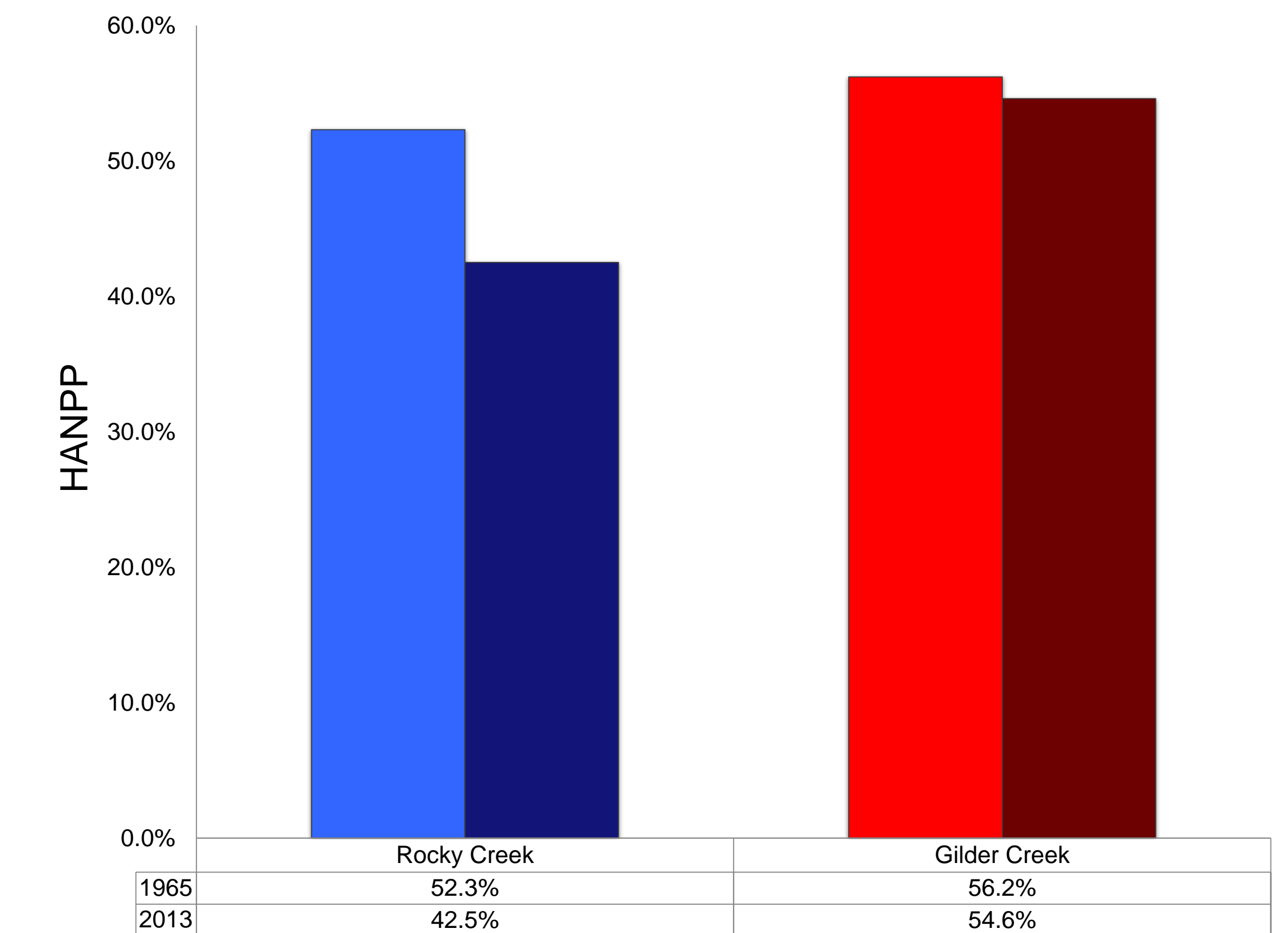
Land cover analysis of four low density residential and four medium density residential neighborhoods.



High resolution analysis for one low-density residential neighborhood.

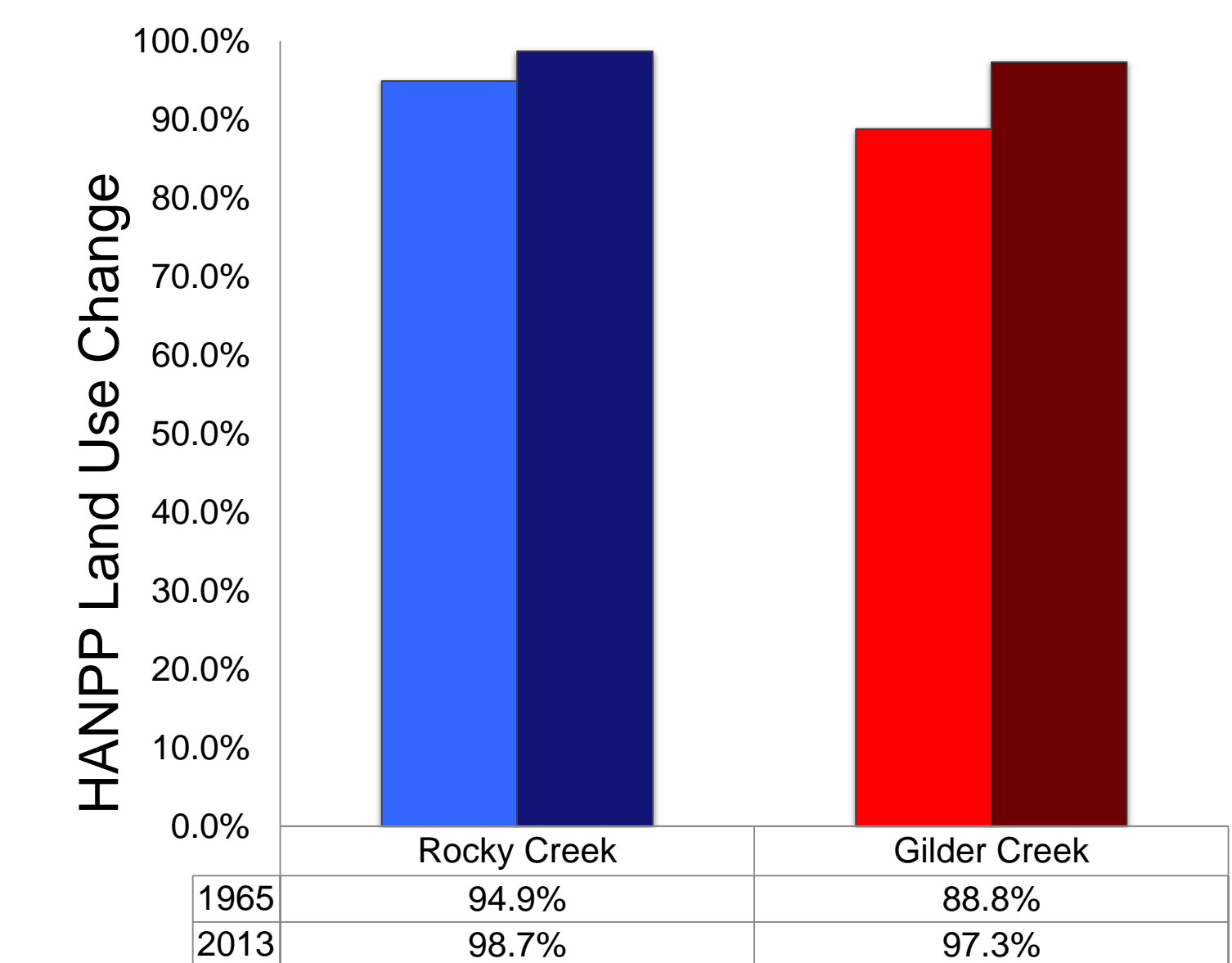
- Urban land cover is a complex mosaic of turf grass, forest, and impervious surface.
- High resolution results: low density residential is 29.8% turf grass, 26.1% impervious, and 43.8% forested; medium density residential is 21.6% turf grass, 52.0% impervious, and 26.4% forested.

Watershed HANPP Analysis



Total HANPP percentage of Rocky Creek and Gilder Creek watersheds 1965 and 2013.

- HANPP slightly decreased in both watersheds.
- Land use change accounted for more than 95% of HANPP.
- In the 1960s, crop production in both watersheds was declining due to soil degradation and shifting of agriculture to the Midwestern United States.



Percent of total HANPP land use change

Conclusion

- HANPP was driven primarily by land use change rather than biomass harvest.
- Urbanization between 1965 and 2013 was mainly residential development and led to a slight reduction in HANPP.
- From a socio-ecological perspective, a major impact on biomass flows away from food production and other services provided by agriculture.
- Understanding the estimation of HANPP in urban environments requires high resolution analysis. Low and medium density residential land covers are characterized by minimizing decline in HANPP.
- Future research will include analysis of more watersheds with different levels of urbanization and analyzing the connection between ecosystem services, biodiversity and HANPP.

Acknowledgements

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