Establishing a Gradient of Environmental Condition in the Mohawk River Basin for use in Prioritizing Environmental Management Decisions

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Introduction

The efficient management of natural resources requires detailed baseline environmental data. In the Mohawk River basin few investigations have attempted to synthesize environmental data in an effort to provide information that would help decision makers (e.g., local municipalities, academia, conservation groups) to prioritize their decisions. For example, managers making decisions regarding land preservation and the direction of monetary funds cannot make informed decisions without first having an adequate understanding of the areas of concern. Baseline information will inform on the areas where data is sparse, recommend areas for preservation, or locate areas for restoration projects. An important and useful set of information is a map-based gradient classification of water quality; where information at varying regional scales (county, town, or city) or by watershed may be extracted.

The New York State Department of Environmental Conservation (NYSDEC), Watershed Assessment Associates (WAA), and the Mohawk River Research Center, Inc. (MRRC) conducted a synthesis of several human and environmental variables to develop a classification of the Mohawk River basin. The classification estimated the relative environmental condition within the basin as a means to prioritize action (i.e., restoration projects, monitoring, research, conservation, or preservation). This type of information is necessary to provide benchmarks for comparison with future conditions (Stoddard et al., 2006; Hughes 1995).

Methods

A classification system was developed in geographic information systems (GIS) using national land-cover data (NLCD 2001), land cover change (NLCD 1992-2001), population data (2000), specific conductance data, percent impervious surface, and biological water quality data. NLCD land cover data was reclassified into seven categories (Anderson et al. 1976) and ranked according to potential impact to stream community. Land cover change between1992 to 2001 (http://www.mrlc.gov/changeproduct.php) values were reclassified into three categories: positive change (e.g., urban to forest), neutral (e.g., water to wetland), and negative (e.g., wetland to urban). Population data was obtained from the 2000 census (www.census.gov) at the block level, converted to a raster file, and reclassified into five population range categories.

Specific conductance data was provided for 264 sites in the Mohawk River basin by NYSDEC and United States Geologic Survey (USGS) water quality monitoring networks. Biological water quality data was provided by the NYSDEC and consisted of water quality assessment scores based on benthic invertebrate communities from 242 sites from throughout the Mohawk River basin. Inverse distance weighting was used to interpolate specific conductance measurements and benthic invertebrate community index scores into a raster map of predicted values

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throughout the basin. The specific conductance map was reclassified into three categories representing a gradient of watershed disturbance: < 150 μ*S*/cm (excellent condition or preservation), 150-800 μ *S*/cm (good condition or conservation), and >800 μ*S*/cm (poor condition or restoration). These categories were based on NYDEC's threshold of 800μ*S*/cm for pristine systems. The benthic invertebrate community index map was not reclassified because the calculated values were already rescaled to range from 0-10 (low quality to high quality).

An algebraic expression was used, in ArcMap 9.2, Spatial Analyst, to create a gradient map of environmental quality throughout the Mohawk River basin. The potential values derived from the calculation ranged from 5 to 33. High values (24-33) indicate excellent quality or preservation areas, moderate values (15-23) indicate good water quality or areas of conservation, and low values (< 15) indicate poor water quality or areas for restoration. Environmental condition was extracted for the entire basin and selected areas to provide examples as to how this information may be used by stakeholders at the county, town or city regional scale.

Results

Environmental condition values, based on the six parameters, ranged from 5 to 31. The distribution of poor environmental condition within the Mohawk River basin was concentrated in cities (Rome, Utica, and Schenectady), and environmental condition improved with increasing distance from these city centers. Good environmental condition with small areas of excellent condition was present throughout the Mohawk River corridor (Figure 1). Two areas within the basin were dominated by excellent environmental condition: the north western "branch" and the south eastern "branch" (Figure 1). These two areas were characterized by low human disturbance values and non-impacted biological communities. Prioritization at the basin scale classified 2% of the area as restoration, 50% conservation, and 48% preservation.

On a smaller regional scale, New Hartford (Oneida County) and Schenectady (Schenectady County) demonstrated higher percentages of restoration areas and fewer preservation areas. New Hartford is a suburban community southeast of Utica, NY. At the city scale 14% was categorized as restoration, 84% as conservation, and 1.7% as preservation; at the county scale 3.4% as restoration, 71% as conservation and 25.5% as preservation. In Schenectady County 15% was categorized as restoration, 71% conservation, and 13% preservation; in the City of Schenectady, 81.5% was categorized as restoration, 18.5% as conservation, and 0% as preservation. These results are not surprising; however the map-based system can quickly inform local stakeholders within these areas the precise location and distribution of restoration, conservation, or preservation areas, determine the streams located within these areas, and reveal the extent of data resources collected within the area.

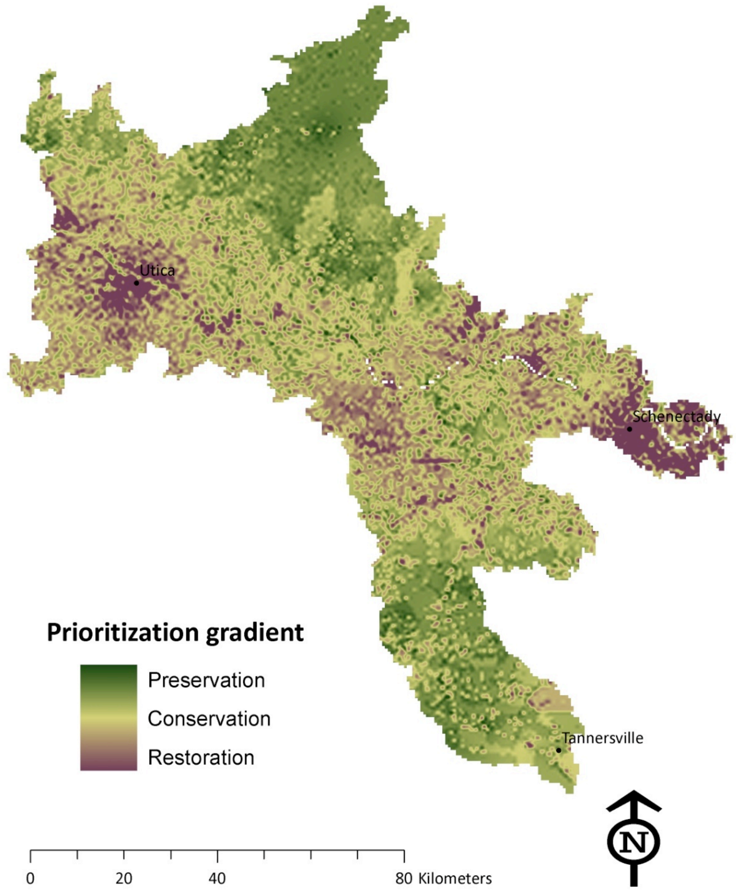

Figure 1. Map of environmental condition throughout the Mohawk River basin.

Discussion

As development and suburban sprawl continue throughout New York, it is imperative that watersheds are evaluated to identify regions where natural pristine conditions exist. Such areas are critical to the maintenance of basin-wide ecological integrity. Their identification and characterization also provides meaningful comparisons to other areas basin-wide and can be used to evaluate the extent of human disturbance elsewhere in a region (Stoddard et al., 2006). Many variables exist that could be used in evaluating the environmental condition and should be selected based on the objective of the classification. Here the objective was to classify environmental condition along a gradient of human disturbance throughout the Mohawk River basin. The focus was on the degradation of water quality, but has relevance to other aspects of the environment since water quality is intimately tied to overall landscape condition. Selecting a set of variables that are readily and easily collected is also important and enables updating on a regular basis. The variables used in this study (both remotely sensed data and field collected data) determined the degree of disturbance with high accuracy. Whittier *et al.* (2007) recommends that the evaluation of reference conditions be performed using both "field-collected" and "mapped information"; by doing so, the evaluation of disturbance does not rely solely on best professional judgment. For these reasons, we chose to utilize national land-cover data, population data, impervious surface, specific conductance and water quality assessment scores. Land-cover and impervious surface data are revised on a regular basis and are easily managed. Specific conductance can be an inexpensive measure of overall contamination as a result of human disturbance and is readily recorded by local, state, and federal organizations. However, the presence of easily dissolved dolomite limestone bedrock, which naturally elevates specific conductance in surface waters, inaccurately indicated greater human degradation in the vicinity of Canajoharie, NY. As this tool is refined, a calculation to down-weight conductance values where this type of bedrock formation occurs will be applied; so that the areas with naturally high specific conductance would not be inaccurately translated to represent human disturbance. In addition, biological water quality assessment data is generated by the State Department of Environmental Conservation on a five-year cycle. These factors make the variables selected reliable, cost effective, easily manageable, and have understandable endpoints.

The prioritization of environmental condition within the Mohawk River Basin is an important tool for natural resource managers, municipal planners, scientists, and many others. All too often decisions are made without consideration to the significant roles in the sustainability of wildlife populations and water quality. The greatest benefits of this system are data driven decision assistance to prioritize research and monitoring, restoration projects, and allocation of funds for preservation, and the ability of stakeholders, no matter their regional scale, to evaluate their environmental condition and compare it to the overall environmental condition of both the basin and adjacent communities.

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