GIS Model of Aquatic Habitat Suitability for the Central Mohawk River Basin

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Many of the processes that determine the physical features of watershed also determine their biological features, including habitat for aquatic organisms. With current digital information and mapping software, it is now possible to model the suitability of freshwater ecosystems for rare species (which typically have narrow habitat requirements), and to use the results for land use planning and watershed restoration studies. In this investigation, we examined stream habitats in 18 sub-watersheds centered on Montgomery County, as part of a broader NY State wildlife conservation initiative.

Previous work found that five parameters (stream size, habitat quality, water quality, stream gradient, and riparian forest cover) were sufficient to predict aquatic biodiversity in stream ecosystems of western NY State (Meixler 1999). Other work, which used sub-watersheds as the unit of analysis rather than stream segments, found that key metrics of ecological integrity were land cover, roads, dams, the total richness of rare species, and water quality (Howard, 2006).

Building on these earlier efforts, we have developed a geographic information systems (GIS) model of habitat suitability for streams in the central portion of the Mohawk River Basin. The model predicts the suitability of a stream reach for ten species of conservation interest, including freshwater mussels, dragonflies, and damselflies. The velocity and size of stream reaches that are known to have populations of these aquatic organisms were used to define the range of reaches that are also expected to have the same species in the study area. Streams were also evaluated for a number of water quality parameters: the NYS water quality classification of the stream; the presence of point sources of pollutant discharge; the percent of natural land cover within 30 meters of the stream; and impairments of the stream flow caused by dams or road crossings. The parameters were individually scored and added, and the total was rescaled to a maximum of 100. Stream reaches with higher scores represent more natural, less-impaired habitat. From the set of suitable stream reaches selected by velocity and size, the highest-scoring reaches were selected based on the sum of the stream quality parameters.

Geomorphic Parameters

The United States Geologic Survey's National Hydrography Dataset Plus combines hydrographic features with modeled attributes such as mean annual flow (cubic feet/sec), maximum velocity (ft/sec) and slope (cm/cm) ("NHD Plus User Guide" 2009). These data provide a way of estimating the range of geomorphic attributes that may be preferred

In: Cockburn, J.M.H. and Garver, J.I., Proceedings from the 2009 Mohawk Watershed Symposium, Union College, Schenectady NY, 27 March 2009

by an aquatic species. In order to identify preferred stream habitats for aquatic species in the study area, NY Natural Heritage Program Element Occurrences for these species were intersected with NHDPlus stream reaches in the eastern portion of the state. Flow, velocity, and cumulative drainage area for each occurrence were extracted and statistics were calculated for each species. The results indicate that the mean annual stream velocity (attribute "MAVELU") and cumulative drainage area ("CUMDRAINAG") have small enough variances that they naturally divide the stream reaches into discrete habitat classes (Figure 1). Habitat suitability classes were defined for each species from the mean value and standard error. "Optimal" habitats are streams with mean annual velocity and cumulative drainage area within one standard error of the species mean. "Marginal" habitat is defined as the range between one and two standard errors of the species mean, for both attributes.

Habitat Quality Parameters

The 2001 National Land Cover Dataset (NLCD) was used to estimate the fraction of natural land within 30 meters of streams in the study area. In our definition, natural land excludes developed classes and cultivated crops. Flow impairment of stream segments was determined from two parameters, the number of stream crossings by roads, and the number of dams, weighted for the dam height. The combined flow impairment score is the average of the road intersection score and dam score. Water quality was estimated using the New York State water quality classification for each stream segment, and the presence of point pollution sources recorded in the US Environmental Protection Agency Region 2 facilities database. The water quality score for each stream segment is zero for streams with point pollution sources; otherwise it is a geometrically weighted value that we assigned to the water quality class, with class AA having the highest value. The three parameters for quality were added, and rescaled so the maximum value in the study area is equal to 100.

Results

The model provides planners and land managers with simple analytical tools. Streams that are found to be potential habitat for an aquatic species may be targeted for biological surveys, to determine whether the species are actually present. Approximately 47 percent of stream segments in the study area are predicted to be at least marginal habitat for one or more species of freshwater mollusk, damselfly, or dragonfly (Table I). We emphasize that these results are based on distributions of sensitive aquatic species. As indicators of habitat quality, they can be useful for locating high-value stream segments and watersheds. Streams can be further prioritized according to their habitat quality score (Figure 2). Streams that are potential habitat, and which also have high scores, may require heightened managment of adjacent land uses. Conversely, streams that are potential habitat but which have low scores present opportunities for restoration.

References

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