

Great Lakes Regional Aquatic GAP: Development of a Physical Habitat Geographic Information System (GIS) Database for Riverine Systems in the Great Lakes Basin

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Introduction

Great Lakes Regional Aquatic GAP is an example of a regional, collaborative project with the goal of adapting the traditional terrestrial approaches of gap analysis to the conservation of aquatic species in the Great Lakes basin. One fundamental component of Great Lakes Regional Aquatic GAP is the development of a physical habitat GIS database. Great Lakes Regional Aquatic GAP has represented riverine habitat at multiple spatial scales using GIS-based habitat data. This approach necessitates the development of a comprehensive habitat database that can be used in modeling efforts to predict species distributions. Given the lack of availability of micro-scale (site-specific) aquatic habitat information for large areas such as the Great Lakes basin, the physical habitat database consists solely of macro-scale or landscape-scale habitat information commonly available in GIS data sets. While not ideal, macro-scale habitat data provide surrogates for finer-scale habitat characteristics that are impractical to measure for large areas. The database was structured so that it maintains the fidelity of numerical attributes by retaining continuous data types, rather than classification into arbitrary, discrete classes.

Spatial Data Sets

Spatial data sets that are national or regional in extent were used, wherever possible, to avoid edge-matching and attribute consistency problems across state lines. These data sets include the U.S. Geological Survey (USGS) 1:100,000 National Hydrography Data Set (NHD), the USGS 1:24,000 National Elevation Data Set (NED), and the Natural Resources Conservation Service (NRCS) 1:250,000 State Soil Geographic Database (STATSGO). In cases where data sets were not available for the entire Great Lakes basin, the best available statewide data were used and a standardized classification scheme was developed to provide consistency between states. Experts in their respective fields were consulted to ensure that the classification schemes employed were representative of the geographic areas under consideration.

The data sets included bedrock geology type and depth, surficial geology, land use/land cover, and climate. In cases where a habitat variable is not currently available in a GIS database, statistical

modeling techniques were used to compute estimates of the variable. A GIS data set was then derived from the statistical model. Modeled variables include groundwater potential, stream temperature, and stream flow. Existing and modeled data were then used to calculate a variety of potentially significant variables for each spatial unit.

Spatial Units

The term *spatial unit* refers to a feature representation of a geographic entity at a specific scale. The spatial units we delineated included the channel, watershed, riparian zone, upstream catchment, and upstream riparian zone. Multiple spatial units were employed because fish species respond to environmental factors at multiple spatial scales. Our spatial units are hierarchical and nest within each other to represent a continuum of habitat variables that directly and indirectly affect in-stream habitat.

A channel is composed of a single confluence-to-confluence stream segment except in the case of in-channel lakes, which are treated separately. To characterize the land area immediately adjacent to a specific stream segment, a 60-meter riparian buffer on either side of the stream channel was generated. The riparian zone represents a more indirect influence on riverine habitat than the character of the stream channel itself; it represents the immediate interface between the riverine system and the upland system and the geomorphologic processes that shape the stream channel. The surrounding landscape (in the form of the watershed and upstream catchment) influences aquatic habitat at a larger scale. Watersheds and catchments may affect in-stream habitat indirectly through surface runoff and groundwater input, and more directly through nutrient and sediment loading. A watershed is delineated based on a hydrologically correct drainage-enforced Digital Elevation Model (DEM) derived from the NED. Watersheds constitute the land area that drains to a channel segment. By tracing up the river network, upstream riparian zones and watersheds were identified. They were then aggregated to form the upstream riparian zone and upstream catchment spatial units.

Methodology

The attribution of spatial units was largely carried out using a series of overlays with the categorical and numerical GIS habitat data sets and the delineated spatial units. In some cases, such as stream order and sinuosity, habitat variables were calculated directly from a GIS data set. Connectivity metrics will be calculated based on network traces on the NHD and the spatial relationship between

stream segments and barriers to fish passage, such as dams and waterfalls. The GIS operations required to attribute the spatial units with habitat information are largely automated. Network tracing, computing connectivity metrics, and many other GIS tasks are relatively complicated and thus lend themselves to a programmatic approach. This is accomplished through a series of AML (Arc Macro Language) scripts. Automation of many of the GIS tasks facilitates standardization within Great Lakes Regional Aquatic GAP. The gains in efficiency are also large, especially considering the low overhead of a scripting language like AML running in command line ARC/INFO, compared to more current but much more resource-intensive languages such as Visual Basic for Applications (VBA) running in ArcMap.

Progress

Great Lakes Regional Aquatic GAP is well on its way to completing a comprehensive macro-scale GIS database of

riverine habitat within the Great Lakes basin. As of June 2005, the GIS habitat database is complete (except for connectivity metrics) in Michigan, Wisconsin, New York, and Illinois and Indiana for the land area within the Great Lakes basin. Ohio is in the process of completing its habitat database.

Conclusions

The physical habitat database contains a variety of GIS-derived attributes aggregated at multiple spatial scales. This multiscale approach provides fish modelers with the habitat variables needed to produce robust predictive models of riverine fish species distributions. The habitat database, as well as derivative GIS data sets, is potentially useful in a variety of other ecologic and hydrologic applications, such as fisheries management, designing stream sampling protocols, predicting stream flow distributions, and monitoring flood frequency, base flow, and water quality.