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what's inside

Rare Species Models

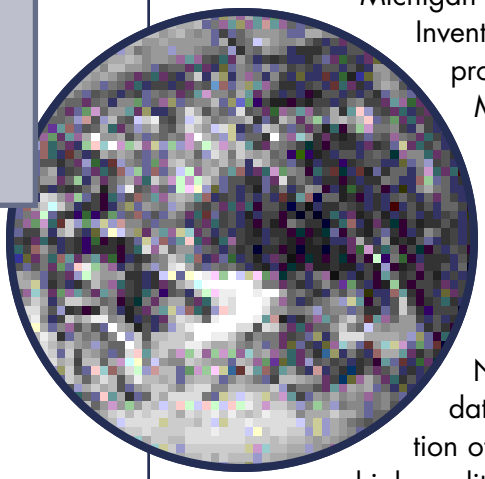
Who's Doing What?

Member News

Did You Know?

Rare Species Models for Land Use Planning

By Ed Schools



Michigan Natural Features Inventory (MNFI), a program of the Michigan State University Extension Service, is Michigan's Natural Heritage program. As such, MNFI maintains the Natural Heritage database, a compilation of rare species and high quality natural community locations. MNFI tracks 417 plant species, 248 animal species, and 74 natural community types. The Natural Heritage database currently contains approximately 15,000 locations of these elements of biodiversity. Sources of data include field surveys by MNFI staff, contributions from outside partners, and secondary sources such as published reports or museum collections.

The MNFI Natural Heritage database utilizes Natural Heritage methodology and data standards originally designed by The Nature Conservancy and now maintained by NatureServe (www.natureserve.org). The Nature Conservancy designed the Natural Heritage database to aid conservation planning efforts. The database includes species protected under State or Federal laws, as well as rare species that lack legal protection. The database also includes historic occurrences of these rare species.

The Natural Heritage database is more than a presence/absence database. Among other information, it contains first and last observed dates, global and state imperilment rankings for species, and a quality ranking for individual occurrences. It is a positive sighting database. Only known and verified species and natural community occurrences go into the database. MNFI scientists continually update the database and it is the most complete record of Michigan's most sensitive species and natural features.

The Natural Heritage database is a spatial database. Each occurrence has a defined polygon spatial extent. Under Natural Heritage database standards, only the known or reported spatial extent of each occurrence can be used to represent the occurrence. For example, if an observer reports a rare plant from a particular square mile section, that section boundary becomes the spatial extent of

RARE SPECIES continued on page 3

Who's Doing What in GIS and Spatial Technology

GENESEE COUNTY DIVISION OF WATER AND WASTE SERVICES

Population: 436,141 (U.S. Census Bureau, 2000 Census)

Geographic Coverage: 649 square mile (1680.902 km^2) consisting of 33 townships, cities, and villages

Number of Staff: 1 GIS Technician, 1 Consultant

Annual Budget: Average annual GIS and related technologies budget: $160,000 (last 5 years)

PROGRAM SUMMARY

The Genesee County Drain Commissioner, Division of Water and Waste Services (WWS; www.gcdcwws.com) is responsible for administration, operation, maintenance, and construction of water distribution, sanitary sewer infrastructure, and treatment plants throughout the 649 square mile (1680.9 km^2) County. The Division services approximately 93,000 sewer and water customers within 33 townships, cities, and villages.

GIS for WWS began in the mid-1990s as an extension of Genesee County's existing GIS program (see *IMAGINews* May/June 2006 for a history of the broader County GIS program). Recognizing the tremendous assets that GIS-based technologies provide, with the support of Genesee County Drain Commissioner, Jeff Wright, the WWS staff developed a budget which enabled them to meet several fundamental objectives. A consultant was retained to develop the initial datasets, specifically AutoCAD-based data from as-built prints. Then, after purchasing GPS units, WWS began locating sanitary sewer manholes throughout the County. Once the original AutoCAD files were converted to shapefiles, WWS began to use ESRI's ArcView 3.2 for water and sewer system map development and basic spatial analysis.

In 2003, WWS decided to extend its GIS data and capabilities. To accomplish this objective, they contracted North Arrow Technologies, Inc. (NAT; www.northarrowtech.com), a GIS consulting firm located within Genesee County. Two goals were established and became the foundation for the project: 1) develop county-wide GIS datasets for sanitary sewer and water infrastructure and 2) implement a GIS-based asset management system.

Data Development

With contextual, site-specific assistance from WWS, a customized GIS database was designed. Using industry-standard geodatabase models for sanitary sewer and water systems as a basis, NAT worked with a group of department administrators, along with several key WWS personnel, to develop a customized database specific to WWS departmental operations. These customized models were used to create a personal geodatabase, which served as the initial development platform for this phase of WWS GIS program.

Constructing the preliminary water and sewer GIS-data began in 2003 by reviewing both paper and digital as-built prints and mapping the relative (i.e., in reference to parcel lines and street networks) locations of infrastructure features. To date, completed GIS data include over 800 miles (1287.5 km) of sanitary sewer and 500 miles (804.7 km) of water system, with several additional communities currently in development. As the datasets are being constructed, WWS personnel are scanning and attaching as-built drawings of the system to the actual GIS features the as-builts represent. In doing so, WWS is moving away from a traditional paper-based storage system to a print-management system that is more efficient. Additionally, this system should prove its worth, helping to locate sewer or water entities during emergencies.

In 2006, the data was migrated from a personal geodatabase environment based on MS Access to an enterprise geodatabase based on Microsoft SQL Server 2005 and

WHO'S DOING WHAT continued on page 4

RARE SPECIES continued from page 1

the database record. In some cases locations are known precisely, e.g. within a few meters. Some records, in particular historic records, are much more general in extent. While general in nature, these records still provide important information for conservation planning efforts. These general records tell a Natural Heritage scientist what may be found in appropriate habitat in a given area. Figure one shows a sample of the database spatial representation.

Natural Heritage scientists designed the Natural Heritage databases and methodology for conservation planning

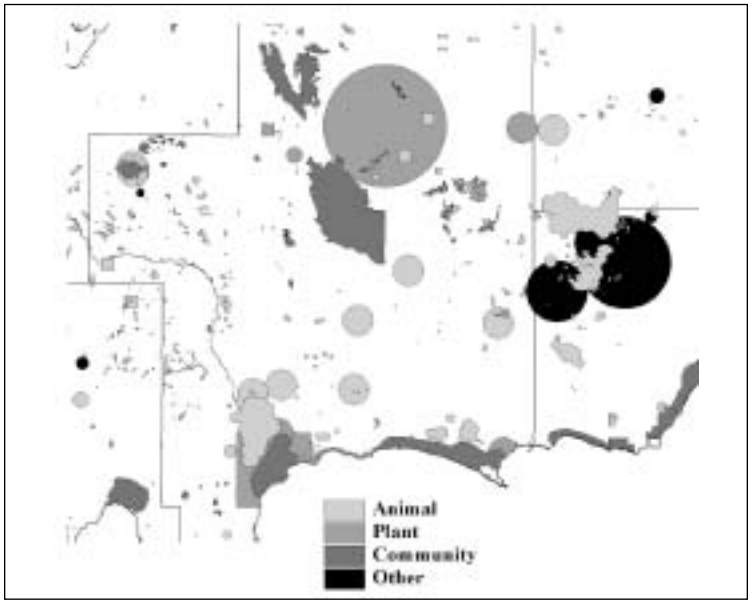


Figure 1: *Spatial representation of the MNFI Natural Heritage database.*

efforts, not for land use planning efforts. While various entities would like to consider rare species locations in land use planning efforts, there are issues limiting the direct usefulness of the data for land use planning.

The primary issue is the sensitive nature of rare species' locations. Some species are particularly sensitive to disturbance or are subject to collection pressures. Indiscriminate distribution of their location information can be detrimental to their long term survival. Also, MNFI data cover private property. There are some landowners that do not wish others to know what is on their property. Another issue is the ambiguous nature of biological information. Nuances such as mapping mobile organisms, different levels of species imperilment, and the importance of older records can make these data difficult for the non-biologist to use and interpret.

To get around these issues, MNFI has created two models based on the Natural Heritage database to facilitate incorporating the database into land use planning efforts. The models are GIS datasets. Users may utilize the models independently or incorporate them into a GIS based Decision Support System.

The first model is termed the **probability model**. The model does not give a statistical probability per se but instead ranks the likelihood of species occurrence within an area as high, moderate, or low. The basic logic behind the model is that more recent occurrences are more likely to still be present on the landscape. The model utilizes the known extent of rare species or natural community occurrences, available habitat within that extent, and the age of the record to assign the high, moderate, or low probability. A high probability means that the area contains a relatively recent species or natural community occurrence, and there is appropriate habitat for the species present. A low probability means that there was a historic occurrence in the area, and there is still potential habitat present. While the low probability results are based on historic records, there is still a non-zero chance of the species being present. A moderate probability is somewhere between the two extremes. Incorporating the habitat within the occurrence spatial extent helps eliminate areas that have no potential habitat. The model assigns those areas with no known occurrences or no potential habitat a "no status" value. In cases where any particular area might have both a low and a high likelihood of an occurrence, the area receives

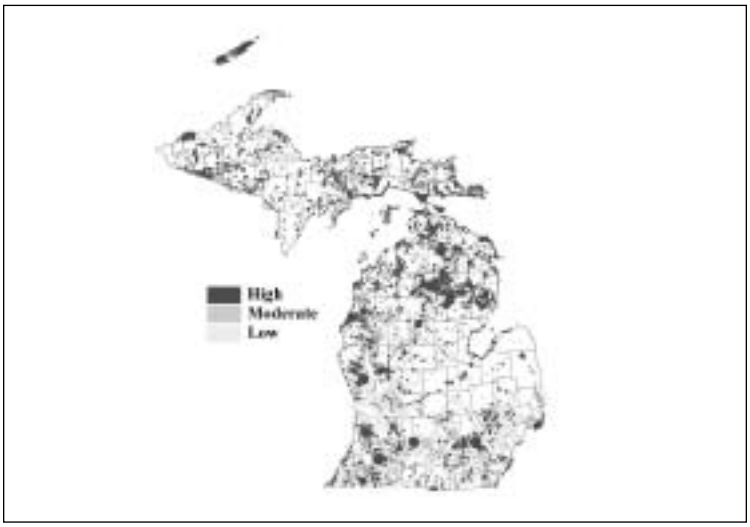


Figure 2: *Statewide probability model at the square mile (2.59 km^2) section resolution*

RARE SPECIES continued on page 5

WHO'S DOING WHAT continued from page 2

ArcSDE. The new database design moved WWS toward the enterprise, integrated system that they desired by allowing multiple WWS personnel to edit the data simultaneously. ArcSDE has an additional utility when working with an off-site consultant. The data can be "checked out" (i.e., the data can be copied for remote editing), updated, and seamlessly re-inserted without hindering the daily operations of WWS.

In a continuing effort to increase the accuracy of its GIS data, and as a cost-savings means, WWS has been employing college students as summer interns to collect GPS location data on manholes, pump stations, hydrants, and valves. To date, over 15,500 features have been located using GPS. As the GPS points are collected, the pre-constructed infrastructure data, along with their attributes and work history, are adjusted to the new, more accurate locations.

Asset Management System

Azteca Systems' (www.azteca.com) Cityworks was implemented as a pilot study for WWS in the summer of 2003. The new system provides WWS with GIS-based asset maintenance and management operations control for their sanitary sewer and water systems. Leveraging the GIS data already constructed, WWS personnel are able to track work history, create service requests, and manage work orders from within ArcMap. This integrated, GIS-centric approach minimizes software costs and ensures GIS users do not have to learn a second software environment to operate a maintenance and management system. Additional capabilities include general and preventative maintenance scheduling (which can be automated), project planning and cost estimation, as well as tracking of labor, materials, and equipment cost.

Tracking work history has provided WWS with valuable reporting capabilities that were previously difficult or impossible to complete. Reporting for MDEQ, SSO, GASB 34, and internal management reporting are now possible. For end-users, the entire work history of any feature can be accessed by simply clicking on the feature in the GIS.

The Cityworks asset management system is administered and maintained by a single GIS technician working at WWS. Training sessions were held for the technician who, in turn, coaches additional users within the larger WWS community.

Current Use

While not yet fully deployed, GIS is operational and used by several people in multiple departments within WWS. To aid in the system integration and end-user success, there have been several multi-person, as well as individual training sessions to transfer ArcGIS 9.x knowledge to WWS personnel. All users are currently using ArcGIS 9.2. WWS departments and the real-world aspects they manage within the GIS include: Sewer Department (pump stations, saddle taps, and cut and caps); Inflow & Infiltration Department (manhole repairs, plugged sewers, jetting, and televising of sewer lines); Water Department (water meter installs, water main breaks, and hydrant flow test); Permits & Construction Department (new connections to the water and sanitary sewer systems).

NEW PROGRAMS AND ACTIVITIES

For 2007, WWS GIS objectives include completing the development of the GIS data, and increasing the scope of the asset management system implementation, both functionally and operationally, within the Division. Efforts are underway to integrate additional infrastructure elements such as fiber optics, rain gauges, grinder stations, and septic receiving stations into the GIS. Incorporating these additional assets will allow for automatic work order and service request generation and subsequent tracking for these assets. Additional steps include the deployment of Azteca Systems' Call Center, allowing WWS personnel to log customer calls and immediately create service requests, in the absence of a GIS workstation. Field personnel will be equipped with rugged notebook computers to create and edit work orders on-site, eliminating the need for paper copies and manual processing. Finally, GPS fieldwork will continue adding accuracy to the GIS database.

Community Collaboration

Prior to this new phase of GIS for WWS, several communities within Genesee County had developed their own GIS programs (e.g., Grand Blanc and Fenton Townships) that included sewer and water datasets. Instead of duplicating this effort, WWS is relying on data-sharing agreements to incorporate existing data from these municipalities into the larger county-wide dataset.

Concurrently, WWS is seeking data-sharing agreements for communities that intend to develop GIS capabilities in the future. In this respect, WWS has realized the value of an

WHO'S DOING WHAT continued on page 6

RARE SPECIES continued from page 3

the high likelihood. Figure two shows the probability model statewide at the one square mile (2.59 km^2) resolution.

The probability model highlights those areas where there is a high likelihood of encountering a rare species or high quality natural community. Planners can use this model to direct development away from more sensitive areas and to areas more appropriate for development. There is still a level of protection for the organism because the user does not know what organism is in the area, just that there is one.

Just knowing the likelihood of an occurrence may not be enough information to prioritize areas for protection efforts. If a user has three areas, all with a high probability of an occurrence, how does the user prioritize among those areas? This is where the second model comes in.

The second model is termed the **biodiversity value model**. The logic behind this model is that not all species are equally imperiled. The more imperiled a species, the more important to protect the area containing that species. Like the probability model, the biodiversity value model utilizes the known extent of rare species or natural community occurrences, available habitat within that extent, and the age of the species or community record. This model also incorporates the global imperilment of the species or community, the state imperilment of the species or community, and the quality rank assigned to each occurrence. The model assigns each occurrence a score based on these values, then the scores for all occurrences within an area are summed and that value is assigned to the area. The end result is a value that indicates the relative importance of an area for rare biota or natural communities. Users can utilize the scores assigned to areas to weigh areas against each other. Figure three shows the statewide biodiversity value model at the square mile (2.59 km^2) section resolution.

MNFI produces the models at three spatial resolutions, the section, quarter section, or quarter-quarter section. At these resolutions the models are useful for regional planning efforts. They are not effective at the site or neighborhood planning level.

Both models are presented in the same data layer. Each feature has a probability level and a biodiversity value associated with it. Quarter-quarter section level models by County are available from the MNFI web site (www.msue.msu.edu\mnfi) under the data resources tab.

Also available at the download page is a white paper that explains the model methodology in more detail. MNFI will provide statewide versions at different resolutions upon request.

While these data layers provide valuable resource information for land use planning, there are caveats to their use. The intent of the data layers is to provide land use planners with information about those areas likely to contain sensitive species. The intent is not to say definitively what areas contain or do not contain sensitive species. The strength of

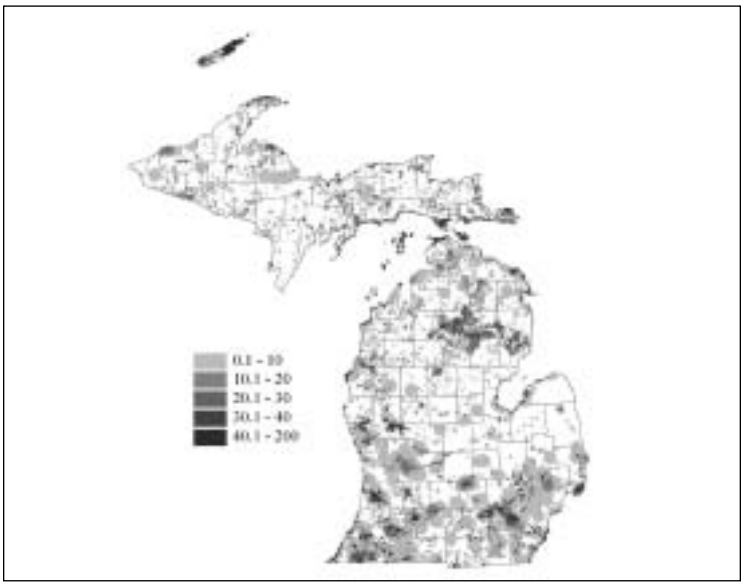


Figure 3: *Statewide biodiversity value model at the one square mile (2.59 km^2) resolution. Darker areas indicate biologically important areas.*

these models is the fact they use only verified occurrences of rare species and high quality natural communities. This is also their weakness. The models make no predictions beyond the known occurrences. MNFI has not systematically surveyed Michigan for rare species and natural communities. One does not know if an area with no known occurrences has never been surveyed or has been surveyed and has no rare elements. Despite these caveats, the models are based on the most comprehensive compilation of Michigan rare species and high quality natural communities. They are a valuable resource for planners throughout Michigan.

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WHO'S DOING WHAT continued from page 4

investment in GIS and has made a decision to lead in the development of a county-wide sanitary sewer and water GIS-based infrastructure. This step not only serves the current needs of WWS, but will also proactively serve as the basis for sewer and water GIS-data for the surrounding communities.

A final point on collaboration, Genesee County has brought together a GIS working group. This working group, which meets on the 4th Monday of every month, is intended to promote cooperation between County departments and municipalities within the County. WWS supports, and regularly contributes, to this effort.

LESSONS LEARNED\RECOMMENDATIONS

Several factors have proved important in achieving the goals of the GIS program at WWS. A pilot project covering a single community was a valuable first step in validating the work before embarking on the county-wide initiative. The entire process, from data construction to the maintenance and management system deployment, was completed for the first community. The demonstrated success of how a fully-functional system would operate garnered support from Commissioner Wright and WWS administrators to continue the project.

Developing an enterprise GIS for infrastructure mapping and management has been a worthwhile and successful project that will ultimately benefit WWS personnel with increased efficiency, added functionality, and mandated reporting. County residents will benefit from more efficient and thorough responses from WWS. The commitment from Commissioner Jeff Wright and numerous departments within the WWS division has provided both the funding and feedback necessary to successfully move toward a fully operational WWS-wide GIS program. Now in its final stages of implementation, the GIS program at WWS is in a position to realize its full potential, making good on the original WWS GIS-investment over 10 years ago.

North Arrow Technologies, Inc., Consulting Partner, Jason J. Taylor, GISP can be reached at (810) 714-3326 or jtaylor@northarrowtech.com;

Genesee County Drain Commissioner's Office Division of Water & Waste Services, GIS Technician, Theresa Ingle can be reached at (810) 732-7870 x4131 or tingle@gcdcwws.com.

Member News

InfoGeographics Inc. – a Traverse City-based GIS services and products company – is pleased to announce the addition of Scott Swan, GISP to its professional staff. Many IMAGIN members are already familiar with Scott through his previous GIS work with the University of Michigan and Stantec as well as IMAGIN's annual map competition and Professional Recognition Committee. In his new Project Manager role, Scott will be supporting InfoGeographics' clients throughout Michigan and the Midwest.

New contact information for Scott is:

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Email: sswan@infogeographics.com
Web: http://www.infogeographics.com

Brian Dubis, GIS project manager of **R.A. Smith & Associates, Inc.** – civil engineering, planning, surveying, landscape architecture, GIS, and visualization consultants located in Brookfield, Wisconsin – recently met the standards and requirements as established by the GIS Certification Institute to become a certified GIS professional (GISP).

Did you Know?

Michigan's first improved road ran from Detroit via Frenchtown (Monroe) to Fort Defiance in Ohio. It is depicted in Abraham Bradley's "Map of the United States Exhibiting the Post Roads" published in 1804. In 1825, a route was surveyed for a road linking the forts at Detroit and Chicago. The route followed the winding and irregular path of the ancient Sauk (Native American) Trail, corresponds roughly to today's highway US 12. For more fun with the history of Michigan Roadmaps, see an online exhibit at http://maps.lib.msu.edu/miroadmaps

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IMAGIN is a non-profit 501(c)3 organization comprised of individuals and organizations interested in the use and application of geographic information system (GIS) technology in Michigan. Our members are committed to improving the quality and availability of digital data necessary to make good use of GIS. We believe that cooperation and open communication are necessary to achieve these objectives.

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