Locating Wetland Loss "Hot Spots" Using GIS

Some areas of the country are more likely to develop wetland problems because of changes in the way land is used. The National Wetlands Inventory uses GIS to locate those areas and minimize the potential for damage.

Rich Young and Tom Dahl

The Wetland Status and Trends component of the National Wetlands Inventory, part of the U.S. Fish and Wildlife Service, monitors changes in wetland acreage for the United States. As part of this effort, Status and Trends is attempting to identify geographical regions where wetland losses are proceeding at a rate higher than the national average.

Past data indicates this usually occurs in areas where rapid land use changes are ongoing, either because of population changes, agricultural or silvicultural practices, or changes in land values. GIS technology is now being used to locate "hot spots" more efficiently, in a timely manner and with less subjectivity.

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Status and Trends is assimilating and assessing a number of national- and state-level thematic GIS data layers and developing several others. Priority is given to identifying hot spots that are discrete geographical units rather than addressing systemic national or statewide trends. For this reason, and for their generally manageable size, counties are most appropriate as units of study.

Remote Sensing Used Extensively

Status and Trends uses remote sensing extensively to monitor wetland acreage changes, since it covers a fairly large area of the landscape and is relatively inexpensive. Color infrared aerial photographs captured at different dates are compared and changes recorded. Status and Trends field-verifies the aerial photography with on-ground conditions. However, because there is a one- to three-year lag time between photo acquisition and the actual analysis, routine field verification often yields after-the-fact information about hot spot areas of wetland loss.

Rather than performing this type of *post mortem* analysis, Status and Trends prefers to be as active as possible in determining land use changes affecting wetlands. They are also concerned that certain areas might be excluded from consideration, since field work is limited to public access sites and is generally used to examine small areas. Due to the limitations of remote sensing, GIS layering and analysis is the best tool with which the entire nation can be examined in a timely and objective manner to identify wetland loss hot spots.

Status and Trends has documented the types of land use that most influence wetland conversions. These include:

Agriculture—Agricultural land use may be defined broadly as land used primarily for production of food and fiber. Historically agriculture has accounted for between 50 and 80 percent of wetland losses.

Urban Development—Urban land is comprised of areas of intensive use with much of the land covered by structures (high building density).

Rural Development—Rural developments occur in sparse rural and suburban settings outside distinct urban cities and towns. They are characterized by non-intensive land use and low building density.

Forested Plantations—Plantations include silvicultural areas such as planted pines, Christmas tree farms, clear cuts and other managed forest stands.

Other Land Use—Other land use is composed of uplands not fitting into the previous categories. Lands in transition from one land use type to another may also fit into this category.

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Understanding that these categories represent the fate of wetlands being converted to land use helps determine where and how to look for GIS layers that may represent these trends.

While wetland losses can occur wherever the above land uses conflict with wetlands, as a general rule, wetland losses are greatest where wetland abundance is greatest due to increased potential conflict with land development activities. For example, Arizona cannot lose the same magnitude of wetlands as Louisiana because the wetlands are not available to be lost. (Alaska is the single greatest excpetion in this regard. Although it contains more wetlands than the lower 48 states combined, its wetland losses are relatively small because land use in the state is so sparse.)

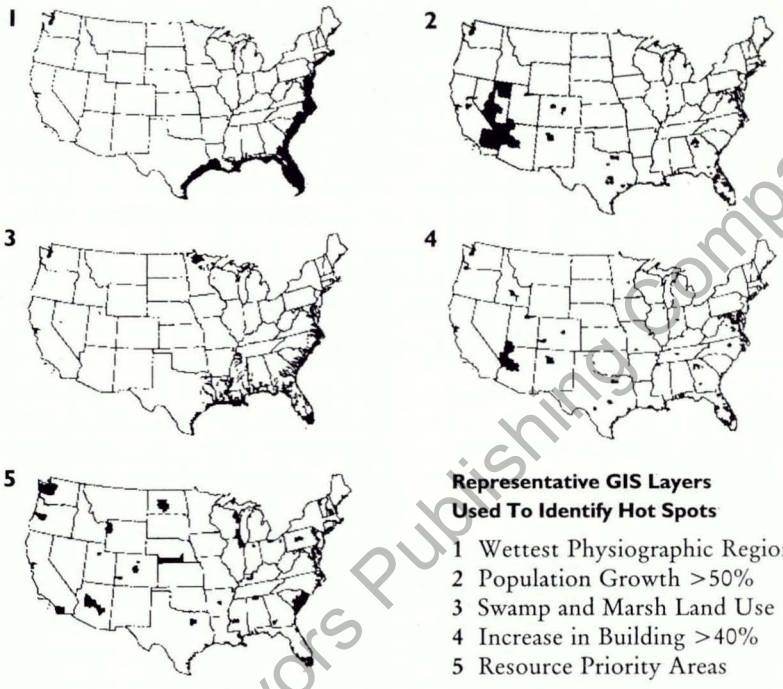
Operating on this basic assumption, if GIS data layers adequately representing the land uses above are developed, these data layers can be examined to determine where intersections with wetland complexes exist. These intersections may represent potential hot spots.

Pinpointing Wetland Hot Spots

Wetland losses are often composed of fractional acreages pieced together over several years that ultimately result in significant cumulative losses. Pinpointing wetland hot spots therefore requires a temporal national coverage with fine resolution of land use changes. The GIS coverages for this study must be national in scope; inexpensive to obtain, manipulate or assemble; and data layers must be readily available (i.e., not involving extensive data collection or proprietary information).

In some cases, no data layers have been located to correspond to the tracking indicators, while in others surrogate data were used as GIS information or automated data base management files were retrofitted to GIS coverages.

The GIS layers obtained for this exercise include sources from several federal agencies. To assemble, view and analyze these data, Status and Trends utilizes the ARC/INFO GIS system and the ORACLE Relational Database Management System



Representative GIS Layers Used To Identify Hot Spots

1 Wettest Physiographic Region
2 Population Growth >50%
3 Swamp and Marsh Land Use
4 Increase in Building >40%
5 Resource Priority Areas

(RDBMS). Both systems run on a network of Sun Microsystem servers and workstations. All analyses and interpolation of data layers are performed in ARC. GIS information received from outside sources is converted to ARC coverage format if necessary. Likewise, flat file data or RDBMS files other than ORACLE are converted to ORACLE tables on the main server. The amount of effort needed to prepare acquired data for use ranges from very little to quite involved. Several representative GIS layers used by Status and Trends to isolate potential wetland loss areas are shown on the next page.

Intersection of the assembled GIS layers is accomplished by classical GIS layering and intersecting operations. Candidate hot spots of wetland loss are derived from intersecting a number of these national data layers. Once a candidate region or state is filtered from the national data sets, other statewide databases may be accessed and combined with the results of national GIS information. Regional refinement of the information will help support the indicators provided by the national model and verify the appropriateness of candidate areas as final study sites. Factors such as the proximity of cities or towns to coastlines or the amount of federal land within the county, found by querying state or regional data, can provide additional insights to characterize these candidate areas.

Matching the candidate county with information such as the availability and timeliness of aerial photography, the size of the county and the availability of collateral resource information helps make a final determination for suitability. Ultimately, these candidates areas are field-verified. Once selected, these hot spots become the subject of intensive studies to monitor land use changes over time and to detect changes in land use practices and other phenomena that may promote wetland losses.

GIS technology makes it possible for Status and Trends to identify potential hot spots of wetland loss effectively and without reliance on either expensive remote sensing techniques or the subjectivity of field reconnaissance. To date, Status and Trends has identified several counties where work is ongoing to analyze recent wetland acreage losses. The preliminary results of these studies are promising and will provide useful information to resource managers and county planners.

The use of GIS in this work is evolving. The data assimilation efforts are massive and continuous, and real-time linkages between relational database management systems and GIS graphical displays are improving. However, this method relies on the availability of timely, nationally based GIS information to provide a cost-effective approach to assessing areas of rapid wetland change. Improvement in the comprehensiveness and availability of these base layers must keep pace with the technological ability to compute and display the information. ■

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