Biographical Information

Strite H. Potter
President
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Specific Responsibilities

Strite Potter is a founder and the President of Links Point, a company focused on the development of mobile solutions integrating GPS and GIS. The company designs and manufactures GPS hardware for mobile computing devices and develops handheld software applications for the use of enterprise information. Strite has the responsibility for driving the growth of Links Point's businesses, achieving operational and revenue objectives, and driving strategic initiatives to ensure the execution of the company's strategy. Strite's responsibilities include the development of the company's product strategies, marketing and business development, business operations and finance, and execution of the company's overall business plan.

Past Experience

Previous to starting LinksPoint, Strite worked for seven years in research successively at Rockefeller University, Columbia University and Cornell University. Previous to this, he worked in marketing in finance in various capacities.

Educational Experience

BA – Literature, University of Richmond

WEST NILE VIRUS: GEOGRAPHIC INFORMATION SYSTEMS MODELING AND FIELD OPERATIONS

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Abstract: With the growing threat to human and equine populations from West Nile Virus (WNV), Geographic Information Systems (GIS) provides innovative and valuable tools for analysis and response to the disease. Geographic technologies can dramatically improve public health surveillance, monitoring and remediation of the threat of West Nile Virus. This paper outlines how GIS and GPS-enabled field applications can help government agencies use these technologies as both an effective "early warning system," and as a means to improve their response to the disease.

Before the summer of 1999 most Americans saw mosquitoes as simply a nuisance. "Skeeters" were unwelcome guests at picnics, barbeques, Friday night high-school football games and other outdoor activities.

That all changed in late August 1999 when the first occurrence of West Nile virus in the Western Hemisphere was identified in New York City. As the threat of the disease spreads on a national scale, public health agencies are turning to innovative technologies, including GIS, in response to the growing danger.

West Nile Virus Transmission Cycle

In 2000, human cases of West Nile virus were reported in three states. In 2001, 11 states and the District of Columbia reported human cases. In 2002, the disease experienced a rapid move west with human cases in 39 states. That year there were 4,161 human cases and 277 deaths nationwide, according to figures released by the Centers for Disease

Control and Prevention (current figures are available at http://www.cdc.gov/ncidod/dvbid/westnile/surv&control.htm). As of August 20, 2003, there were 715 human cases and 14 deaths reported in 29 states. Many experts believe that West Nile virus will be identified in virtually the entire continental United States by the end of the 2003 mosquito season.

Epidemiologists call the carrier of a disease from one host to another a "vector." Mosquitoes have shown to be the primary vector of West Nile virus for humans, birds and horses. In the northeast, the Culex Pipiens species of mosquito is the primary vector.

Culex Pipiens Mosquito
(Source: USGS)

West Nile virus has an effective transmission cycle. Mosquitoes (the vector) bite birds and spread the disease. The birds act as an amplifying host. As more birds become infected, the number of infectious mosquitoes increases. As more birds die as a result of infections, the vectors turn to humans and other mammals as hosts, and the disease "spills over" into the human population.

GIS as an Early Warning System

In New York City, during the 1999 and 2000 seasons, mosquito control efforts were based on laboratory testing to confirm the presence of West Nile virus before taking action in the field. In many cases, the testing process would take up to two weeks and was fairly expensive.

At this point, Sean Ahearn, an associate professor of GIS and remote sensing and the director of the Center for Analysis and Research of Spatial Information (CARSI) at New York's Hunter College, began working with the New York City Department of Health and Mental Hygiene to use GIS as a way to address the threat of West Nile virus. Ahearn led a team of top-notch researchers, including Constandinos Theophilides, a Ph.D. candidate working on his dissertation on GIS modeling of West Nile virus, and Sue Grady, who recently joined the New York State Department of Health. The team sought to develop a GIS model to identify areas of high risk for West Nile virus. The Department of Health used the GIS model, along with other GIS applications and more traditional approaches, for targeting disease control efforts.

“We wanted a system that would be predictive and dynamic as well as provide a picture of the geographic spread of the disease,” explains Ahearn.

Dead bird clustering has been used elsewhere as a way to monitor West Nile virus activity. However, simply counting the number of dead birds per unit area ignores the biology of the disease and can lead to arbitrary findings that suffer greatly from reporting bias and the potential for false negatives.

“The real challenge was to create a system for identifying the geographic extent of West Nile virus activity to target remediation efforts,” says Ahearn. “Ideally, we also wanted to develop a system that could be used to monitor the efficacy of the remediation efforts.”

The goal of Ahearn’s team was to develop a model that took into account the biology of the disease’s vector, host and transmission cycle. High mortality rates in crows and certain other bird species suggested that dead bird collection data would be a strong starting point in developing the model. Since the first outbreak of West Nile virus, the Department of Health had been collecting dead bird reports from the public. In addition, various statistical models of disease propagation and specific details on how the disease affects birds and mosquitoes were examined. The result was the Dynamic Continuous Area Space Time (DYCAST) system, which was developed to identify and prospectively monitor areas at high risk for West Nile virus.

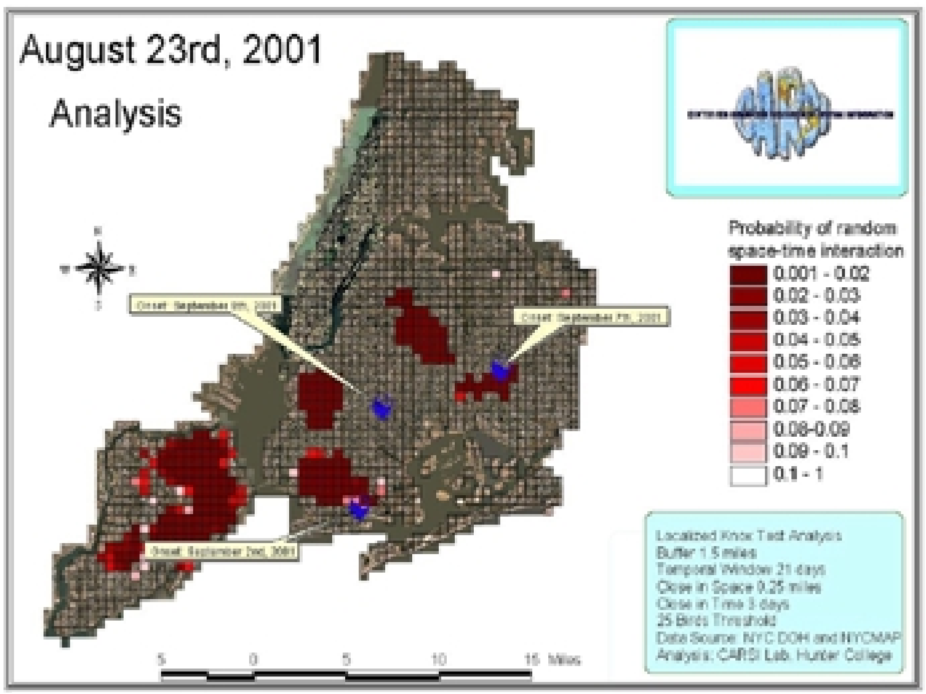
<u>The DYCAST Model</u>

The DYCAST system uses a geographic model that examines dead bird collection data for significant relationships in space and time. By applying a statistical test it can determine whether such space-time interactions are random or not, with nonrandom space-time interactions serving as an indicator of viral activity. The identified “hot spots” of viral activity are shown on maps that can be used to plan mosquito control activities. The system was built using GE Network Solution’s Smallworld GIS, with modeling handled in Smallworld’s Magik programming language.

The system uses a Knox test, a statistical tool widely used in epidemiological research, to measure the significance of the interaction of disease cases in space and time. First, the model identifies bird pairs out of all possible data points (dead bird reports and locations) within the defined geographic test area and time period or “temporal window.” Next, it tests the dead bird pairs against assigned values of what’s considered significantly “close” in space and time. It then compares the pairs against what would be expected to be random to determine the probability that the space-time interaction of the pairs isn’t random and thus an indication of localized disease activity.

“Our statistical approach lets us know whether events were close in space and time and at what point the interaction becomes so significant that it indicates intense viral activity in specific localized areas,” relates Ahearn.

The model uses a 0.5-mile grid that was overlaid across New York City. On a daily basis, the Knox test was run at the center (centroid) of each grid cell. The Knox test looked at all possible dead bird pairs within a 1.5-mile radius and a 21-day window. The critical time and space values were developed based on specific knowledge about the ecology of West Nile virus. The 1.5-mile buffer represented roughly twice the feeding distance of the Culex Pipiens mosquito species. Additionally, it ensured an overlap of test data occurs so the disease is modeled as occurring across a continuous surface rather than within an arbitrary set of adjoining areas.



Risk Map of New York City for Aug 23, 2001. Darker red areas indicate higher probability of viral activity. Blue "head" icons were added later and show where human cases will occur within the next two weeks.

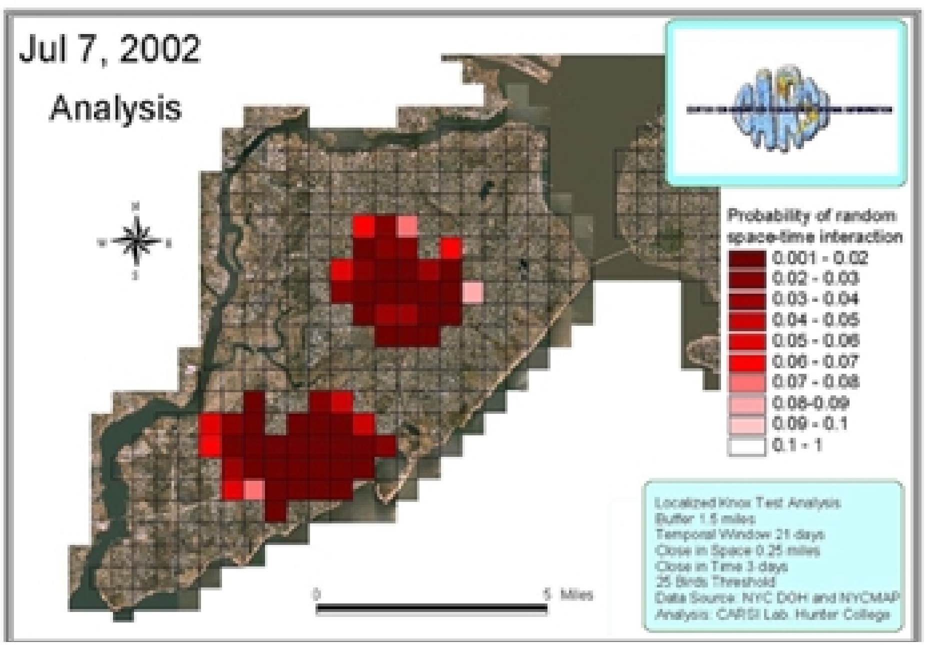
The 21-day window represented three amplification cycles (from infection to death) of the disease within the bird population.
In terms of reporting, color maps that show areas at risk and intensity were generated on a daily basis for the Department of Health. In addition,

animations were created to show the propagation of the disease over time.

“The dynamic nature of the model allowed us to see areas of increased West Nile virus activity,” says Ahearn. “As those areas were treated, you’d see the ‘hot spots’ fade away, showing the effectiveness of the model.” Implemented during the 2001 season, the model successfully identified areas of high risk for West Nile virus infection. The model identified high-risk areas at least 13 days prior to the onset of the disease in five out of the seven human cases reported.

During the 2002 season, the model was one of the GIS tools used by the city to target its response to the virus.

“We’d pull all the resources at hand before we’d make the decision to [spray for mosquitoes],” said Daniel Markowski, who served as deputy director of vector surveillance for the New York City Department of Health and Mental Hygiene. “We’d use the results from the DYCAST model, see where the area of higher risk was, use [mosquito] traps and review standing water reports as part of our overall analysis.”



Risk Map of Staten Island Borough of New York City for July 7, 2002 identified two major areas of intense viral activity.

The system offered several operational and economic benefits. First and foremost, it provided an “early warning system” that could be used with other GIS and traditional methods to target the response to West Nile virus to better protect the public. The model also reduced the significant cost and time lag that resulted from relying on dead bird testing to assess risk.

“The ability to better plan and target spraying and other remediation can save cities considerable expense,” says Ahearn.

Ahearn also noted that the system could be used by other agencies seeking to model West Nile virus risks after re-calibration based on information on local mosquito and host bird species.

A paper on the DYCAST Model was published in the American Journal of Epidemiology in May 2002. (Journal Reference: Theophilides CN, Ahearn SC, Grady S, Merlino, M, Identifying West Nile virus risk areas: the dynamic continuous-area space-time system. Am J Epidemiol 2003;157:843-54.)

For the 2003 season, techniques similar to the original DYCAST model, with a number of modeling enhancements, were used to create the *LinkPoint VectorWatch* model, which was deployed for use by a major US city. It is the expectation of the author that the results from the use of the new model will be presented at the URISA conference.

Monitoring Pesticide Application in the Field

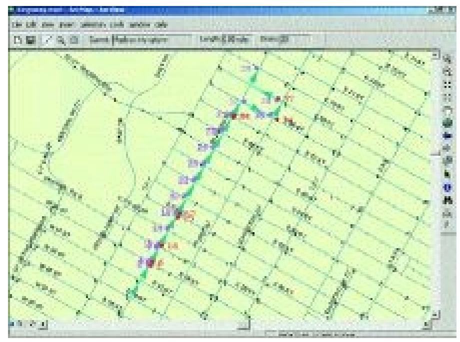
Trying to predict West Nile virus is a major task. Conducting a citywide program to prevent the spread of the disease may be equally daunting. A cornerstone of mosquito control efforts is aimed at cost effectively reducing mosquito populations through applying pesticides to places where mosquitoes breed. Key breeding spots for mosquitoes are wastewater catch basins. Unfortunately, New York City has more than 135,000 catch basins.

The task is made more manageable by New York City’s comprehensive NYCMap GIS base map, which includes detailed information on streets, properties, building footprints and other infrastructure, including the location of the 135,000 catch basins. (Some of the information included in NYCMap is available to the public from the New York City Open Accessible Space Information System Cooperative at http://www.oasisnyc.org.) Having location information on the catch basins allowed for a program of GIS-based field worker routing, treatment verification and reporting.

Previously, the application program was managed using paper maps. Additionally, the manual task of recording a treatment often took longer than the treatment itself, and recording the treatments was a large data-entry bottleneck. In 2002, the city chose to award the larviciding program to an outside contractor while requiring detailed reporting as part of the effort. To meet the challenges of ensuring effective tracking and verification of field treatments, the project team developed a GIS-based route-creation and field verification application to meet the city's reporting requirements.

These requirements resulted in a complete solution for importing NYCMap data, creating and assigning routes to field technicians and verifying the work done in the field.

The solution involves an application built on top of ESRI Inc.'s ArcView 8.0 to map the locations of catch basins. The program administrator views unassigned, assigned and treated catch basins in a graphical map on the desktop. Treatment routes are created through a simple "drag-and-drop" interface by highlighting street segments on the map. As a street segment is highlighted, the number of catch basins and the length of the route are displayed to help manage productivity targets. Once a route is created, it can be assigned to a ruggedized Pocket PC handheld computer and downloaded via a wireless local area network. Route maps also are printed with directional markers for the technicians to follow. The decision not to display maps on the handheld devices was made to keep the user interface simple due to a general lack of significant computer skills on the part of the technicians.



Administrator highlights street segment to create route.

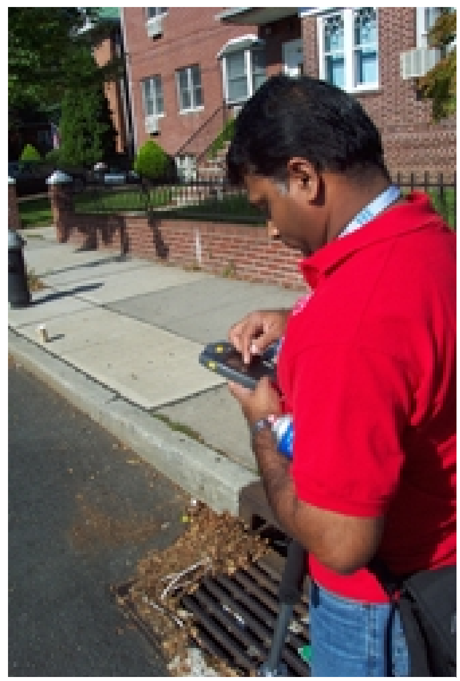
In the field, the handheld computers and route maps are distributed daily to the technicians with their larviciding chemicals and other supplies. The technicians use Razor scooters to travel from catch basin to catch basin, using LinksPoint's handheld software to accurately follow their route, verify the catch basin to be treated from a sequential route list and record the type of treatment done in the field. Global Positioning System (GPS) technology is being added to the solution to provide a "location-stamp" as an additional point of verification.

Field technicians were an unusual sight--even in New York City--as they traveled on Razor scooters with a mobile computer and treatment bag slung across their shoulders. After making a treatment, the technicians mark the catch basin.

At the end of each day, the handheld computers automatically upload the data collected in the field via the wireless local area network. Once the data are uploaded, the program administrator at Kingsway can easily generate a variety of reports, including detailed information on where and when larvicide was applied. Such information serves as backup for the billing reports submitted to the city. The system also allows the transmission of field treatment status to the Department of Health on a weekly basis, rather than weeks or months after the fact as was done previously.

"Initially, I had several concerns about this, as it's quite a daunting task," relates Markowski. "They were able to report this data to us on a weekly basis through the database. It allowed me within an hour or so to find out exactly where they were in the city, what they had done and whether they were following the protocols I had set out."

The field solution brings benefits to everyone involved. For the city, it allows significant cost savings from outsourcing the larvaciding program while increasing the visibility into data on the program's status. It provided a digital record of routes created and treatments made, allowing a high level of accountability on behalf of the field contractor. For Kingsway, it greatly streamlined the process, cutting administrative costs, increasing field productivity and greatly decreasing the billing cycle.



Field Technician records inspection and treatment data on handheld computer.

Comments Kingsway President Richard Kourbage, "Kingsway is a bottom-line-oriented business, and this solution allowed us to do our job better, faster and at a lower cost."

The program was again successfully used in the 2003 season and it is the author's expectations that findings from this season will be presented at the URISA conference.

Conclusion

As such activities demonstrate, GIS is being used creatively and effectively to counter the threat of West Nile virus as an “early warning system” and in engaging the disease in the field. As the threat of the disease continues its path west, communities can look to the innovative approaches used by cities like New York to help plan and execute their responses. It’s clear that GIS and mobile technologies can be powerful tools to ensure a better local response to West Nile virus and, ultimately, a safer and healthier population.