GIS for Agribusiness

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In This Issue

North Carolina Builds GIS-Based Farmland Preservation Model

By Jim Baumann, ESRI Writer

During the past 30 years, the population of North Carolina has grown more than 60 percent to nearly 10 million people. Inevitably this has resulted in the conversion of some existing farmland to other uses, thus reducing the land available for agriculture. This trend has escalated during the past several years, with the state losing more than 6,000 farms and 300,000 acres of farmland, making North Carolina the leader in farm acreage loss in the United States.

This development is of great concern to state officials, as agriculture is North Carolina's largest industry and contributes a significant amount to the state's annual budget. However, this is much more than a loss of revenue to the state. Farmland is an integral part of the open space, wildlife habitats, groundwater recharge areas, and recreational areas of North Carolina.

Daniel Madding, information systems support (ISS) director for emergency programs, North Carolina Department of Agriculture and Consumer Services (NCDA&CS), states, "Our farmlands and other open spaces are an essential part of the quality of life for our residents. North Carolina is known for its rural areas, and we must work to protect their immeasurable benefits."

To mitigate the loss of arable lands, the North Carolina General Assembly passed House Bill 607 in 2005, which established the state's Agricultural Development and Farmland Preservation (ADFP) Trust Fund. The fund is used to support programs that promote profitable and sustainable farms by assisting farmers in developing and implementing plans for food and fiber production, agro-tourism, and other agricultural business activities.

To successfully administer the funds, the ADFP Trust Fund advisory board requested an assessment of all farm and forestland in the state to prioritize the preservation of working lands in North Carolina. Subsequently, the state's General Assembly instructed NCDA&CS to help with that assessment.

Because ESRI's GIS software has been an integral part of the workflow at NCDA&CS since the early 1990s, the department naturally turned to ArcGIS to develop the North Carolina Department of Agriculture Farmland Preservation Model.

The model groups agricultural areas into two sections: Viable Agricultural Lands and Threatened Agricultural Lands. In each section, a set of parameters to measure the viability and threats to the state's farmland was developed and agreed on by North Carolina ADFP Trust Fund staff and the ADFP advisory committee. The group also determined the data layers required for the model and assigned weights (values and threats) to those layers for analytic purposes.

"City limits required special attention in our model," notes Madding. "In North Carolina, there are several municipalities that have incorporated to restrict growth or annexation by faster-growing towns. Incorporation suggests

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ESRI on the Road

ESRI Federal User Conference
February 17–19, 2010
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2010 ESRI Worldwide Business Partner Conference
March 21–23, 2010
Palm Springs, CA
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ESRI International User Conference
July 12–16, 2010
San Diego, CA
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10th International Conference on Precision Agriculture
Denver, CO
July 18–21, 2010
www.icpaonline.org

ASA-CSSA-SSSA Conference
October 31–November 4, 2010
Long Beach, CA
www.acsmeetings.org

For additional ESRI events, visit www.esri.com/events.

Share Your Story

Submit an article to *GIS for Agribusiness* to share your knowledge and innovative ideas about your work with GIS in agriculture. Contact the editor, Jim Baumann, at jbaumann@esri.com for additional information.

ESRI News

ESRI's 2009 Special Achievement in GIS Award Winners in Agriculture

Trade & Investment Program for a Competitive Export Economy (TIPCEE), Ghana: TIPCEE is dedicated to improving Ghana's competitiveness in world markets through an improved and enabling environment as well as a strengthened capacity of the private sector to respond to market demands. The organization uses GIS technology and data to help achieve its economic objectives.

United Nations Food and Agriculture Organization (FAO)—Fisheries and Aquaculture Department, Italy: GIS and remote sensing are used by FAO to map the distribution of aquatic resources, aquatic environments, fishery management units, and production systems. These technologies are also helping the organization improve the sustainability of fisheries and aquaculture.

International Livestock Research Institute (ILRI), Kenya: Over the last 20 years, researchers at ILRI have used GIS to collect and generate an extensive range of spatial data layers specific to livestock, such as distribution, health, and production. The organization is using Web-based GIS to share this data with students, researchers, farmers, policy makers, and the general public.

Animal Health Board (AHB), New Zealand: GIS is an integral tool within AHB. To eradicate bovine tuberculosis in cattle and deer herds in New Zealand, the board employed GIS technology to create a system for sharing geospatial projects. AHB's VectorNet is an application that uses a map-based interface to access, query, and report on all aspects of AHB's disease and vector control processes.

Ministry of Agriculture, General Directorate of Agricultural Production and Development, Turkey: The Ministry of Agriculture works closely with the country's provincial directorates to collect, integrate, and maintain agricultural information. This geospatial data is made available to farmers, farmer associations, directorates, and other government institutions.

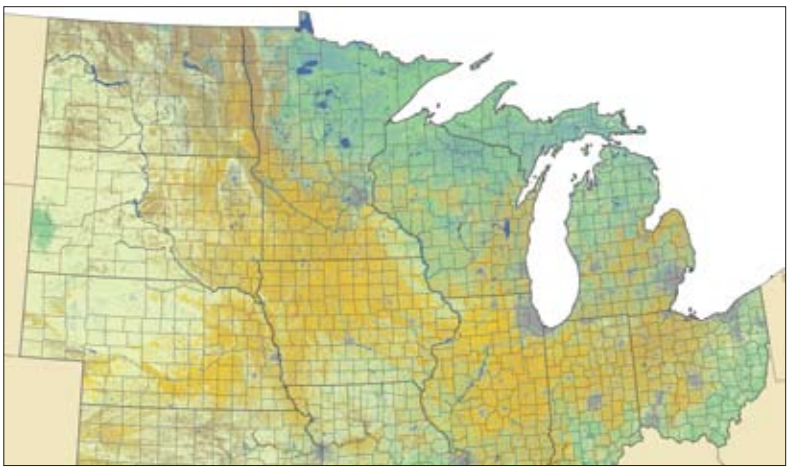
Featured Map

Top 12 States for Harvested Corn Acreage—2007 Cropland Data Layers

United States Department of Agriculture, National Agricultural Statistics Service

By Claire Boryan, Mike Craig, Dave M. Johnson, Bob Seffrin, Patrick Willis, and Lee Ebinger

This map illustrates the predominance of corn grown throughout the midwestern United States in comparison to all other crops and noncrop land-cover categories. Harvested corn includes corn for grain/silage, sweet corn, popcorn, and ornamental corn. The categorized Cropland Data Layer (CDL) imagery shown on the map was produced by the USDA, National Agricultural Statistics Service (NASS). CDL is used within NASS to generate supplemental acreage estimates of commodities for major agricultural states. State-level CDL-categorized imagery is available for download from the USDA/NRCS Geospatial Data Gateway Web site at http://datagateway.nrcs.usda.gov.



The USDA's 2007 *Harvested Corn Acreage* map for the Midwest clearly shows the predominance of corn acreage, colored gold, as opposed to all other crops, which are indicated in brown (*ESRI Map Book,* Volume 24).

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North Carolina Builds GIS-Based Farmland Preservation Model

urbanization, and we didn't want to identify these municipalities as areas of high threat to farmlands because their actual intention was to limit growth. So we looked at their percentage of growth from the 1990 Census to the 2000 Census. This special analysis helped prevent overweighing the agricultural threat of those towns."

The viable lands are those that currently have the necessary agricultural infrastructure to support farming such as irrigation, energy, post-harvest storage, packaging, and transportation. Threatened lands are endangered by suburban growth and a lack of agricultural infrastructure. The model is designed as a multipurpose tool to assist with the prioritization of conservation projects. This benefits local planning agencies by providing a regional perspective on agriculture and educates residents about the importance of their working lands.

The North Carolina Department of Agriculture Farmland Preservation Model was completed in less than a year. It is based on the USDA Farm Service Agency's Common Land Unit (CLU) data, which is a standardized GIS data layer that allows easy integration of agricultural data and helps identify lands that are most threatened by development. The preservation model includes 24 layers of data developed from the NCDA&CS Multi Hazard Threat Database (MHTD). It includes agricultural-specific information, such as preserved farmlands, feed mills, tractor supply stores, fertilizer and pesticide dealers, and slaughter plants. More general data includes sewer lines, waterlines, and military bases. NCDA&CS shares some of its datasets with the North Carolina Department of Environment and Natural Resources (NCDENR) for NCDENR's projects. The data is also used by the North Carolina Department of Transportation's interagency leadership team to determine the best routes for new roads around the most viable agricultural land.

The model is hosted on NCDA&CS's ArcGIS Server and is available for viewing by the general public at www.ncmhtd.com/FarmlandPreservation/farm_model.html.

Manitoba Agricultural Services Corporation—Provincewide GIS Delivery

Manitoba Agricultural Services Corporation (MASC) is a Crown Corporation of the Province of Manitoba, Canada, that provides agricultural insurance programs (agri-insurance), hail insurance, and lending programs to Manitoba farmers. In 2008, MASC insured over 9 million acres—about 90 percent of the annually cropped land in Manitoba—under its agri-insurance program, with premiums of $196 million and a total liability of $2.1 billion.

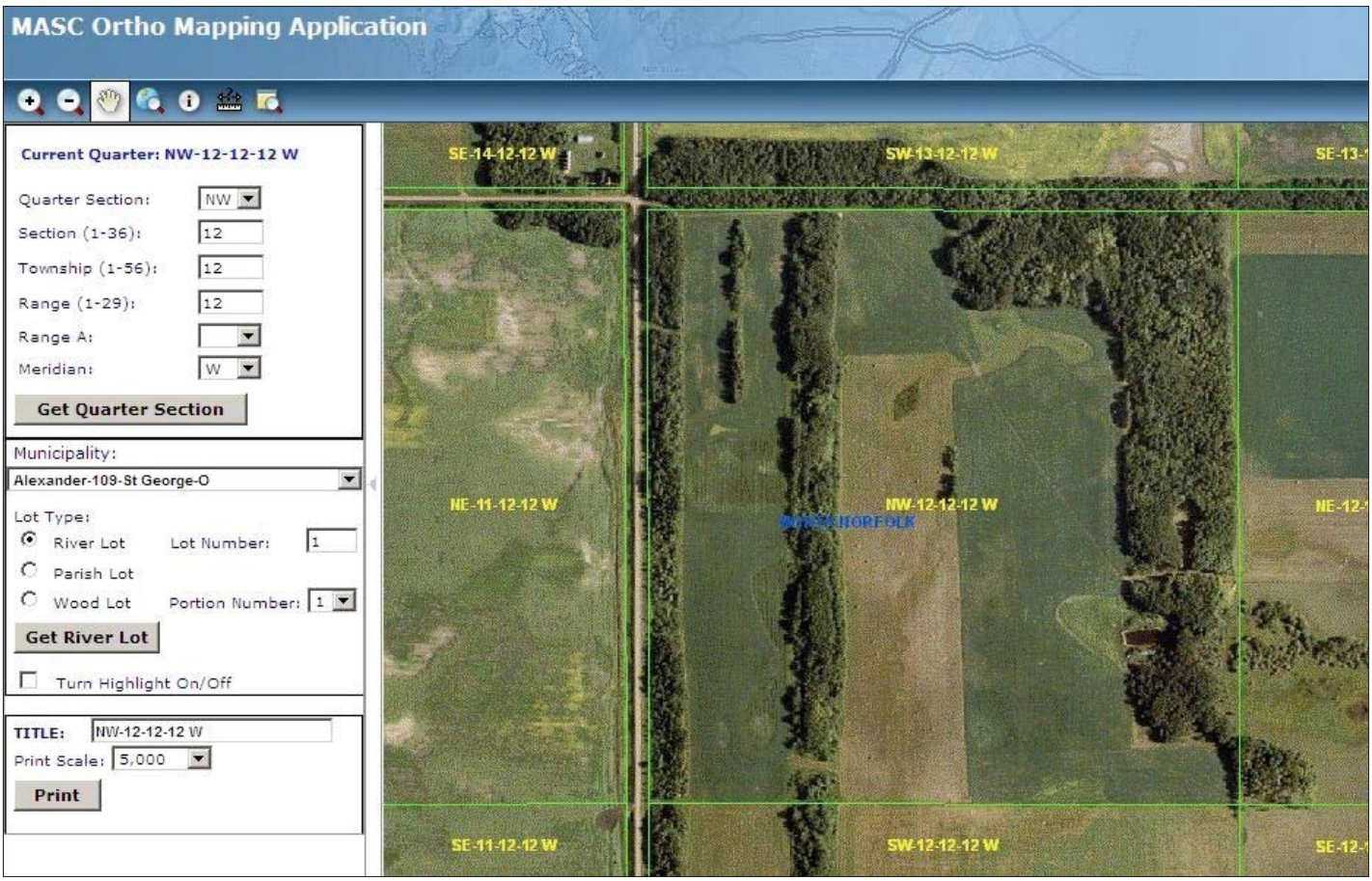
GIS plays a significant role at MASC. Orthophotos, used as a georeferenced backdrop for vector data, provide the means to quickly and easily locate, measure, and understand the geospatial relationships of land features. In turn, this information supports one of MASC's fundamental business functions (adjusting insurance claims) and serves as an effective tool for making informed decisions.

MASC crop insurance agents, agency clerks, team leaders, and adjusters all utilize orthophotos in various ways. Adjusters working on claims use orthophotos as an integral part of their inspection reports, helping them locate the appropriate fields and inspection areas. Team leaders use orthophotos when conducting excess moisture insurance claims, as well as for irrigation audits, where spatially locating objects in a field is important. Agency clerks and agents use orthophotos to confirm information on seeded acreage and harvested production reports, and hard copies of orthophotos are often placed in a producer's records for future reference.

Orthophotos also help MASC's customers accurately establish the size and location of natural features and attributes on their land such as sloughs, trees, or drainage ditches. Accounting for these attributes can be an important consideration when determining lease payments or total seeded acres for crop insurance documents.

Producers can optionally request orthophotos of their land for use as a crop production management tool. MASC can measure a producer's field using an orthophoto, summarize the acreage by legal description, and print the orthophoto along with the associated land information. Producers can then use this to plan fertilizer and spraying regimes and to accurately estimate and oversee chemical formulation and costs during their busy cropping season.

The size of MASC's orthophoto dataset has grown considerably since orthophotos first became available to it in the 1990s. Originally, the dataset was 60 GBs, which was compressed to just over 5 GBs, but in early 2000, new higher-quality orthophotos became available. While the increase in quality was desirable, the new orthophoto database would have grown to



MASC Ortho Mapping Application can locate and print a producer's field using an orthophoto along with the associated land information.

between 1 and 4 TBs. This raised serious concerns about how to provide MASC staff (spread out in offices across the province) with timely access to such an enormous database.

To address these issues, in 2007 MASC's GIS department created MASC Ortho Mapping Application, a Web-based application developed with Microsoft Visual Studio 2005 and ArcGIS Server Enterprise for Windows. All orthophoto products and other basemap data were loaded into the geodatabase, taking advantage of raster indexing and compression and allowing effective management of the large image files. This greatly reduced the amount of server storage space required; using a 50 percent JPEG compression, the original TIFF files (around 500 GB of data) now reside in the geodatabase as a 66 GB dataset.

MASC staff can now access the application and associated imagery from any computer connected to the provincewide network. Adjusters are able to measure any legal land description in the province, helping to provide more accurate claim assessments to producers. Reductions in driving time, mileage, and time spent in the field have resulted in significant cost savings, improved efficiencies, and better claim accuracies.

"In the next couple of years, MASC expects to receive another 500–700 GB of orthophoto data, but we're not concerned," says Janos Boda, GIS analyst for MASC. "Once the data is loaded into the geodatabase, the size of our entire database will still not exceed 200 GB."

"Last year, adjusters printed 9,500 legal descriptions using the MASC Ortho Mapping Application. Since its inception, we estimate that, on average, it saves them about one hour per quarter section of land inspected," notes Boda. "The prints of river lots are especially useful when determining river lot boundaries. Many times the use of the orthophoto is critical to the accurate adjusting of a field or the revision of a claim."

Development of a new acreage measurement application is currently under way in the ArcGIS Server 9.3 environment, which will add more functionality to the current viewing application. The user will be able to digitize field boundaries and store field measurements in the geodatabase for future use, with these previously entered boundaries available for staff to view and/or edit at a later date.

For more information about the Manitoba Agricultural Services Corporation, visit www.masc.mb.ca/masc.nsf/index.html.

This article is published with permission from ESRI Canada Limited and was previously published in the Spring 2009 issue of *ArcNorth News*.

GIS Battles Exotic Pests

GIS-Based Incursion Monitoring System Protects New Zealand's Native Resources

By Karen Richardson, ESRI Writer

After a 2001 influx of red fire ants from an overseas shipping container, New Zealand's Ministry of Agriculture (MAF) took action by developing a computerized system to assist in surveillance, monitoring, and emergency response to biohazards threatening the nation. The resultant Incursion Response System incorporates GIS software for spatial viewing and modeling of biohazard outbreaks.

MAF began providing farmers with expert scientific advice to improve the quality and quantity of their production back in 1892. More than a century later, MAF has expanded its role to forests and fisheries and continues to protect New Zealand's interests by managing the quality and security of its food stocks throughout the nation.

Times and technology have changed since the late 19th century, and MAF has been on the forefront of innovation every step of the way to protect New Zealand's interests. "The New Zealand government is strong on protecting our ports; biosecurity is a big deal," states Clifton King, MAF GIS project manager.

Protecting New Zealand from imported pests is important for the economy and general health of the land and its people and animals. The 2001 fire ant invasion was of particular concern. Native to South America, these small ants are particularly aggressive and will repeatedly sting anything that appears threatening.

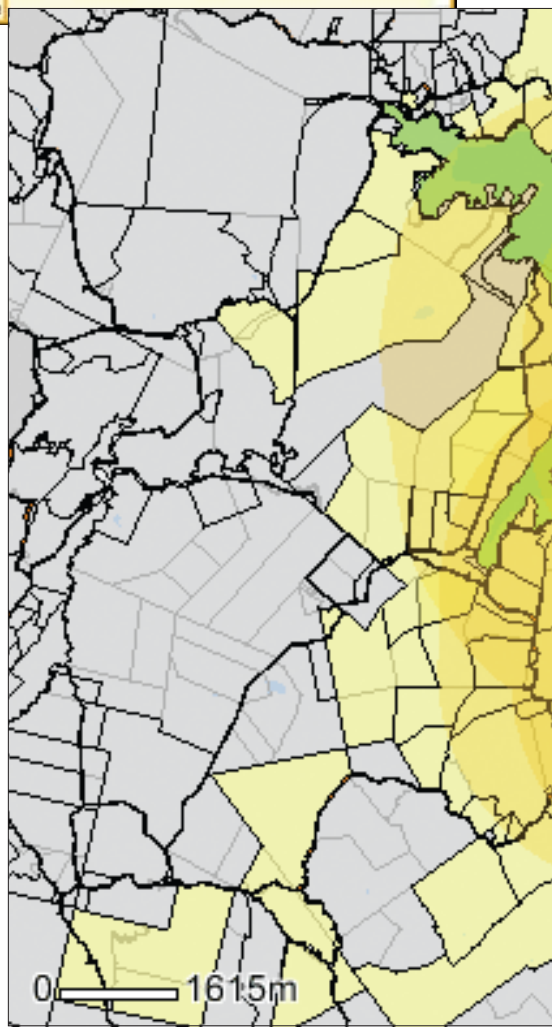
While the stings are not dangerous to most people, they are painful, and the ants pose a serious threat to New Zealand's native plants and wildlife. Of all the exotic ants discovered in the country to date, the red fire ants would have the most significant impact if they should become established, with a projected annual cost of at least US$180 million annually due to human health, environmental, and economic impacts.

After eradicating the pest at the first attempted incursion, MAF realized containment might not always be possible at the entry port. The ministry went to tender the next year to create a computerized system that could assist in surveillance monitoring and emergency response to biohazards threatening the health of the nation.

MAF's Incursion Response System uses ESRI's ArcGIS Server software to manage its biohazard data.

Eagle Technology Group, Ltd., an ESRI international distributor, won the contract and added new capabilities to an existing system, creating a comprehensive information system to help authorities deal with unfolding biohazards. The solution, named the Incursion Response System version 2 (IRS2), incorporated ESRI's ArcGIS Server software for spatial viewing and modeling of biohazard outbreaks. "With biohazardous organisms able to travel quickly, rapid response and containment mean the difference between a minor incident and a national disaster," says King.

The system was up and running within four months and provides necessary datasets in current map-based views to field response teams. Information from all government ministries is part of the system, including survey-accurate 1:50,000-scale topographic maps and a database with farm locations and boundaries called AgriBase, developed by AgriQuality New Zealand. This database provides an index of farm type, ownership, and management. MAF also

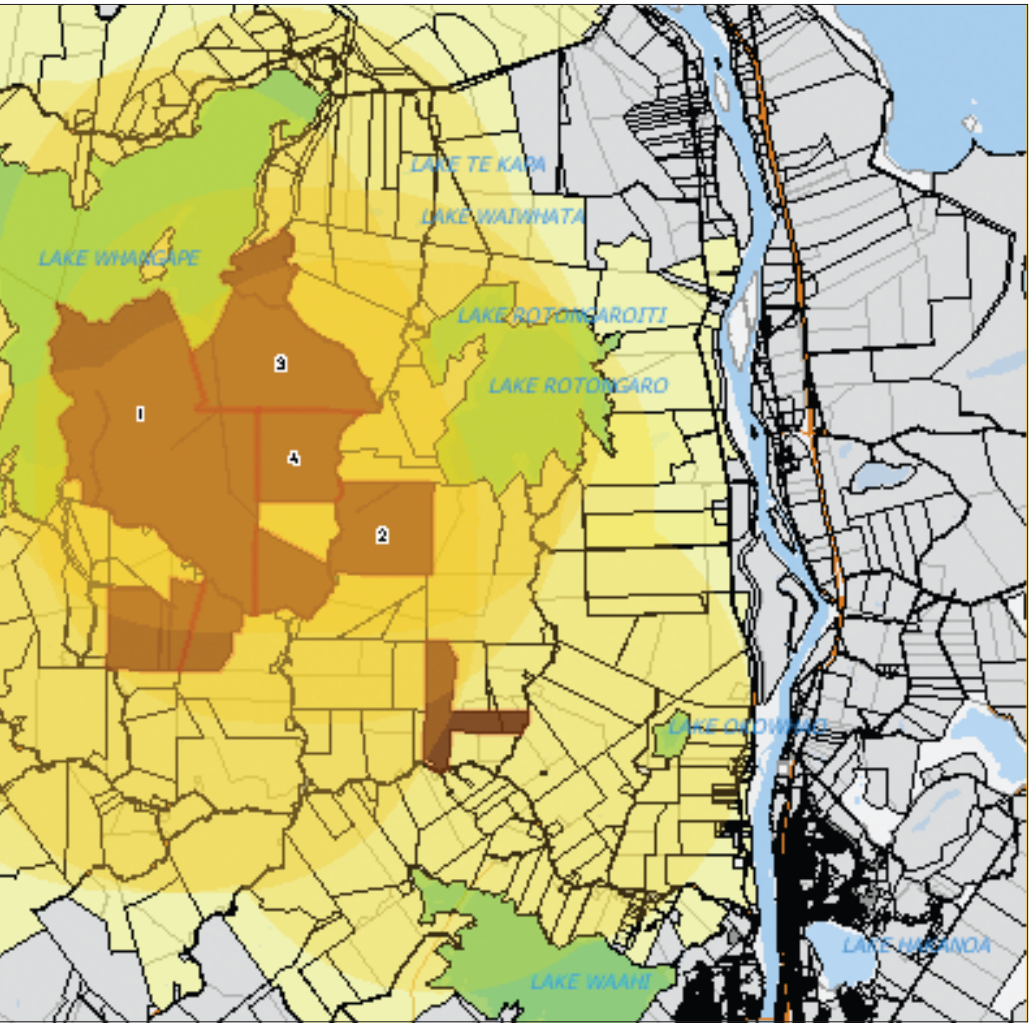


includes information on the coastline and inland water bodies for possible marine incursions.

The data is stored and maintained in an IBM Informix Dynamic Server (IDS) RDBMS with Informix Spatial DataBlade Module. DataBlade expands the IBM IDS object-relational data server to provide SQL-based spatial data types and functions, which can be used directly through standard SQL and with ESRI's ArcGIS. To further enhance the accessibility of spatial data, MAF employs ArcSDE technology, enhancing data management performance, extending the range of data types that can be stored in the database, and facilitating a multiuser editing environment. "The low overhead of this solution makes it one of the better databases for complex spatial operations," states King.

Built around an XML browser application framework and employing .NET Web services to communicate, IRS2 is set up for fast data service over the Internet. However, in response to real-life conditions, it also employs a rich JavaScript-based client application allowing it to communicate with a server via XML, providing a highly interactive client environment while also reducing network traffic and server loading. This is especially important when surveillance and monitoring teams go out in the field to areas not set up for high-speed Internet services.

Sharing of information between field response teams and office personnel has become almost real time by using dynamic HTML, which allows individual calls to the Web service. As a result, IRS2 provides a fast response to queries, and response personnel can immediately update the system with the new information, allowing teams both in and out of the office to know immediately who has been where and what they have found. "Sharing information in this manner vastly improves coordination between the many different teams and ensures that all at-risk areas are investigated and recorded," says King.



Easy-to-use map views of specified areas are used for surveillance and incursion response.

Armed with this arsenal of data and ArcGIS Server clients set up with easy-to-use map views of the specified area, MAF uses the system for surveillance, incursion monitoring, and containment. The ease of use of the system allows MAF to bring in the experts it needs depending on the problem at hand, whether beekeepers or veterinarians, and get them up and running in record time. Depending on the emergency, the system can easily handle anywhere from a few users performing monitoring to a couple hundred staff necessary during an emergency.

For example, to detect foot-and-mouth outbreaks, veterinarians must visit a farm every two days and examine sheep, pig, or cattle symptoms. Thanks to IRS2, the results of these examinations can now be made immediately available to other teams for further analysis.

"We had a clear mandate from [New Zealand's] Cabinet to address the threats posed by exotic incursions," adds King. "Government research showed that a limited outbreak of foot-and-mouth disease affecting pigs, sheep, or cattle would result in a cumulative loss of US$3.4 billion in the first year and around US$5.6 billion after two years, not to mention the loss of 20,000 jobs. Clearly, every effort had to be made to reduce the chances of an outbreak like this happening and have systems in place to mitigate and contain such an outbreak if indeed it did occur."

In some cases where a link to the office from all field locations is not possible, MAF sets up a front online response team (FORT) at the location and dispatches experts into the field with printed maps and forms. The experts are able to visit the farms, fill out the necessary information, and return to FORT instead of traveling back to the main office. This saves valuable time and resources and has made MAF very efficient when responding to threats, whether it is collecting avian blood samples or monitoring the incursion of slow-moving pests like the red fire ants.

"On average, four midlevel exotic incursions occur each year," says King. "With global threats such as foot-and-mouth disease and avian flu, we need to take every precaution we can to intercept any exotic organisms before they get here and contain and eradicate them when they do. IRS2 has given us the tools and the confidence to respond quickly and effectively if and when the inevitable happens."

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