Federal GIS Connections

GIS for Federal Government

In This Issue

Federal/State Mapping Program Supports Ocean Management and Research

Brian D. Andrews, USGS, and Seth Ackerman, USGS/CZM

The U.S. Geological Survey (USGS), in partnership with the Massachusetts Office of Coastal Zone Management (CZM), is conducting mapping off the Massachusetts coast to characterize the geology of the seafloor. The primary goal of the project, which began in 2003, is to produce high-resolution geological information and maps that support ocean-resource management and marine research. The seafloor maps show the distribution of bottom types (i.e., rock, gravel, sand, and mud) and seafloor topography (i.e., water depths) in an area covering about 1,300 km² of the inner continental shelf. Knowledge gained from this project supports new ecosystem-based approaches to managing fisheries in nearshore state waters and enhances the ability to predict the impacts of storms and coastal erosion on adjacent sandy beaches.

Managing the large amounts of survey data is a key issue in a large mapping program like the USGS/CZM project. Each survey day can collect 10–20 gigabytes of data and cover 8–12 km² of the seafloor. A three-week survey generates 200–300 gigabytes of data from several types of sonars, underwater camera systems, and sediment grab-sampling devices. To date, the program has acquired 7,000 km of high-resolution sonar data, 2,800 bottom photographs, and 275 sediment samples in six separate surveys. Clearly, this large volume of high-resolution data requires a data management system to provide standardized, documented access by federal and state agencies involved in the project.

Finding the Right Data Model

The USGS/CZM mapping program collaborated with the ESRI Arc Marine Working Group to tailor the schema and design of the data model to accommodate several types of marine geophysical data routinely collected by the USGS/CZM project. The mapping program required a database that would organize the multidimensional data collected from the marine surveys and provide a logical representation of this complex data in the object-oriented framework of the geodatabase. The Arc Marine data model supplies both the basic building blocks to represent or model common marine data types and the tools for extending these basic representations to more complex marine objects through relationships and custom behaviors. This extensible feature is at the core of Arc Marine's value in the USGS/CZM project and is further described as a case study in *Arc Marine: GIS for a Blue Planet* (ESRI Press, 2007).
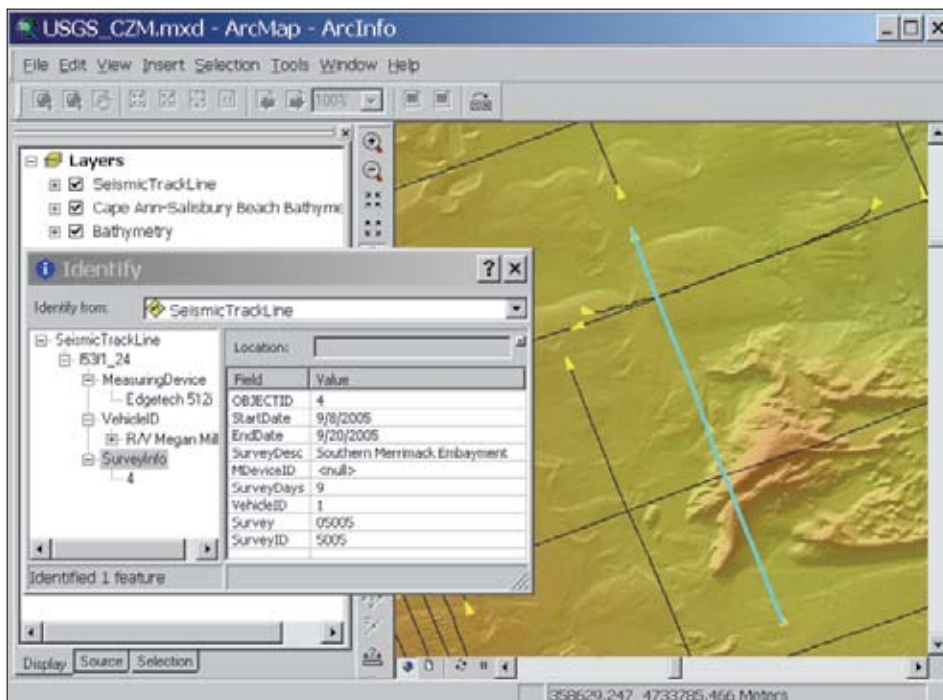

Figure 1. These results from the Identify tool show the three common attributes measuring device, vehicle ID, and survey information used to manage project survey data.

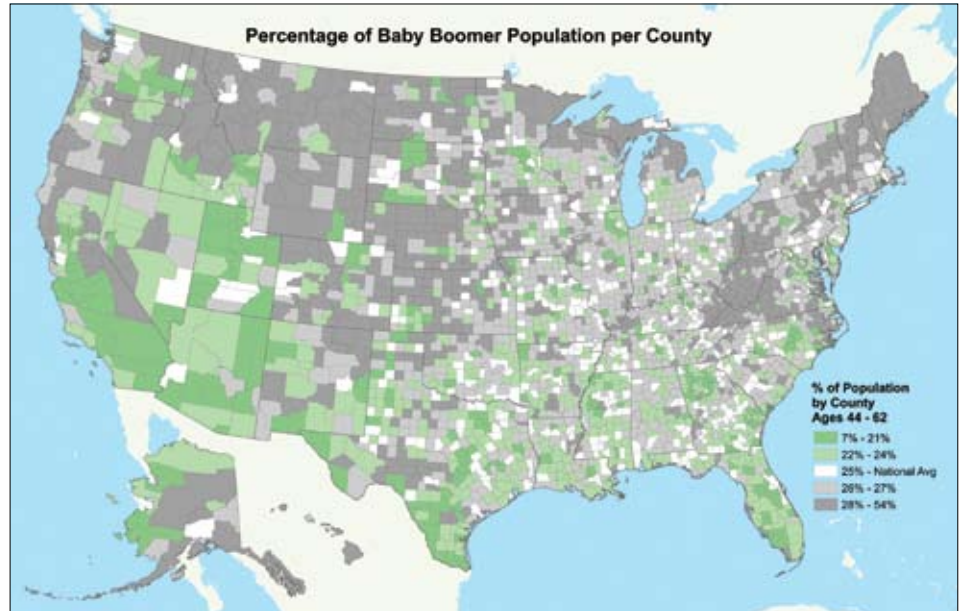# How Government Agencies Can Use Data to Better Analyze Their Populations

All levels of government agencies are challenged to provide age-appropriate, cost-effective services to every group in the United States, from babies to our oldest seniors. Access to current, accurate data developed with benchmarked methodologies can provide government analysts with valuable information that will help them make better decisions, focus resources, and maximize budgets. To learn which services are required by each population group and where services should be located, agencies need demographic, segmentation, business, and consumer spending data.

Demographic Data

Demographic data describes people and provides information about the types of people who live in an area. Variables such as age, income, family type, presence of children, housing, and employment furnish basic details about an area's resident population. To refine analyses, these variables can be supplemented by demographics such as net worth, age by sex and by race, language spoken at home, commute times, and more specific housing information such as owner-occupied or renter-occupied housing. The more demographic data variables are applied to analyses, the more detail can be learned about resident populations.

Segmentation Data

Segmentation systems operate on the theory that people with similar tastes, lifestyles, and behaviors seek others with the same tastes—"like seeks like." These behaviors can be measured, predicted, and targeted. ESRI's segmentation system, Community Tapestry, combines the who of lifestyle demography with the where of local neighborhood geography to create a model of various lifestyle classifications, or segments of actual neighborhoods with ad-

Percentage of Baby Boomer Population per County

% of Population
by County
Ages 44 - 62

7% - 21%
22% - 24%
25% - National Avg
26% - 27%
28% - 54%

This map of the United States by county shows areas where people aged 44–62 are located.

dresses—distinct behavioral market segments.

Segmentation data provides richer detail about constituent populations than simple demographics including their propensity to buy/use certain products and services, their media preferences, and the likelihood that they will participate in certain activities. Government agencies can use segmentation data to learn about how their populations would respond to messaging; for example, do they gain information from watching TV, reading the newspaper, or listening to the radio?

Business Data

In addition to learning about an area's residents, understanding elements of working populations and businesses in an area can provide agencies with valuable business information. ESRI's business data includes the total number of businesses, the total sales volume, the types of industries in the area, the total number of employees, and the number of people who commute into the area for work. For easier dissemi-

nation, this information can be divided by standard SIC or NAICS industry codes. Agencies should know about the types of businesses in an area to better allocate resources to cover workers who commute into the area.

Consumer Spending Data

Vibrancy of local economies depends on the dollars spent and taxes raised from consumer spending by area residents, workers, and visitors. ESRI's 2007 CEX data is reported by product or service and includes total expenditures, average spending per household, and a spending potential index (SPI). Because the average expenditure reflects the average amount spent per household, total expenditure represents the aggregate amount spent by all households in an area. SPI compares the average local expenditure for a product to the average amount spent nationally. An index of 100 is average. An SPI of 120 shows that average spending by local consumers is 20 percent above the national average.

The more agencies know about their constituents, the better the agencies can serve and reach out to them. Including data in analyses can help achieve these goals.

For more information about ESRI data products, visit www.esri.com/data.

Census Bureau Offers TIGER/Line Shapefiles Online

Topologically Integrated Geographic Encoding and Referencing (TIGER)/Line shapefiles are now available for download at www.census.gov/geo/www/tiger/index.html. ESRI users can easily incorporate TIGER/Line shapefiles into their GIS as supplemental data or as a base layer. This data supports mapping and geocoding and includes points of interest such as roads, railroads, rivers, and lakes.

Full Support for FDCC Security Policies Included in ArcGIS Desktop Products

Permits Faster, Easier Application Deployments within a Secure Environment

ESRI now supports the Federal Desktop Core Configuration (FDCC) security policies on all ArcGIS Desktop 9.2 products. The FDCC, as defined by the U.S. Office of Management and Budget, provides guidelines for implementing security on computer hardware that runs either Microsoft Windows Vista or XP Professional operating systems.

"ArcGIS Desktop 9.2 products have undergone rigorous testing to ensure compliance," says Dr. Satish Sankaran, product manager for interoperability and standards at ESRI. "ESRI's support for FDCC security policies permits faster, easier application deployments with one less path for security breaches. Users know their mission-critical information is secure."

ESRI has tested the following products, which compose the ArcGIS Desktop 9.2 product line, for FDCC security policy compliance:

- ArcInfo
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- ArcView
- ArcGIS Desktop Extensions
- ArcGIS Explorer
- ArcReader
- ArcGIS Engine

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    This discussion explores ArcMap, describes how it fits into your workflow, and explains some of its default behaviors. This is one of a four-part series titled Understanding the ArcGIS Desktop Applications.

- **Speaker Series—Interviews with ESRI Users**

    Interview with the Author of *Designed Maps: A Sourcebook for GIS Users*

    Cynthia A. Brewer, professor of geography at Pennsylvania State University, discusses her new book. Brewer hopes the book will inspire GIS users with design ideas to help them produce useful, meaningful, good-looking maps.

- **Speaker Series—Interviews with ESRI Business Partners**

    NAVTEQ's Small Municipal and County Street Data Enterprise License Agreement

    Skip Parker, global account representative for ESRI at NAVTEQ, provides highlights and benefits of the new NAVTEQ Small Municipal and County Street Data Enterprise License Agreement (ELA).

- **Speaker Series—Interviews with ESRI Staff**

    How to Leverage ESRI's Enterprise License Agreement Program for Small Municipal and County Governments

    Christian Carlson, regional manager of ESRI's Charlotte, North Carolina, office, talks about how small municipal and county governments can leverage this ELA, which has been specifically designed for them.

Find a Job at ESRI

The new ESRI Careers blog (www.esri.com/careersblog) is a one-stop resource for career-related news. Receive up-to-date information on hot jobs, summer programs, recruiting events, and regional office opportunities. Subscribe to the blog's RSS feed and be instantly notified of new posts. You can also select specific categories and receive just the posts that are of interest to you.

Get Inside the Geodatabase

The geodatabase development team has created the new Inside the Geodatabase blog at www.esri.com/geodatabaseblog. This forum will give readers a range of information from general functionality to advanced topics and developer-related intelligence. Best practices, example workflows, updates about events, and code samples will also be included.

Federal/State Mapping Program Supports Ocean Management and Research

The basic design of the data model used by the project is summarized in the following description of a typical survey. On each survey (SurveyID) a research vessel (VesselID) collects data along planned track lines with one or more sonars or sampling devices (DeviceID). These are the three basic attributes (SurveyID, VesselID, DeviceID) and tables currently utilized by the project to manage the survey data collected from different surveys, years, research vessels, and sonars. Each point, line, or polygon feature representing data collection locations has at least these three common survey attributes that are linked to a table through a relationship class (figure 2). The geographic information science portion of this project is now focused on extending these basic objects and adding supplemental data types such as sound velocity profiles and oceanographic model outputs (bottom current, bottom stress). This complementary data will move us along the path toward an integrated science approach to investigating the inner continental shelf off the coast of Massachusetts.

A Method for Multidisciplinary Science

Each year, new technologies allow us to collect coastal and marine data faster, at higher resolutions, and with more precision and accuracy. These advances in mapping technologies should also enable us to extract empirical information from the data at similar rates and resolutions. One method to achieve a corresponding advance in geographic information science is leveraging the tools in the geodatabase and Arc Marine framework to build smarter data models of real-world features and represent them in the digital form of an object-oriented relations database.

The Arc Marine data model proved to be an excellent framework to internally manage large volumes of marine geophysical data for the USGS/CZM project. The spatial data collected in the project is published in Arc Marine format so that other researchers studying the same geographic area can easily incorporate their own data using the marine data model framework.

The USGS/CZM cooperative mapping program is now entering the next five-year project cycle with advanced tools in both the mapping and geographic information sciences that will produce more detailed and comprehensive views of the seafloor. For example, the ability to manage and analyze different types of marine data may shed new light on the health of a marine ecosystem and its ability to rebound from catastrophic events.

Multidisciplinary science and *integrated science* are two terms often used in coastal and marine research. This type of research cannot be achieved without first adopting a method, such as the Arc Marine data model, to analyze different types of marine data collected in the same geographic area.

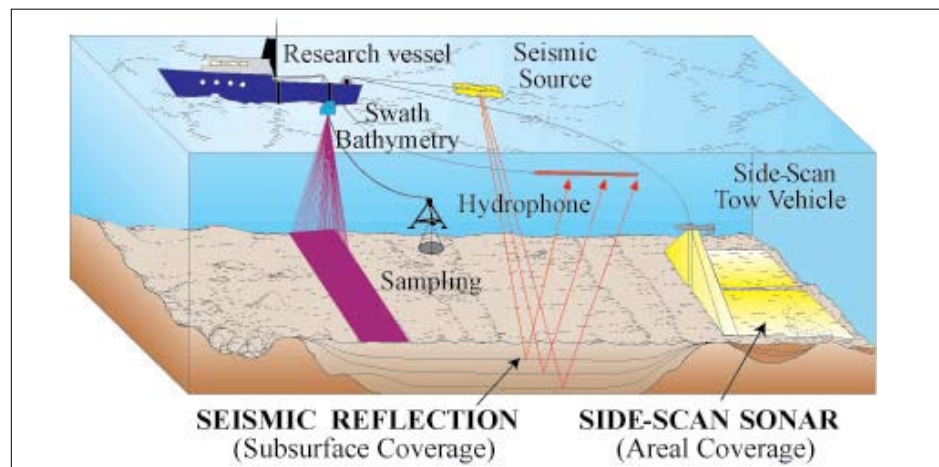For more information, contact Brian D. Andrews, USGS, at bandrews@usgs.gov. FC

Figure 2. The above is a typical survey configuration for the USGS/CZM project including a survey vessel and swath bathymetry, side-scan, and seismic sonars.

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GIS Assists New Zealand's Ministry of Agriculture and Forestry in Its Battle against Exotic Pests

GIS-Based Incursion Monitoring System Protects Native Resources and Saves Hundreds of Millions of Dollars

New Zealand's Ministry of Agriculture and Forestry (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 at 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, systems design manager, MAF.

Protecting New Zealand from imported pests is important for the economy and general health of the land and its peoples and animals. In 2001, New Zealand experienced unwanted hitchhikers on a container shipment from overseas: red fire ants. 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 influence if they should become established, with a predicted impact of NZ$318 million due to human health, environmental, and economic repercussions over the next 30 years.

After eradicating the pest at the first attempted incursion, MAF realized containment might not always be possible at the entry port. The ministry committed 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.

Eagle Technology Group, an ESRI partner, 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),
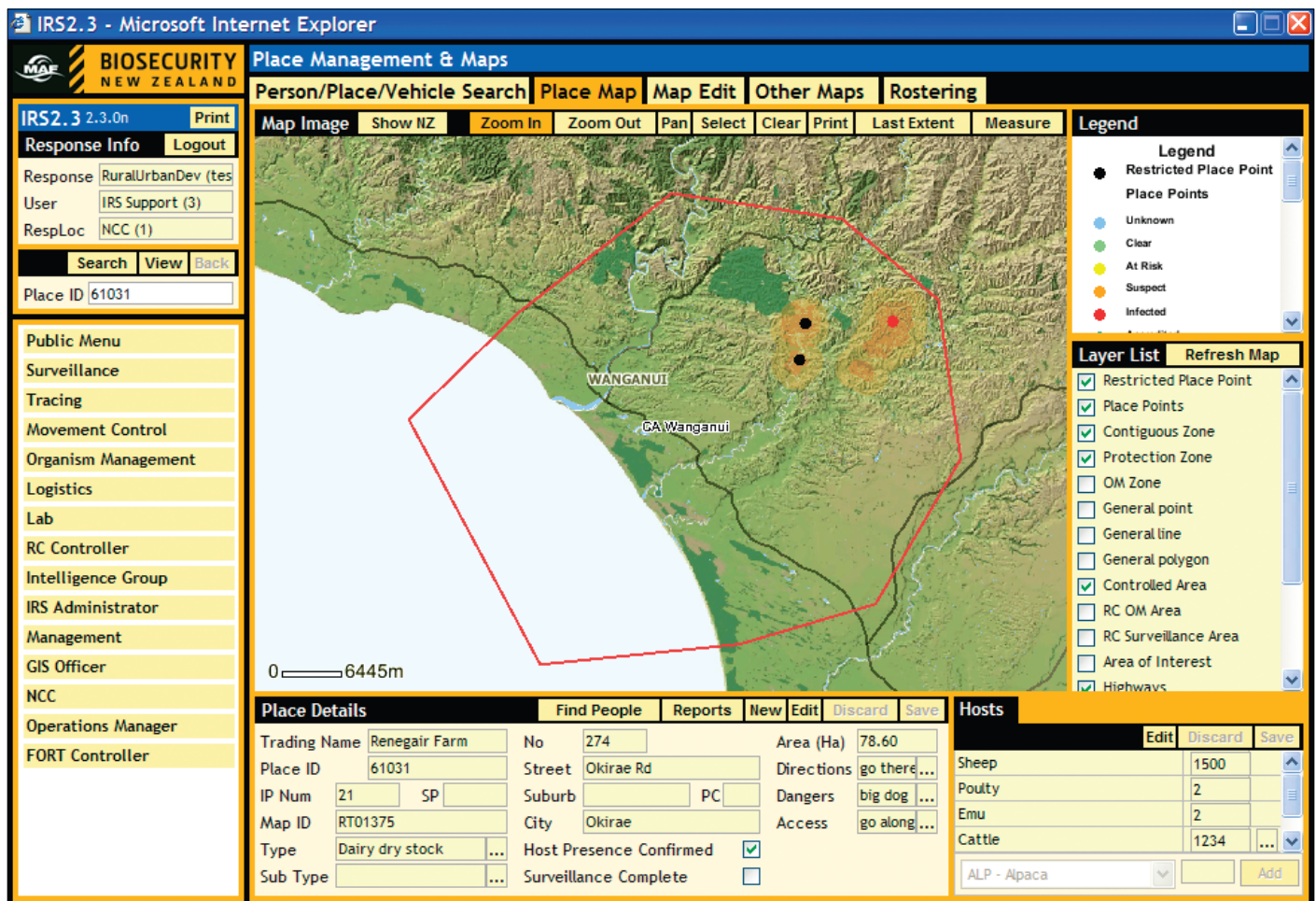
MAF uses ArcIMS Server clients set up with easy-to-use map views of specified areas for surveillance and incursion response.
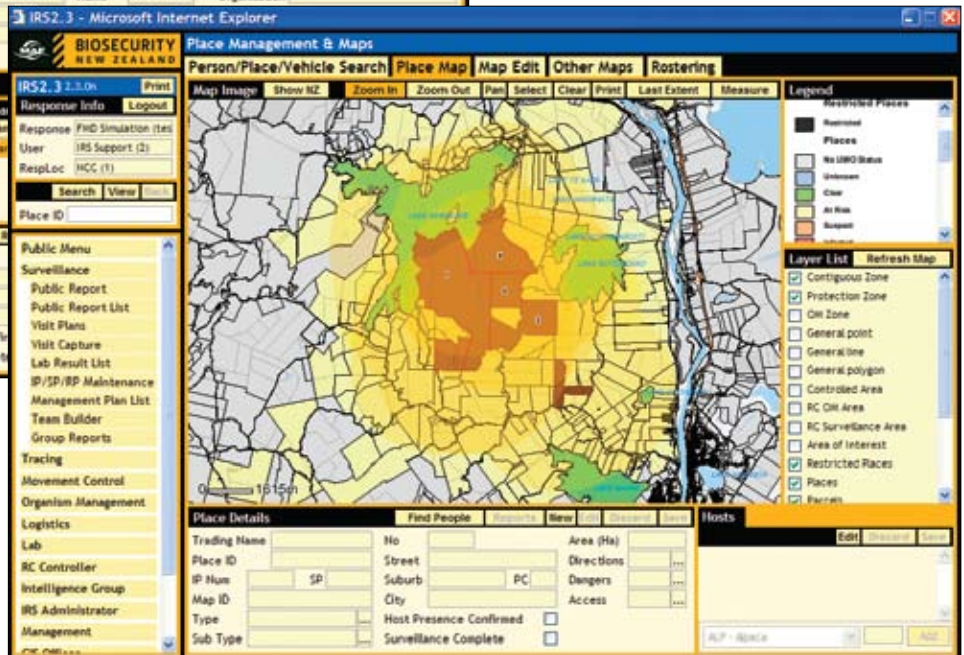
Dynamic HTML makes the forms used in the field quickly available to use, providing fast response to queries.

ArcGIS Server helps MAF spatially view and model biohazard outbreaks.

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 means the difference between a minor incident and a national disaster," says King.

The system was up and running in 2005 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 topographic maps and a database with farm locations and boundaries called AgriBase, developed by AsureQuality New Zealand. This database provides an index of farm type, ownership, and management. MAF also includes information on the coastline and water bodies in the country for possible marine incursions.

The data is stored and maintained in an IBM Informix Dynamic Server (IDS) RDBMS with the Informix Spatial DataBlade module. The data blade 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 software. 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 and 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. In these instances, the reality is that paper continues to be the chosen method of communication between field and office. The advantage of the system comes when field response teams are able to share information without traveling back to the office.

In some cases, where a link to the office from

all field locations just 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 the 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 collecting avian blood samples or performing incursion monitoring for slow-moving pests like red fire ants.

Sharing of information between multiple field response teams from various offices while out on investigation has become almost real time. By using dynamic HTML, individual components of the form make their own calls to the Web service. As a result, IRS2 provides a fast response to queries and 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

GIS Assists New Zealand's Ministry of Agriculture and Forestry in Its Battle against Exotic Pests

where and what they have found. "Sharing information in this manner vastly improves coordination between the many different teams and ensures all at-risk areas are investigated and recorded," says King.

Armed with this arsenal of data and ArcIMS Server clients set up with easy-to-use map views of the specified area, MAF uses the system for surveillance and incursion response. 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 state of 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 at-risk farms 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," says 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 $6 billion in the first year and around $10 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
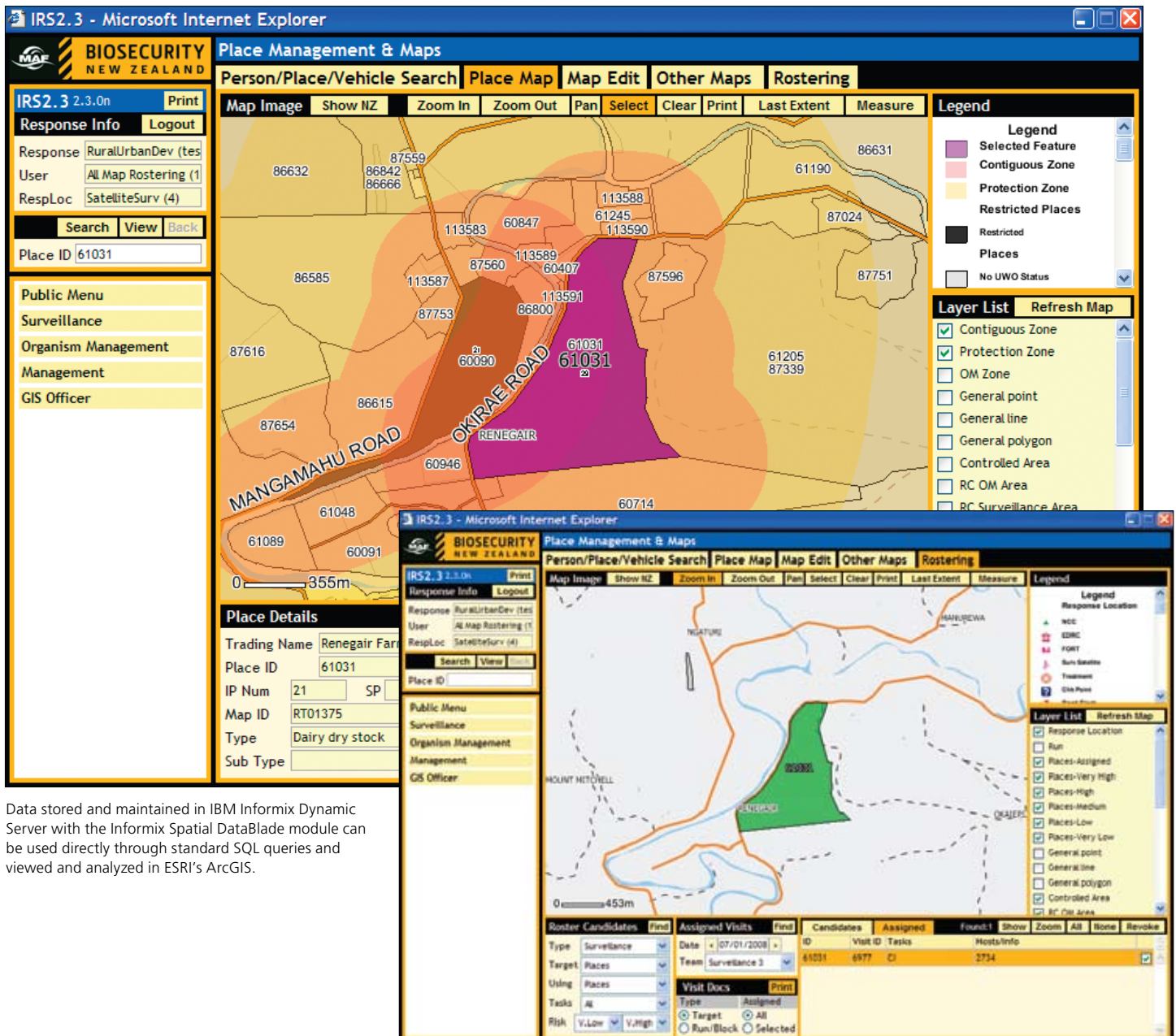
Data stored and maintained in IBM Informix Dynamic Server with the Informix Spatial DataBlade module can be used directly through standard SQL queries and viewed and analyzed in ESRI's ArcGIS.

Veterinarians must visit at-risk farms every two days to examine livestock, and this information is made available through IRS2 to other teams for further analysis.

and have systems in place to mitigate and contain such an outbreak if indeed it did occur.

"On average, four midlevel exotic incursions occur each year," King continues. "With global threats such as foot-and-mouth disease and avian flu, we need to know we are taking 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."

MAF CIO Allan Frost states, "The Incursion Response System, an enterprise application, enables the management of incursions using spatial and nonspatial information. This has advanced MAF's ability to plan and manage biosecurity incursions, helping New Zealand by keeping our environment safe."

For more information, contact Parker Jones, Eagle Technology, at parker_jones@eagle.co.nz.

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Sharing information online has vastly improved coordination among many different teams and ensures all at-risk areas are investigated and recorded.

Power Provider's Land Managers Use GIS to Manage Resources

Tennessee Valley Authority

The largest public power provider in the United States, Tennessee Valley Authority (TVA), uses GIS to track landownership. TVA has been a longtime user of ESRI GIS to support the many aspects of its integrated resource management mission including evaluation of siting alternatives for TVA projects.

The authority uses its Resource Stewardship Information System Integration Project (ISIP) to help manage land operations including agreements for interim and long-term uses of federal property. ISIP is composed of many layers of information pertaining to TVA land rights including fee lands. The system also includes disposals (sales or transfers), ownership, land-use permits, special-use permits, and easements. In addition, the system is used to maintain related resources information such as eroded shoreline to be repaired and sensitive areas, wetlands, and archaeological sites that could influence the location of particular facilities. All this data is stored in TVA's enterprise GIS using ArcSDE technology.

TVA needed an efficient way for land managers to evaluate real-time data before issuing land-use permits on the reservoir shoreline or public lands. It also needed a way to monitor the status of private facilities along the shoreline and locate violations and encroachments on TVA lands and waterways. Since the ISIP data is stored within ArcSDE, TVA chose to continue using ESRI GIS software to gain access to this data. Most TVA desktops are not equipped with GIS software, and many land managers have little or no experience using GIS. The organization decided to use ArcIMS to deliver the necessary GIS data over the Web to its land managers. TVA made the application as simple as possible by creating eMap, a user application on top of ArcIMS. The eMap application allows users and managers to access, view, and query the TVA ISIP data through an easy-to-understand user interface.

The eMap application is built on top of the ESRI Java Integration Toolkit (JITK) and is a JavaServer Pages (JSP) viewer. The eMap Web application is available over the TVA intranet, allowing managers to view the inventory of data, generate maps, and create external datasets such as landowner information. Managers have found the application intuitive, eliminating the requirement for intensive training, and they now use eMap to perform in-depth spatial and data analyses.

ArcIMS Metadata Services is also used to create a central, online metadata repository that allows TVA to easily publish and browse metadata for the ISIP database and other geospatial data over the intranet. The metadata is published through an ArcGIS Desktop application using industry-standard and user-definable style templates. ArcIMS Metadata Services allows the metadata to be optimized for rapid and efficient searches using a variety of clients including lightweight browser-based clients such as eMap and ArcGIS Desktop. Searching for metadata is quick and efficient now. Users can perform searches based on any combination of geographic extent, content type, data format, or keyword.

The eMap application allows users to access enterprise-wide data in the office. They can also access it via a wireless network in the field. Users and managers now make better decisions about land- and water-related issues and identify problems involving violations and encroachments. This cost-effective application promotes information collaboration, data consistency, and sharing. It allows users to coordinate requests with other users and provides a tracking system to monitor these processes.

For more information about GIS applications at TVA, contact Roy J. Teal, senior manager, Geographic Information and Engineering, Tennessee Valley Authority, at rjteal@tva.gov.
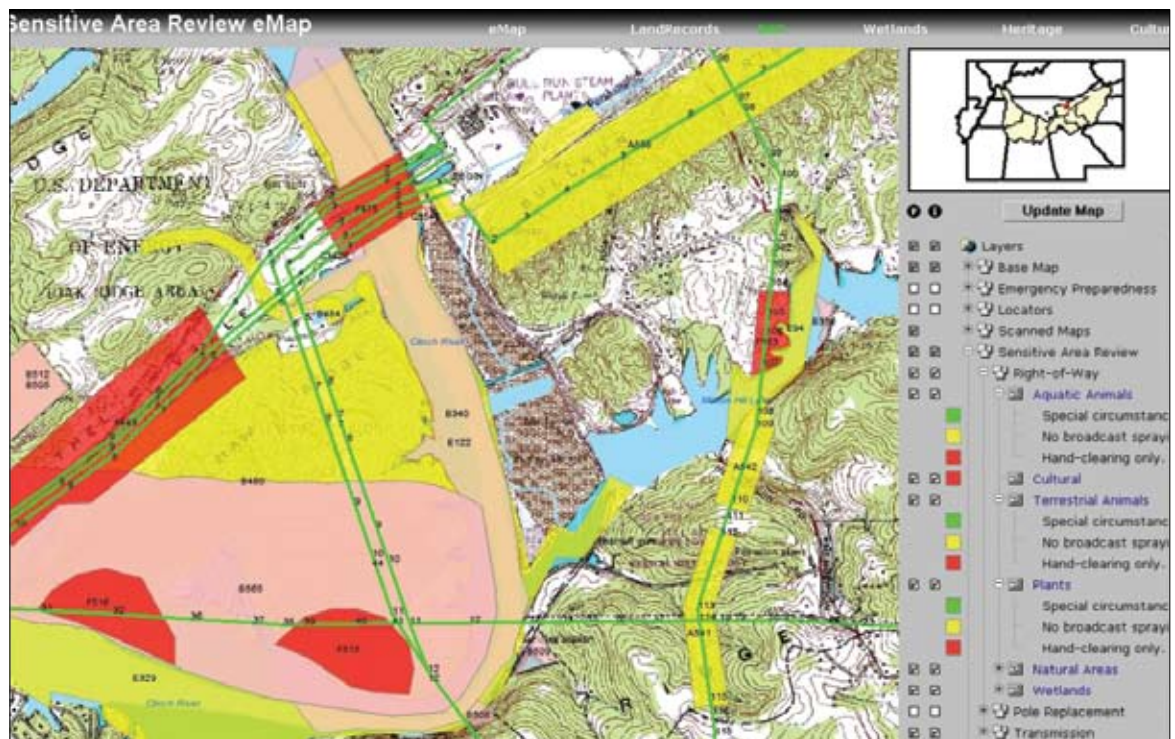
TVA land managers use eMap forms and maps to track land rights and monitor shoreline development.

39°54'50.9206"N
105°08'17.8710"W
09:38:58 MDT

39°54'50.8894"N
105°08'17.8650"W
09:39:27 MDT

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