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Authors

Carson, Robert
Kirkman, Robert
Jones, Rick
et al.

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ODOT'S SALMON RESOURCE AND SENSITIVE AREA MAPPING PROJECT – APPLICATION DELIVERY OF GIS BIOLOGICAL RESOURCE DATA

Robert Carson (Phone: 503-224-3445, Email: bcarson@masonbruce.com), Environmental Services Manager, and Robert Kirkman (Phone: 503-224-3445, Email: rkirkman@masonbruce.com), GIS Manager, Mason, Bruce & Girard, Inc., 707 S.W. Washington St., Suite 1300, Portland, OR 97205, Fax: 503-224-6524

Rick Jones (Phone: 503-228-8708, Email: rjones@spaceimaging.com), Director of Western Regional Operations, Space Imaging, 421 SW 6th Ave., Suite 850, Portland, OR 97204, Fax: 503-228-8751

Jason Neil (Phone: 503-423-3700, Email: jason.neil@hdrinc.com), Environmental Science Program Manager, HDR Engineering, 1001 SW 5th Ave., Suite 1800, Portland, OR 97204, Fax: 503-551-7244

Abstract: The Oregon Department of Transportation (ODOT) undertook an innovative project in 1999 to develop a GIS-based inventory of fish-bearing streams, wetlands, threatened and endangered plant and animal habitat, and other sensitive resource sites within the transportation corridor of state-maintained highways. The objective of this effort was to create an environmental management tool for ODOT's maintenance and operations activities and to facilitate an exemption under Section 4(d) of the ESA.

As a contractor to ODOT, Mason, Bruce & Girard, Inc. (MB&G) has completed this process for four of the five ODOT regions, totaling more than 7,000 miles of state roadway. The project involves the unique integration of high-technology data capture methods, including: (1) high-resolution digital infrared orthophotography, (2) imagery interpretation and on-screen digitizing of sensitive resource features, (3) road-side verification and capture of sensitive resources using laser rangefinders linked to vehicle-mounted real-time GPS units, and (4) sophisticated GIS modeling. With these tools we are able to accurately determine the locations and attributes of sensitive resources with an error rate of less than five percent.

Key project deliverables include: (1) GIS coverages, or data layers, for twelve categories of sensitive resources present along all state roadways, (2) straight-line maps showing locations of sensitive resources for use by ODOT maintenance crews to facilitate resource protection, (3) high-resolution digital imagery of the state-wide transportation corridor (extending 500 feet each side of centerline), and (4) a desktop computer application that allows non-GIS users the ability to access and view these data. The comprehensive spatial database – comprised of the GIS and the digital imagery – allows biological resources to be considered early in the design process for roadway improvement projects, thus facilitating resource protection and environmental permitting.

The desktop computer application, GeoBook™ allows environmental scientists, transportation planners, and engineers to query various segments of the state transportation corridor by highway name, number, or milepoint. Functionality includes the ability to pan and zoom in and out so that the user can move through the landscape and view the transportation corridor at any desired scale. The application also allows users to toggle on or off the GIS coverages of the twelve categories of sensitive resources so that they can perform “virtual” environmental project scoping and preliminary alternatives analyses for transportation improvement projects.

SRSAM and GeoBook

What is SRSAM?

Environmental Inventory of the Transportation Corridor

The Salmon Resource and Sensitive Area Mapping (SRSAM) project is an inventory of environmental features within the Oregon state transportation corridor (defined as 500 feet on each side of the road centerline). Its primary goal is to provide a series of maps depicting existing sensitive resources and to detail restricted maintenance and operations adjacent to those resources. These maps display all highways as straight lines, with the presence of environmental features mapped to each side of the road and noted with milepoints to the nearest 1/100th mile. Used by ODOT's maintenance crews, the maps ensure that ODOT maintenance activities avoid sensitive resource areas (such as wetlands and endangered species) in compliance with environmental regulations.

The GIS Approach

MB&G developed an integrated approach using GIS, GPS, digital imagery, and surveying techniques to collect the required data for this project. ArcView™ was used for digitizing, while spatial modeling was performed in ArcInfo™, and an ArcPad™/GPS interface was used to capture and attribute inventory features in the field. [ArcView, ArcInfo, and ArcPad are trademarks, registered trademarks, or service marks of ESRI in the United States, the European Community, or certain other jurisdictions, and are used here by permission.] This integrated approach yielded the hardcopy maps needed by the maintenance crews, yet also yielded additional products for use throughout the agency, specifically a comprehensive GIS database of biological resources and an image library of high-resolution orthophotography.

Unlike traditional roadside resource inventories, MB&G's approach resulted in greater data depth. Multiple resource features could be represented at the same milepoint along the centerline, some inside the clear zone (maintained area adjacent to the roadway), and others inside the transportation corridor (but outside of the clear zone). Where traditional methods offered only a single feature per unit, this integrated approach gave ODOT a more realistic view of existing sensitive resource features.

GeoBook: The Next Step

The final phase of the project is the development of an application that can deliver the library of GIS and image data to agency personnel. The solution was provided by MB&G's subconsultant on the project, Space Imaging, whose GeoBook is a GIS application that organizes, displays, and queries the GIS, imagery, and tabular data generated through the SRSAM project. GeoBook is designed to look and function like a book, complete with organizing tabs. This intuitive book metaphor and layout helps people unfamiliar with GIS to begin using the data immediately.

MB&G has completed imagery acquisition and data collection for four of the five ODOT regions covering approximately 7,000 miles of road. This four-year effort has yielded over 750 GB of data. GeoBook puts the data into the hands of non-GIS users at ODOT, such as engineers, biologist, planners, and operations/maintenance staff. In addition to serving as a data delivery tool, GeoBook is helping the agency plan its own internal application development and data delivery needs.

Inventory Recap

The SRSAM inventory process and its legislative impetus were detailed in a paper published in the *2001 ICOET Proceedings* (Carson, et al. 2001). For the purposes of this paper, a shortened summary of the methods detailed in the previous paper is presented here.

Methods

Digital Orthophotography

Digital high-resolution imagery lies at the core of the approach used for this project. Due to advances in orthophotography generation, the imagery is a primary control for data generation. Its 2-foot resolution allows the team to collect hydrologic features too small to have been previously mapped on most publicly-available natural resource data sets. The digital imagery is used to shorten field time by allowing the team to assess, and make preliminary delineations of, the project area before going into the field. During the pre-field process, existing features on base data are confirmed and spatially reregistered, and previously unmapped features are identified, attributed and delineated. Imagery is also used in the post-field processing phase to confirm and delineate any new features missed in the pre-field process but captured during the field effort.

Data Preparation: Pre-Field

Essential to the integrated approach is the use of existing data. ODOT's existing CAD data are augmented with NWI, USGS, and other sources to provide a preliminary work product. All data are converted to GIS, appended, edited, and attributed in ArcInfo.

Field-Verification Using ArcPad

Hydrographic features and their attributes are field-verified. A two-person team performs the fieldwork in a specially-equipped field vehicle outfitted with a customized ArcPad interface. This GIS-GPS interface allows the field team to make corrections directly to the GIS data derived from the prior pre-field effort. Using a real-time GPS feed and ArcPad, the vehicle location is continuously displayed on the computer screen and superimposed on the GIS data and imagery. This allows the field crew to focus their efforts on verifying the on-screen display of GIS data developed during the pre-field processing stage, rather than the traditional and time-consuming field crew role of original mapping. Those few natural resource features that may have been missed during the pre-field process are captured by the field crew using the GPS unit and a laser rangefinder. The field crew averages more than 50 miles per day using this approach.

GIS Modeling

Before the project's inception, ODOT planners and biologists identified twelve specific fields of information critical to determining whether ODOT's maintenance and construction activities would adversely affect sensitive natural resources. We developed GIS algorithms to take advantage of the natural interrelationships of many of the features. Ultimately, seven of the twelve fields collected for the project are derived in whole or in part from GIS modeling of correlated fields.

Linear Referencing

All fields are related back to the digital centerline in ArcInfo in a procedure called linear referencing. Linear referencing derives the exact location of features along a linear feature. In this case, the features are the environmental fields collected by MB&G, and the linear feature is the road. The linear referencing process gives exact milepoints ($\pm 1/100^{\text{th}}$ mile) for each feature along the roadway.

GeoBook: Cost-Effective Solution

GeoBook has proven to be an attractive and cost-effective solution for ODOT. It is a stand-alone application that resides on a standard laptop or personal computer. Space Imaging offers the GeoBook as a rapid-development application. With the core programming already developed, time and monetary expenditures were channeled to customizing the interface and developing specialized tools. Ultimately, GeoBook was deployed at a fraction of the cost of an original programming effort.

GeoBook is built on the ESRI MapObjects LT architecture. This royalty-free version of the mapping tools has less functionality as compared to the full version, but embedding them in GeoBook allows ODOT to freely distribute the application without incurring licensing costs.

Most important, GeoBook application met two primary needs of the agency. First, it is an effective means of rapidly deploying the GIS and image data throughout the agency. Second, the GeoBook is functioning as a needs-assessment for the agency's planned development of its own application.

High-Tech Data Delivery

User-Navigation

At its simplest, the GeoBook acts as a means to deliver the high-resolution orthophotography and complex GIS data. The basic functionality of the GeoBook gives the user the ability to explore the virtual landscape of the transportation corridor. Using standard pan, zoom, and identify tools – familiar to users of standard desktop and internet mapping software – users can view and query the data on their own. Buttons on the interface allow map themes to be toggled on and off as needed.

Data needs are simplified within the GeoBook as well. Users can take advantage of other (non-SRSAM) project data by adding their own shapefiles to the Main View. Once in the Data View, maps can be printed or exported digitally for use in word processing with WYSIWYG (*what-you-see-is-what-you-get*) maps using programmed map templates.

Advanced Functions

Beyond the core MapObjects LT functionality, Space Imaging programmed more advanced capabilities. When more sophisticated spatial operations are required, GeoBook enables users to buffer features (points or lines) to a user-determined distance and query all of the GIS data features intersecting those buffers. One example: for a roadway project in which ODOT must identify all wetlands within one-quarter mile of the site, GeoBook allows rapid navigating to the site in the GIS, the definition and buffering of the project area, and the exporting of all relevant features to a spreadsheet for further review and incorporation into planning and permitting documents. Also offered is the ability to edit and update the data layers – essential in maintaining their currency and usefulness, as well as an advanced map labeling tool.

The project team designed tools specifically to meet ODOT's transportation system management needs. Most transportation projects are referenced by an internal eight-character highway number (known as an LRS) and specific milepoints. An interactive dialog allows users to quickly identify and zoom to a project area rather than navigating through the GIS layers.

A similar tool allows users to manage the image library on laptop deployments. To date, more than 700 GB of image data have been collected for the project. Even with image compression software, the entire library exceeds 30 GB – pushing the limits of most field laptops. Space Imaging built a flexible image indexing system that allows users to deploy portions of the image library. When only part of the imagery is loaded, or is carried on CD, the indexing system ensures that users load and access the correct imagery for the area of interest.

Environmental Scoping

GeoBook is the first step in a “virtual environmental scoping” process for transportation projects. In this process, substantial preliminary assessments of environmental impact and fatal-flaw analyses can be performed in the office. This process, which can take several weeks to accomplish with traditional methods such as data gathering and site visits, can now be accomplished in just a few hours in the office.

Foundations of Application Development

ODOT policy mandates in-house development of customized applications for agency-wide use. However, ODOT realized that such an application development process could take several years to complete. To ensure maximum usage of the resource and imagery data developed through the SRSAM project, ODOT approved development of the GeoBook as an interim solution until ODOT's internal application development process is completed. During this interim period, the SRSAM GeoBook functions as a user-needs assessment for the ultimate, ODOT-generated application. The various SRSAM data users can test the functionality provided by GeoBook and provide suggestions for modifications they wish to see in the ODOT-generated application.

Summary

By incorporating modern spatial technologies, the SRSAM project is redefining how biological resource data are captured and used in transportation planning. The integrated, high-tech approach developed for this project has produced accurate resource data and useful ancillary products including a library of high-resolution imagery. GeoBook has proven to be an effective, user-friendly tool to deliver the project resource data and imagery to biologists, planners, engineers, and operations/maintenance staff. Ready access to accurate resource data state-wide helps to ensure that ODOT's activities are carried out in compliance with state and federal environmental laws and regulations.

Biographical Sketches: Bob Carson is the manager of Mason, Bruce & Girard, Inc.'s Environmental Services Group, and is the principal-in-charge of the SRSAM project. He has more than 18 years of experience helping clients with regulatory compliance and environmental permitting. His technical expertise includes wildlife, forest, wetland, and range ecology/management. He has authored numerous publications on ecology, wildlife habitat, and wetlands, and is a frequent speaker at conferences and workshops dealing with endangered species permitting issues.

Robert Kirkman is the GIS manager and senior spatial analyst for Mason, Bruce & Girard, Inc., in Portland, OR. Robb is the SRSAM project manager, and developed data development techniques and spatial modeling algorithms for the project. He has 10 years of experience in urban and natural resources GIS, and provides expertise on integrating GIS in field efforts, database development and environmental modeling.

Jason Neil is the Oregon Environmental Sciences program manager and a senior project manager with HDR Engineering in Portland, OR. Jason managed the Oregon Department of Transportation's NEPA and environmental coordination programs, and developed natural resource inventory techniques to support the implementation of the Oregon Plan for Salmon Recovery. He has 11 years of experience managing environmental projects and extensive experience managing and preparing NEPA and other environmental documentation for the Federal Highway Administration, United States Forest Service, and Bureau of Land Management.

Rick Jones is the western operations manager for Space Imaging, Inc. Rick oversees the imagery and application development components of the SRSAM project. He has over 10 years of experience in remote sensing, GIS, and application development.

References

Carson, B., J. Neil, and R. Kirkman. 2001. ODOT's Salmon Resource and Sensitive Area Mapping Project: A High-Tech Procedure for Obtaining Biological Resource Data for Resource Protection and Regulatory Compliance. *Proceedings of the 2001 International Conference on Ecology and Transportation*.