

# Forestry GIS Journal

Esri • Winter 2011/2012

GIS for Forestry and Timberland Management

## Forest Assessment: A Model for Prioritizing Needs

by Barbara Shields, Esri

Forest managers need to perform forest assessments for certification, funding application, policy recommendations, regulatory compliance, and value assessments. To receive federal funding provided by the US Forest Service's 2008 Farm Bill, state forest services must complete assessments of their forest landscapes and create strategies for forest re-

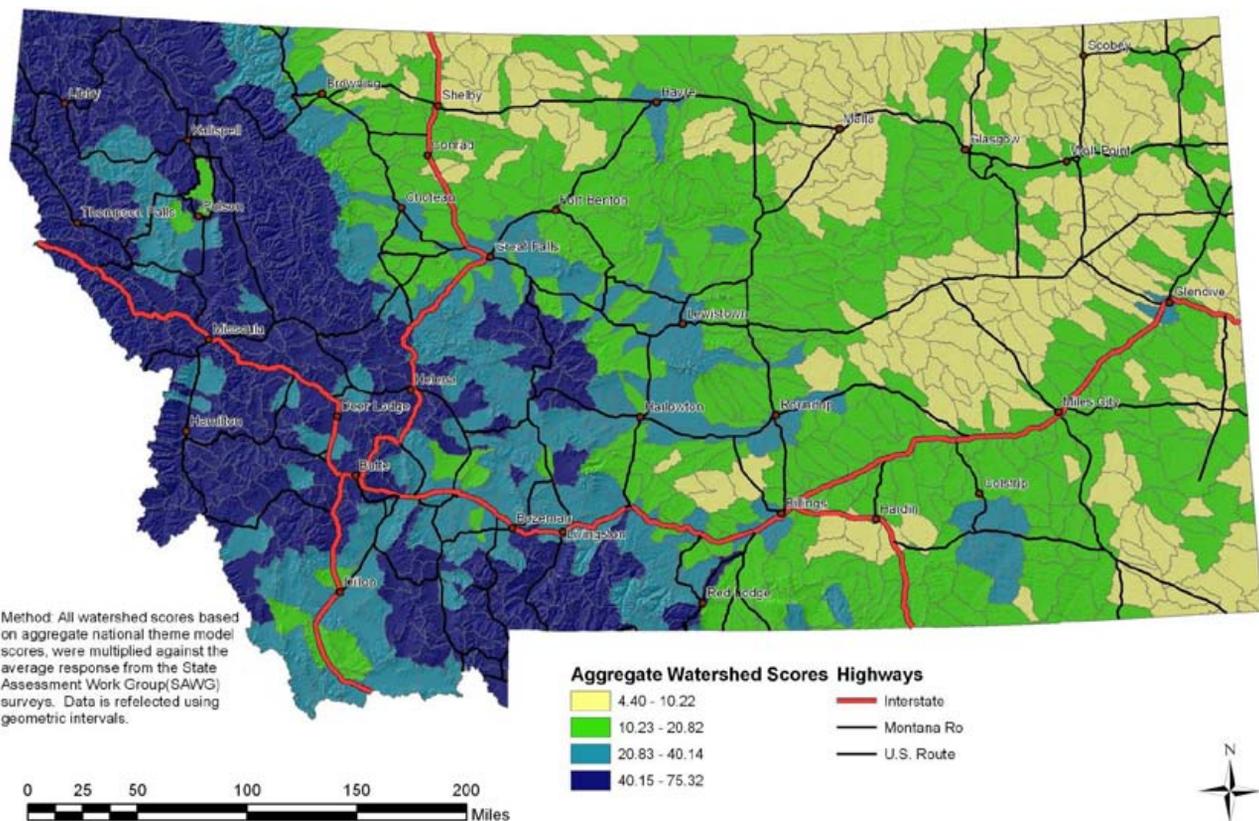
sources statewide. Assessments need to show an analysis of forest conditions and trends, prioritize needs for rural and urban forest landscapes, and outline a long-term plan for how Farm Bill funding will be used. Furthermore, the Farm Bill asks that multiple partners be involved in the forest assessment process.

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### Aggregate Watersheds based on 2010 SAWG Survey



A suitability model rates 1,000 watersheds in Montana and prioritizes resource planning needs.

## Forest Assessment: A Model for Prioritizing Needs

The Montana Department of Natural Resources and Conservation (DNRC) addressed these requirements through a program called the Statewide Forest Resource Assessment and Forest Action Plan. The program is designed to meet 11 US Forest Service objectives, categorized into three national themes: conserving working forest landscapes, protecting forests from harm, and enhancing public benefits from trees and forests.

DNRC invited more than 40 stakeholders to participate in the Statewide Assessment Working Group (SAWG) and help shape the forest assessment and action plan. This group of experts combined its knowledge and used geographic information system (GIS) outputs to assign value rates to forest resources and prioritize needs.

The first step was to obtain the data necessary for understanding, defining, and analyzing forest needs. The Department of Revenue was a valuable resource. It had completed its 2009 statewide forest productivity database, which reappraised private forest lands for taxation purposes. The database included data for nearly four million acres of commercial forestland, including potential forest productivity and yield, ownership, and commercial quantities of wood products.

Another data resource was the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil database, which includes four soil elements that are determinants of forestland productivity. The USDA data also provided National Agriculture Imagery Program (NAIP) digital orthographic imagery from 2005 at 1-meter resolution. Used to delineate forest and nonforest areas, this database includes progressive classes of potential forest productivity. In addition, the University of Montana contributed climatological data for the state.

The second step was to create a suitability model. Because DNRC was already using Esri's

ArcGIS software, managers knew that it could save them a lot of money, time, and effort. Therefore, they asked the local GIS consultant, Geodata Services, Inc., to create a forest suitability model tool for ArcGIS. This team, headed by Ken Wall, used the ArcGIS software extension CommunityViz to create and run the model. CommunityViz performs weighted sum calculations and prioritizations and provides tools for easy analysis by users who know little or nothing about GIS. Eventually, Geodata Services would build the GIS data



The assessment tool cited wildfire as a priority issue.



Logging is considered in the forest assessment process.

layers, create model layers for each resource, and configure the suitability model for other natural resources.

DNRC staff developed Montana's statewide assessment by creating 11 different submodel layers based on the Forest Plan's National Guidance Objectives. Three weighting calculations were applied to each layer to rate levels of relative importance, geographic scale, and quality of source data. Between three and nine GIS analysis layers formed the basis for each objective.

DNRC also designed a suitability model to assess watersheds. SAWG experts and resource specialists provided insight for building the model layers, model components, and default layer weightings. They collaborated via WebEx conference calls, an enterprise wiki, ArcGIS Online, and an intranet to discuss data and weighted averages. Because SAWG members needed to compare disparate data layers as equally as possible, the GIS team normalized data source layers and adjusted data to account for differences in watershed size and shape.

In his article "Montana's State Assessment of Forest Resources: Base Findings and GIS Methodology," Montana DNRC project manager Dan Rogers wrote, "To compare and aggregate data while minimizing bias, the team decided to limit the upper end of the weighting range of some layers, such as the generalized county GIS data, in order to make it comparable. It may be an important layer from a values perspective, but mapping inequalities required that it be reduced in importance simply because of its resolution and quality. The potential mathematical bias of using multiple layers was handled by normalizing all GIS analysis to actual counts or percent of watershed. This also neutralized slight differences in the size and shape of the watersheds."

The data model was used to prioritize 1,000 watersheds within the state. SAWG weighted each data layer in each submodel based on the group's consensus on the value of importance.

"In both instances, (1) the aggregate snapshot of the SAWG, or 'popular vote,' and (2) the weighting of GIS layers making up each objective, we asked each participant to assign 100 points among each component," noted Rogers. "A weighted average score from this weighting exercise was then calculated. Participants were allowed to allocate points freely and could spread them out more or less



Montana is a trove of natural resources.

equally, or they assigned more points to some components and no points to others, as long as they summed to 100.”

The process of weighting GIS layers for each objective requires subjective input by the area expert. In most GIS analyses, weighting the importance of one GIS layer is complicated, so it is usually done within the GIS modeling environment by a GIS analyst. However, using the CommunityViz suitability tool, forest managers were able to bypass the technology analyst and apply statistical weights to data layers within ArcGIS themselves, making adjustments based on their expert insight.

Once the watershed model was completed and approved, DNRC and Geodata Services began working to complete the remaining forest decision support tools. DNRC developed 120 GIS layers from existing and newly collected GIS data. It converted these into 53 unique layers of natural resource categories. Using the same analysis process applied to the watershed theme, GIS calculated the zonal mean, categorized outcomes within a range, and applied the SAWG weights for these other natural resource themes. The forest productivity tool evaluates biomass potential and site productivity; the forest industry infrastructure tool evaluates existing or planned mills and other forestry infrastructure; and the forest economic characteristics tool evaluates federal, state, and private landownership as well as Montana legacy data for public landownership.

In each case, Geodata Services combined

some or all of the natural resource data layers into one composite map layer. CommunityViz tools, such as slider bars, are intuitive and allow anyone to easily combine layers, see relationships, and understand adjusted values for prioritized objectives.

The assessment model displays results from several perspectives and resolutions. The user can see critical landscapes and drill into data to see risks and opportunities. The model shows the priority of landscapes for the three national themes: conserving working forest lands, protecting forests from harm, and enhancing public benefit from trees and forests. In addition, it can produce a final aggregate of the data.

Montana’s Statewide Forest Resource Assessment was adopted by the Montana State Forester in 2010 and submitted to the US Department of Agriculture. The assessment data models provided key resource materials for the Montana Statewide Assessment of Forest Resources and the Montana Statewide Forest Resource Strategy. Both works were submitted to and approved by USDA.

The assessment tool helped DNRC identify five priority issues for the forests of Montana: forest biodiversity and resilience, wildfire and public safety, forest product and biomass utilization, sustainable urban forest landscapes, and changing forest ownership patterns. The assessment model gave decision makers insight about where to direct specific outreach and what types of outcomes to expect.

Although the GIS assessment model was

not the sole criterion of the scoring matrix, it was a valuable tool in defining it. Meanwhile, the forest assessment and the strategy analysis were being used for other related projects such as assessing watershed evaluations, marketing biomass feasibility, scoring grant applications, and comparing prioritization models with other land management agencies.

“The future intent is to allow forest managers to use the model to assess potential responses to funding programs,” concluded Rogers. “This will effectively move resource management analysis from the back office to the front desk, saving time and steps.”

The GIS forest assessment model helped DNRC

- Show state project priority scores.
- Create a living document that can be continuously used, updated, and applied.
- Streamline analysis.
- Generalize data in a dynamic way.
- Interpret multiple data layers easily at one time.
- Interact easily with a massive volume of data via slider bars.
- Adjust and update analysis tools.
- Update and add more data layers as needed.
- Support professional collaboration and community engagement with easy-to-use tools.
- Adapt the model to other types of projects.

Learn about the statewide forest assessment model and CommunityViz by contacting Ken Wall of Geodata Services, Inc., at [KWall@geodataservicesinc.com](mailto:KWall@geodataservicesinc.com).

# Korea's Forest Service SDI

Korea Forest Service (KFS) specializes in planting and taking care of forests. It aims to build a sustainable green welfare nation with a mission to promote healthy forests, rich mountains, and a happy populace. To satisfy this vision, KFS is making an effort to further encourage and strengthen the forest sector at the domestic level and act as a global green leader based on successful experiences in forest rehabilitation at the international level. KFS plans to reinforce carbon cycle economy, improve the quality of green life, conserve and manage green resources, and become a global green leader.

KFS created a website, the Forest Spatial Data Information (FSDI) portal, which is used in forestland administration. The FSDI por-

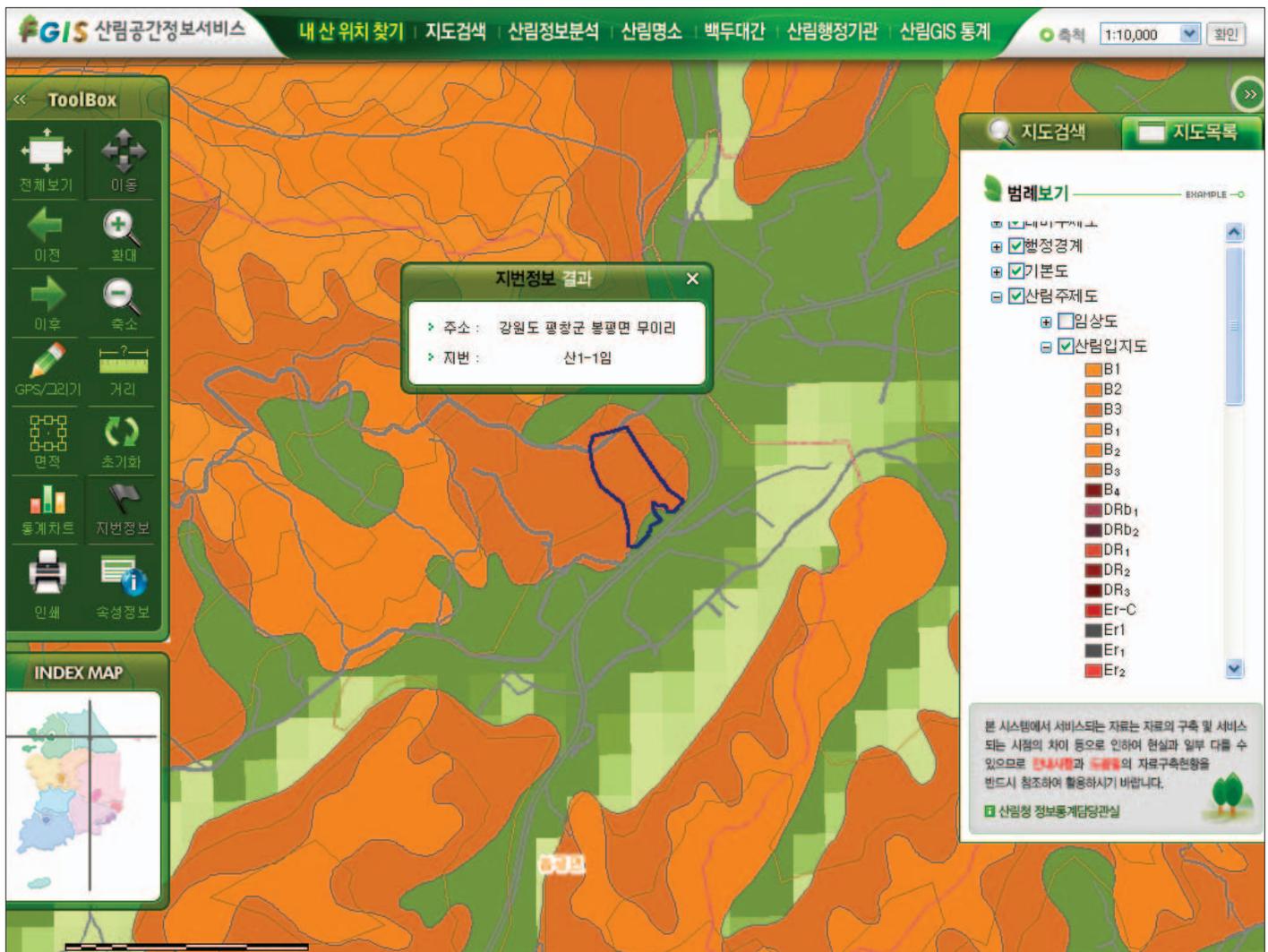
tal provides forestland and national property management including map and data distribution services and a forestland thematic map. Customers and the nation demanded accurate forestland information that they could access quickly. The Forest Spatial Data Information portal provides detailed information to help users find specific mountains; search maps; and analyze forestland information, land statistics, and attraction information.

Korea Forest Service applied ArcGIS API for JavaScript with ArcGIS for Server caching to enable quick loading of massive amounts of data. The portal also improved the safety and function of data with an enterprise-based ArcGIS for Server dispersion structure. This system supports optimum functionality for

searching appropriate space structure for data extraction as well as copying and querying the geodatabase.

Adopting a web-based system made it easy to check related attribute information for forestland thematic maps as well as obtain data from various sources through online requests. Additionally, the organization was able to reduce the license management cost and manage the data more safely and efficiently.

With easy access to the web-based system, KFS can handle its official business in a more accurate and efficient way, and forest owners and the public are now able to check their own lands' information on the web and use the system for forest management. Foresters can realize increased profit by inquiring about



Results of Address Searching with the Forest Spatial Data Information Portal

related data. The public has gained access to data it has a right to know, and the policies of the forest industry can be better implemented. What is more, this web system has an ability to increase the quality of public services; by providing many kinds of information to 2.1 million forest landowners, the web portal has made it simple to conserve the environment and manage environmental resources.

The FSDI portal provides various kinds of information related to location, including attribute data that will be analyzed and used by planners and decision makers. The data can be integrated with software, hardware, and human resources.

This system has enhanced functionality in three ways. It improved service management

by reducing the data migration and maintenance burden on human resources by about 30 percent. It maximizes data value by enhancing productivity, creating the forestland information as data. Last, the web service decreases the time required between investigation and permission from 15 days to two hours.

The portal saved 200 million KRW (US\$175,500) and about 12,000 worker hours in 2009. Korea Forest Service has plans to expand this GIS service in 2012 to provide forestland information for mobile services through iOS and Android.

For more information, visit [fgis.forest.go.kr](http://fgis.forest.go.kr) /fgis.

## Esri Forestry GIS Conference Is for You

Connect with GIS users for forestry. Grow your skills. Learn GIS applications.

May 1-3, 2012  
Esri Headquarters  
Redlands, California, USA  
[esri.com/events/forestry](http://esri.com/events/forestry)



The screenshot displays the FGIS (Forest GIS) web portal interface. At the top, there's a navigation bar with options like '내 산 위치 찾기' (Find my forest location), '지도검색' (Map search), and '산림정보분석' (Forest information analysis). The main area shows a map of South Korea with regional labels such as '강원도' (Gangwon-do), '충청남도' (Chungcheongnam-do), and '경상남도' (Gyeongsangnam-do). On the left, a 'ToolBox' contains various GIS tools like '전체보기' (Full view), '이동' (Move), '이전' (Previous), '확대' (Zoom in), '이후' (Next), '축소' (Zoom out), 'GPS/그리기' (GPS/Draw), '거리' (Distance), '면적' (Area), '초기화' (Reset), '통계차트' (Statistics chart), '지번정보' (Parcel information), '인쇄' (Print), and '속성정보' (Attribute information). On the right, a search panel titled '주소검색' (Address search) allows users to search by city, district, and neighborhood. Below the search panel, there's a table for search results with columns for 'No.', '주소' (Address), and '정보' (Information). At the bottom right, there's a disclaimer in Korean: '본 시스템에서 서비스되는 자료는 자료의 구축 및 서비스 되는 시점의 차이 등으로 인하여 현실과 일부 다를 수 있으므로 [본 시스템]과 [도출물]의 자료구축현황을 반드시 참조하여 활용하시기 바랍니다.' (The data provided in this system may differ from reality due to differences in data construction and service times, so please refer to the data construction status of [this system] and [output] before using it.)

The distribution portal service is used for forestland administration.

# Cartographic Design of an Urban Forest Restoration Map

By Christopher Walter, Cascade Land Conservancy

The Green Seattle Partnership is a community-based collaboration between Cascade Land Conservancy, the City of Seattle, community groups, and city residents to restore and establish long-term maintenance for the city's 2,500 acres of forested parkland by the year 2025. The success of Green Seattle relies entirely on community support in the form of advocacy; philanthropy; and, most importantly, volunteer labor that actively works to remove invasive plants and restore native vegetation to city parks.

The Cascade Land Conservancy created the *Urban Forest Restoration Sites* map to help address the challenges of mobilizing a constituency and galvanizing support for a 20-year project. This map was created using ArcGIS. It remains one of the primary tools supporting publicity, outreach, and public education. Partnership staff and volunteers display the poster-sized map during frequent presentations to schools, businesses, and community groups and at a wide range of public venues such as community fairs, trade shows, and other events held throughout the city. In most cases, the map is part of a larger, visually oriented display that illustrates the threat of invasive plants; makes the case for restoring urban forests; and demonstrates how the Green Seattle Partnership works to manifest a shared vision of healthy, sustainable urban forests throughout Seattle. Most importantly, the map and other display materials tell the story of how volunteers play a critical role in the success of the project and deliver the message that there is both need and opportunity for everyone to contribute.

The map illustrates the magnitude of the conservation challenge by prominently highlighting the locations of Seattle's forested parklands and portraying them in the context of the familiar urban landscape. Bright red stars indicate which parks that have been active in the program are in need of a forest steward to coordinate the local volunteer cadre so that restoration work may resume.

The map helps readers find their own

locations. Familiar navigational references such as neighborhoods, highways, arterial and local streets, public trails, streams, water bodies and shoreline features, and parks are all carefully portrayed and their names clearly labeled.

To impact an audience beyond the subset of cartography aficionados, a map must be both attractive and engaging—it has to grab and hold the audience's attention before it has a chance to convey its message. Cartographers attempted to give the map a prominent and appropriate title, create a balanced layout of map elements distributed with a deliberate amount of blank space, include a limited amount of text to minimize competition with the more compelling imagery, and choose a fairly simple palette of contrasting and complementary colors to ensure that the map puts forth an attractive, professional appearance worthy of further inspection.

The basemap content takes advantage of Seattle's fascinating geography to draw the viewer into exploring the landscape in greater detail. A subtle elevation color ramp and shaded relief bring out the complex patterns of hills, valleys, bluffs, and sinks in noticeable detail. The variety of water features connecting the uplands to the sound and lake that define Seattle's character, as do its forest and nearby mountains, are shown in a contrasting blue in detail appropriate to the scale of the map and with names clearly labeled.

To round out the map and give it a finished look, the map labels nearby cities and towns, as well as familiar ferry routes, to provide a sense of context and connectedness. The entire basemap is intended to offer rich detail for those who are interested without diminishing the primary subjects of forested parklands and forest steward vacancies.

Finally, to reach a wide and diverse audience, a successful map must have a simple message and must communicate it clearly. With the fundamental principles of cartography in mind, mapmakers layered and symbolized the dozen spatial datasets involved with

careful attention to an appropriate hierarchy of information. For the main subjects of forested park sites and leadership vacancies, they chose a bold green and red, respectively, and labeled park names in black with thin white halos to set them off against the park areas themselves. All elements of the basemap appear in various muted shades of either tan for land areas or blue for waters. Labels for corresponding features have similar colors just different enough from the background to be read legibly yet avoid becoming a distraction.

Since the effort's inception in 2004, thousands of volunteers have contributed more than 400,000 hours of labor during 2,500 restoration events. The partnership has enrolled 625 acres of invasive-infected parkland into the care of its 108 volunteer stewards. To date, volunteers have planted some 65,000 native tree saplings to rejuvenate lost canopy on newly restored land.

The project's cartographer would like to attribute the *Urban Restoration Sites Outreach* map with some portion of the Green Seattle Partnership success in attracting volunteers. But only anecdotal evidence in the form of compliments occasionally delivered in public and the indirect evidence of the growing volunteer base supports this claim. Success is more likely a combination of essential marketing tools such as the Green Seattle Partnership website and blog, traditional public media outlets, posters, brochures, advertisements, and the power of both peer pressure and viral marketing. Still, reason suggests that the map likely plays some role in the success.

## Christopher Walter

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## Data Sources

Cascade Land Conservancy, Seattle Parks and Recreation, EarthCorps Science, King County GIS, Washington Department of Natural Resources



# Esri Forestry Field Lab

## Foresters Try Out Technologies in a Forest

On a beautiful spring day in May, Esri and partners Critigen and Laser Technology Inc. (LTI) sponsored a forestry workshop at Descanso Gardens in Southern California. At field labs located throughout the park of towering redwoods and lush vegetation, industry experts demonstrated the latest geospatial technologies for working in the forest. Sixty participants divided into groups of seven or eight people rotated through these labs. Everyone tried out tools and talked with station experts. Here are descriptions of a few of the labs:



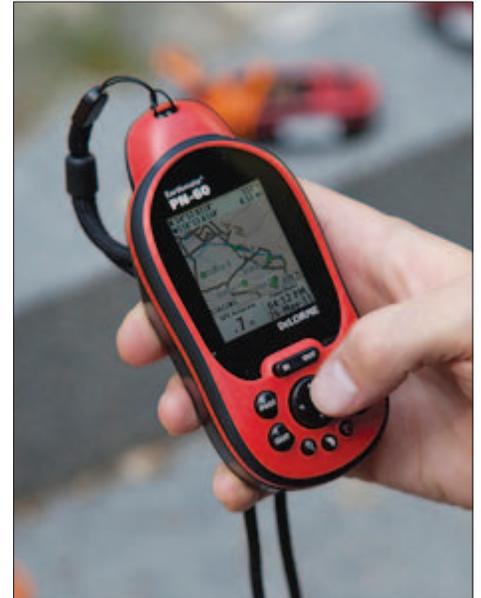
Measuring Distances, Tree Heights, and Crown Widths, by Laser Technology: While using the TruPulse 360 compass laser, participants took basic field measurements using built-in targeting modes for measuring through dense brush or with background obstructions. They also used a Criterion RD 1000 Electronic BAF-Scope/Dendrometer to take timber inventory measurements.



GIS Mapping with Lasers, GPS, and ArcPad, by Laser Technology: A laser expert showed how using LTI lasers with the Laser GIS software extension for ArcPad improved connection and flexibility. Participants learned the value of GPS laser offsets, collected height attributes, and performed traverse mapping.



High Yield Data Collection, by Trimble GIS Data Collection Group: At this lab, a GIS-GPS specialist helped foresters use the Trimble Floodlight technology GeoExplorer 6000 to collect data. Beneath the garden's thick canopy, the handheld device collected data and boosted accuracy where normally only low-accuracy data is possible.



Basic GPS Data Collection and Navigation, by DeLorme: Participants used the DeLorme PN-60 series GPS unit for basic navigation and a track area calculation exercise. The device was preloaded with multiple types of data, allowing foresters to experiment with the utility of data layer choices including color imagery, USGS quad maps, a GIS data layer, and DeLorme topographic base data.



Mobile Mapping Anywhere, by Esri: Esri's wildland fire specialist directed a wildfire scenario exercise using ArcGIS on a rugged PDA. Cellular Internet connectivity is not always available in remote locations where wildland fires burn. Participants transmitted and received field data through a Wi-Fi connection using an Inmarsat BGAN terminal. After synchronizing their data with ArcGIS for Server, their edits instantly appeared in a common operating picture.



Streamlining Forest Inventory Data Collection, hosted by LandMark Spatial Solutions LLC: This lab focused on streamlining workflows, collecting inventory data, and using analytics for accuracy by using the SilvAssist toolbar in ArcMap and LandMark forest inventory data collection tools loaded with Esri ArcPad software. Foresters learned to collect inventory data in the field using streamlined workflows and analytics for accurate reports.

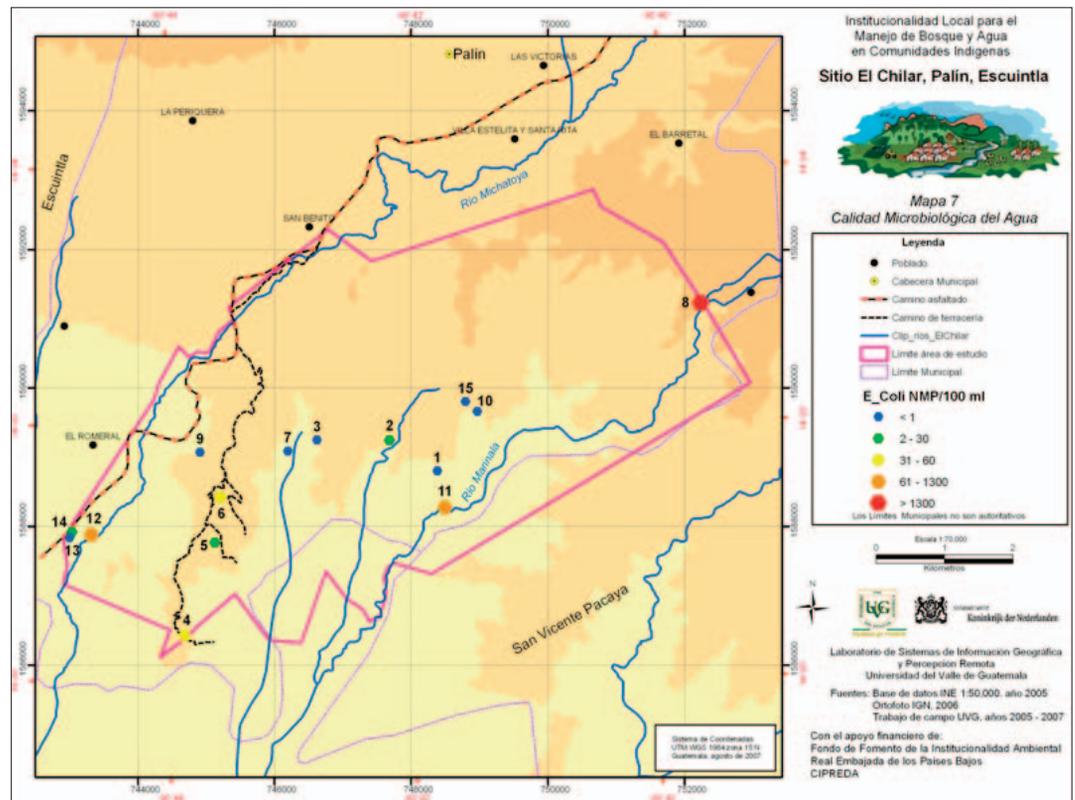


Rapid Deployment of Geotagged Photos and Reference Data during a Wildfire, by Wind Environmental Services: Learning some advanced methods of using geotagged photos for data collection, users set up and took photos using high-accuracy GPS and geotagged them with attributes. They took offset photos using a laser range finder and the Wind Image extension for ArcGIS.

# IFRI Maps Forest Health for Sustainable Management

By Rachel Kornak, IFRI GIS and Database Manager

International Forestry Resources and Institutions (IFRI) is a network of researchers that uses a common methodology to collect ecological, social, and institutional data about community forests and the people who depend on them. The partner network is made up of universities and nongovernmental organizations in 13 countries in North America, Latin America, Eastern Africa, and Southeast Asia. In 2008, Esri awarded a grant to IFRI for the use of ArcGIS and ArcGIS Spatial Analyst and on-line training, which IFRI made available to its network partners for a variety of projects around the world. Forestry projects from Guatemala and Kenya exemplify the success of IFRI's GIS outreach.



This map shows levels of *E. coli* found in water samples collected in the rivers and springs within the communal lands. The presence of this bacterium is an indication of pollution by fecal material. The blue dots indicate locations where the water is safe for drinking.

## Guatemala Project

Researchers from the Center for Environmental Studies, Universidad del Valle de Guatemala, worked with IFRI to study ways that indigenous communities in Guatemala manage natural resources, particularly forest and water.

The project used GIS, remote sensing, and IFRI social and ecological field data to under-

stand how forests changed between 1996 and 2006 within six communities in Guatemala. The project was led by principal investigator Edwin Castellanos and was funded by the Embassy of Netherlands, Guatemala. Six communities were chosen to represent the diversity of forest and land management practices found in the country. For each community,

the team used ArcGIS to generate maps showing project location, populated centers, forest plots, current land use, changes in forest cover, conflicts in land use, and water quality.

Researchers shared these maps with each community at workshops to help its residents understand key issues such as the extent of its territory, the amount of forest cover lost in the



IFRI researchers facilitate community mapping exercises.

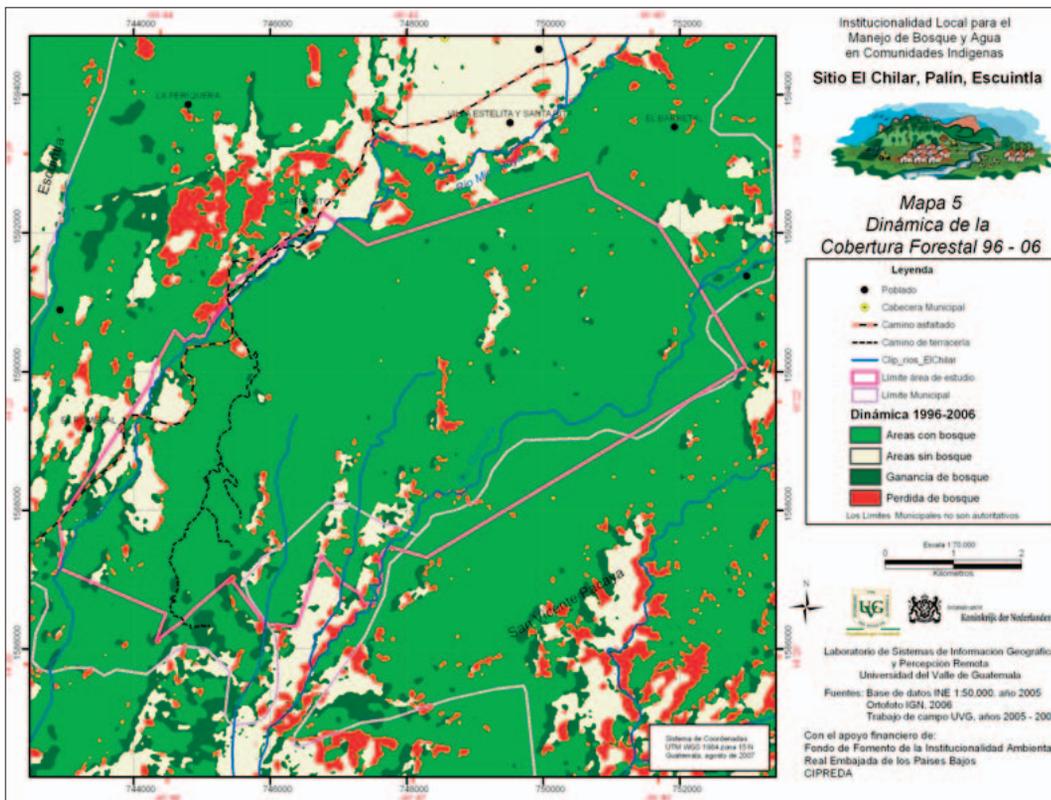


Data collectors plan strategies.

last 10 years, and the quality of the water collected from the springs supplying the community. Residents were better able to understand the state of their local resources, develop a stronger sense of ownership of their land, and take action to increase the value of those resources. This knowledge helped them better manage their forests.

## Kenya Project

IFRI's Kenya project coordinator Paul Ongugo and GIS



This map shows forest cover change. The magenta line is the delineation of the communal land, red areas indicate deforestation, and dark green areas designate forest regeneration.

technician Samuel Kimani used GIS to study changes in two forests in Kenya. The Arabuko-Sokoke Forest covers 43,000 hectares, making it the largest intact coastal forest in East Africa. It is only a small remnant of the indigenous forest that once dominated Kenya's coastal fringe. The Upper Imenti Forest reserve, located on the slopes of Mt. Kenya, covers 6,000 hectares and is made up of dry olea, a protected hardwood species. These forests are managed by the government and used by local communities for honey harvesting, pole and post cutting, charcoal burning, herbal medicine collection, firewood harvesting, and open land farming. Lacking a sustainable harvesting schedule, they are consuming the forest faster than it can regenerate.

The IFRI team used ArcGIS to measure and map changes in forest health from 1986 to 2006 for both forests. Satellite imagery and ground attribute data using GPS taken during this period were overlaid on existing base-maps to show likelihood, severity, and actual

forest damage. During forums and capacity-building workshops, the team presented results to the communities that manage and exploit the forests by using maps to show how the communities' extraction of forest products directly affects forest health.

In a follow-up study, comparing field data collected at both forests in 2000 and 2010 indicated improvements in grazing, human and wildlife conflicts, forest fires, and vegetation regeneration. "The study confirmed that GIS is an important tool in visualizing what would otherwise not be possible to capture using other conventional tools used in the natural resource sector," said Kimani. "It is a good tool for changing community perceptions on the severity of resource degradation and gaining community acceptance for proposed remedial actions."

#### IFRI Training Program Puts GIS in the Hands of Researchers

IFRI wants to make GIS more accessible to scientists and project teams to answer questions,

grow insight, and better communicate with local communities. Although some IFRI research partners have made significant progress toward this goal, others need ArcGIS training due to the complexities of learning ArcGIS for Desktop software and lack of specific examples on how they can use the technology to improve their research. The author developed ArcGIS training workshops for beginners that were customized for specific projects and used real IFRI data. Students learned to use ArcGIS Explorer for analysis.

In January 2011, IFRI network members gathered in Hyderabad, India, for their biennial network meeting. The author led two GIS workshops demonstrating specific ways researchers could use the software

to explore data, perform spatial analysis, and share information. Soon, conference members from Ethiopia, Tanzania, Kenya, India, Nepal, and Germany were experimenting with search tools to locate their study forests. Next, they added World Imagery and OpenStreetMap basemaps from ArcGIS Online, created new polygon boundaries of forested areas, and added points for site features such as village locations. Students experimented switching between 2D and 3D views. In Kenya, some IFRI sites are next to Mt. Kilimanjaro, so looking at this terrain in 3D was quite interesting. The instruction helped participants create interactive mapping presentations of their research sites. They also created KML files for sharing their GIS data layers and maps with other online users. IFRI plans to create a series of more advanced lessons.

Learn more about IFRI at [umich.edu/ifri](http://umich.edu/ifri), or send questions to [ifridatahelp@umich.edu](mailto:ifridatahelp@umich.edu).

# First Esri Forestry GIS Solutions Conference Tracks Trends

By Matt Ball, V1 Newsletter

The first Esri Forestry GIS Solutions Conference took place May 24–26, 2011, at Esri headquarters in Redlands, California. The community of Esri forestry users is more than 1,000 strong, with more than 250 conference attendees from 13 countries. The event program highlighted the increasing focus on sustainable development practices, the accounting for ecosystem services, the use of lidar, advances in fieldwork with tools to bring GIS into the field, and the emergence of full online GIS.

## Government Forestry Data

The comprehensive management of forestry lands in the United States involves 750 million acres of forestland, with 193 million acres in the public estate. The rest is privately held and managed by 11 million owners with federal and state oversight. The effort to manage those lands relies heavily on imagery and GIS to visualize and help landowners understand policy objectives, according to James Hubbard, deputy chief for state and private forestry, Forest Service. When the objectives are conveyed precisely, with weighting of risks and benefits, the management trends move mostly toward conservation and sustainability.

The forest industry has moved away from timber harvest as the main driver of management. At the height of timber harvest in the country, 12 billion board feet were produced per year, and due to environmental concerns, that number has been reduced to 2 billion board feet currently. Protecting the forests for other uses has been more prevalent, but forests not managed closely are more susceptible to fires or insect disturbance. A lot of the disruptions that occur have direct impact on water quality, which is becoming more of

a management objective. Another ongoing management issue is the carbon storage capacity of the forest, with the health of the forest relating directly to the forest's ability to capture and store carbon.

- Forest Inventory and Analysis (FIA) is a long-standing national dataset used to continuously monitor the conditions, species, size, and health of forests.
- The LANDFIRE tool provides a national dataset for the evaluation of risks and threats and the active management of wildfire incidents. Climate change and extended drought have made forests drier than in historical patterns, and the



Keynote speaker James Hubbard, US Forest Service deputy chief for state and private forestry, describes comprehensive land management values.

tool has a 95 percent accuracy rate for assessing threat and risk. LANDFIRE has had a major effect on how the US Forest Service fights fire.

- State assessments, used by all 50 states, set priorities for investment on a landscape scale and are used for forest action plans. Because these independent plans often do not fit together at the boundaries of states, a big issue is the integration of plans that represent multiple objectives. Coordination and consistency are ongoing challenges at the agency.

## Ongoing Education and Outreach

Michael T. Goergen, Jr., executive vice president and CEO, Society of American Foresters, addressed the need for ongoing education given the changes in management practice. The focus on sustainability has a large underpinning in this change. The focus has shifted from the stand to the landscape and looks at all the resources that a forest provides.

The technology has also helped foresters work more closely with people to help them understand all the benefits of forestry. It helps describe the management of a landscape and convey how using forestry can make the world a better place. The tools model what the future

can be for this important resource, and through mapping and modeling, support from the community is gained that allows foresters to do their work. The power of the tools really comes into play when members of the community become the advocates for the landscape management practices that are in place.

The Society of American Foresters has 13,000 members, but membership is declining as forestry program enrollment decreases and natural resources and

environment degrees increase. The academic shift to more holistic management of land isn't directly related to employment and job opportunities, so the organization feels the need to better relate the work of foresters to the shift toward sustainability. The use of computers and modeling within the industry is a strong incentive for incoming workers.

## Changed Management Practices

Neal Ewald, vice president of California operation at Green Diamond Resources, the California Redwood Company, spoke about how far we have come in terms of environmen-

tal management in the forest industry. The photo representation of clear-cuts in redwood forests—displaying old caterpillar tractors cutting roads wherever they could reach and leaving the land barren and unremediated—provided the “pin-drop” moment of the presentation. These practices led to outrage and a dramatic change in how forests are managed.

As a result of the need to manage impacts, the company created a fish and wildlife department to demonstrate in a scientifically valid way the habitat management plans for forests. Conservation planning is now a huge part of the operation, with broad changes including cuts that retain 25 percent of the forests. The strategy of leaving a lot of trees on the landscape is designed to protect and improve watersheds and terrestrial species.

Among the changed management practices are

- Moving away from tractors on the landscape that leave skid trails, driving erosion and impacting water quality, toward shovel logging
- Replacing helicopter spraying of herbicides with on-the-ground single applications that decrease the cost by 50 percent
- Reducing the road system to one lane and remediating erosion events

The heavy management of forests trades off the landscape of devastation, going from war to peace in conservation efforts. Redwood is heavily managed because heartwood sells at a 50 percent premium in the market. The company is trading off knowing more about the forests so that yields are high, because it can charge that premium. The expectation of higher returns provides the benefit of investing for the future.

### From Images to Models

Generating an accurate 3D model of the earth’s surface with lidar has many advantages over imagery, given that it is a move toward modeling as opposed to just a photo. The rich information provides three main deliverables—a digital surface model (DSM), a bare earth or digital terrain model (DTM), and the

lidar intensity image. Measuring intensity of return allows foresters to classify coniferous from deciduous trees and decipher nuances such as concrete versus asphalt.

Lidar can be recorded day or night, but there are limitations. For example, lidar does not work above clouds or after rain, and returns are best during leaf-off periods from late November through early May in much of the northern hemisphere for bare-earth models.

Good vegetation mapping requires high-density lidar. With the details returned, forest height can be classified and analyzed for stand delineation. Lidar minimizes the number of field plots taken, reducing costs and field times. The semiautomated method of lidar also allows forest-scale mapping in very little time.

Integration of imagery and lidar produces valuable information for forest management and has applications for carbon accounting to understand the ecosystem services of forests. Lidar is a critical component for more accurate measurement of logging practices and emission and carbon sequestration calculations.

The true 3D data from lidar is a good tool for study of canopy information on height and percentage of cover, 3D visualization of ground and land cover, and analysis of slopes and the impact of forestry practice. We are in the early days of understanding how this relatively new technology can be effectively used for natural resource management, and many more tools, processes, and insights are sure to come.

### Esri Tool Evolution

Jack Dangermond, founder and president of Esri, addressed the start of the company with the audience. GIS as a science-based framework to inform better decisions is changing how people work. In the forestry community, it aligns with resource management, carbon accounting, sustainable forest management, workforce management, and field operations.

Trends within the geospatial technology sector are that networks are getting faster, measurement is becoming pervasive, real-time data is common, software is more open

and robust, geographic science is driving tools and analysis, and open data policies are providing new ways of looking at government metrics. This is all leading to a better knowledge of how the world works, with greater consciousness of the interconnected nature of systems.

GIS professionals are also building knowledge and sharing it in new ways, with data sharing across the Internet and on mobile devices, publishing data in applications, and developing more collaborative tools and ecosystems. Intelligent web maps encapsulate knowledge and make geospatial data come alive. By simplifying, and *mapifying*, data, users provide a visual abstraction that takes complicated issues and makes them simple and more easily communicated.

Social media and real-time feeds are turning into a new kind of media. The easier it is to share information, the more collaborative things become, and when it comes to government, there is more access and interaction.

GIS today is primarily implemented on the desktop; it’s increasingly on servers, and it’s becoming more federated at the enterprise level. The new patterns are on the web with cloud services and on devices with greater interaction. The vision is not to have different stovepipes of these patterns but to have users accessing and interacting at all these different levels.

The first Esri Forestry GIS Solutions Conference was a good balance of technical and policy direction for this growing community and drew an impressive international audience. There are already plans to repeat the event in early May 2012 at the same venue. Given the many changes under way in landscape-scale forestry management and the evolution of the GIS toolset to tackle these challenges, this will be an event not to be missed.

This event recap first appeared in *VI* magazine ([VI magazine.com](http://VI magazine.com)).

## USDA and Esri Build Geospatial Portal Mapping Service

The US Department of Agriculture (USDA) and Esri worked together to implement a fully cloud-based geospatial portal. USDA's prototype portal, Enterprise Spatial Mapping Service (ESMS), is built with Esri's new product Portal for ArcGIS, managed by Esri, and hosted on the Amazon cloud within USDA's web environment.

Stephen Lowe, geospatial information officer for the USDA Enterprise Geospatial Management Office, and Esri product and professional services teams designed the prototype's geospatial interfaces with a focus on search and discovery, managed service hosting, and web service publishing of USDA-owned data. The portal introduced GIS productivity services for provisioning and consumption of web map services and the capability to geoprocess, display, and analyze data. The private cloud GIS makes the central repository for authoritative content accessible to users within the department as well as other public agencies. ESMS provides a platform to

- Quickly create maps and apps using templates and web mapping APIs.
- Form groups to collaborate on projects or common activities.
- Exchange maps and apps with private groups or the entire organization.
- Embed maps and apps in custom web pages or blogs.
- Eliminate transaction costs in reusing and repurposing spatial assets.

USDA and other external government agencies go through the portal to access valued agricultural datasets and maps from a browser and perform spatial analytics. Esri Managed Services maintains and supports the GIS and infrastructure for USDA. Users have the same collaboration and sharing tools as those provided in the public cloud mapping environment ArcGIS Online, but the site retains the USDA customization and brand. Esri's Portal for ArcGIS is a geospatial content management system that can be hosted on premises or as an off-premises cloud environment to provide a private, multitenant, geospatial content management system. USDA will soon integrate its security environment e-Authentication access and identify control system with the private cloud solution to extend the platform's value to diverse user requirements.

In May 2011, the prototype USDA portal was tested at the New Madrid National Level Exercise, which is an event for assessing and developing regional catastrophic response and recovery capabilities. USDA representatives from the Animal and Plant Health Inspection Service (APHIS), Farm Service Agency (FSA), Natural Resources Conservation Service (NRCS), and other USDA agencies worked within the ESMS portal environment to rapidly create, locate, and elaborate on disaster response spatial presentations, templates, and briefings. Furthermore, the single ESMS portal framework enabled USDA to crowdsource complex map product design and development problems among multiple subject matter experts to quickly benefit from enterprise solutions and knowledge.

Learn more about Portal for ArcGIS and see examples at [esri.com/software/arcgis/portal-for-arcgis/](http://esri.com/software/arcgis/portal-for-arcgis/).

## Esri Career Opportunities

### Consultant/Project Manager

#### —Natural Resources/Environmental

Help clients transform real-world needs into state-of-the-art, GIS technology-driven solutions. Lead project teams and manage the entire GIS implementation process.

### Agriculture Industry Solutions Manager

Assess and identify practical applications of GIS for agriculture. Coordinate and manage Esri's strategic marketing and solutions efforts as they relate to the development and use of GIS products and services within the agriculture market.

Learn more and apply at [esri.com/careers](http://esri.com/careers).

## Save the Date

### 2012 Esri Federal GIS Conference

February 22–24, 2012  
Washington, D.C., USA  
[esri.com/fedcon](http://esri.com/fedcon)

### Esri Partner Conference

March 24–27, 2012  
Palm Springs, California, USA  
[esri.com/events/partner-conference](http://esri.com/events/partner-conference)

### Esri Developer Summit

March 26–29, 2012  
Palm Springs, California, USA  
[esri.com/events/devsummit](http://esri.com/events/devsummit)

### Esri Forestry GIS Conference

*Hosted by the Esri Forestry Group*  
May 1–3, 2012  
Redlands, California, USA  
[esri.com/events/forestry](http://esri.com/events/forestry)

### Esri International User Conference

July 23–27, 2012  
San Diego, California, USA  
[esri.com/events](http://esri.com/events)



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