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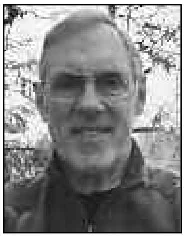
Emerging Technologies in Forestry

BY MICHAEL RENSLOW



I am not much of a gadget person, but emerging technologies based on fundamental measurement principles are completely addictive to me. I have experienced a rich and rewarding career in the geospatial sciences, and have witnessed and been part of mapping and measuring the Earth and the features above bare ground for the past 48 years. By the way, mapping the bare ground and visualizing is still one of the most sought-after features in our work as mappers and forestland managers.

This issue of the *Western Forester* is focused on emerging technologies that are of value to the forestry community. Although I am not a forester, I did work for the US Forest Service for 12 years and supported foresters with mapping to supplement and categorize their fieldwork. That work included quite a lot of long focal length aerial photography, field surveys, base mapping, and management unit maps. In those days, we had difficulty mapping areas with dense timber in steep terrain.

In my career, there have been a few milestone technology game changers that need to be mentioned as they fundamentally changed the methodologies we utilize today. GPS became available in 1979, and although of variable accuracy and relative difficulty in its infancy, it has now become a positional tool used throughout the world and integrated into millions of devices from sophisticated surveying instruments to smart phones. With the addition of inertial measurement, the GPS/INS combined technology allows for real-time positioning in motion whether ground-based or airborne.

PHOTO COURTESY OF COLORADO STATE FOREST SERVICE

Improving technology allows foresters to generate a map from an information portal application and view it on a tablet with a cooperator in the field.

The Internet, World Wide Web, and computing power essentially changed our ability to share data and obtain information for almost anything we desire to know. We have integrated these tools professionally, socially, and personally. For geospatial practitioners, data collection, processing, analysis, and reporting was fundamentally accelerated and reinvented in a generation. More intriguing is the use of these technologies in handheld devices, wearables, and nearly anything that moves. The development of cloud storage and computing is rapidly changing our ability to store and process data in near real-time.

Lidar became commercialized in the mid-1990s. Although somewhat complicated and expensive to operate, the potential was very attractive. In the fall of 1997, I recall using a "dense" lidar dataset with one point per two meters and overlaying multiple-return lidar in 3D over digital stereo photography of the McDonald-Dunn Research Forest north of Corvallis, Ore. I could not see the ground that was out of sight under the tall trees, but there were lidar returns near the top of the canopy as well as 3D points within the canopy and on the ground. Until lidar became available, the "best" mapping solution was photogrammetry; it only took a few years for lidar to

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In This Issue: Changing Technology and Mobile Applications

Emerging Technologies in Forestry

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be the technology of choice. Today, the Northwest is a leader for availability of high-density lidar of forestland and demonstrates the value of lidar for forest management.

With this background, I have some comments related to emerging technologies that utilize many of the technologies and resources mentioned above. The commercial examples I refer to are just that—examples; I am not endorsing any specific firm or product.

Figure 1. An example of an sUAS quad-copter equipped with an imaging system.

Small Unmanned Aerial Systems (sUAS)

Although in use for the last several years, sUAS have become the hot topic at conferences and tradeshows, and in publications. These inexpensive platforms combine remote sensing, photogrammetry, and GIS for a portable and flexible data collection system requiring very little training and overhead. Compared to traditional aircraft/sensor models and the accompanying expertise and costs, the owner/operator model is changing especially for small projects requiring data quickly. For a small woodland owner, sUAS are a very powerful solution for forest assessment and health data. For a larger landowner, sUAS are effective for data acquisition of a watershed or management unit.

Figure 1 is an example of an sUAS quad-copter equipped with a digital camera, GPS/IMU, flight planning software, a tablet remote with a joystick (using GoogleEarth™ imagery for planning and sUAS positioning), and a suitcase for portability—for a cost of about $2,000. There are about 30 firms in the US that manufacture sUAS systems, and several firms offer inexpensive mosaicking and georeferencing software and services to handle image data processing. Riegl USA now offers a lidar sensor/software specifically designed for sUAS.

In the United States, sUAS can be operated on a hobbyist status (must follow FAA standards), but not for commercial use unless approved by the FAA. Regulations are being developed. Internationally, sUAS are in wide use for a variety of applications including vegetation analysis, hazardous site evaluation, precision agriculture,

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Next Issue: What is the Future of Multiple-use Forestry?

emergency response, journalism/movies, real estate, and utility corridor mapping.

Lidar

Lidar is the most rapidly growing 3D technology, predicted to grow at 15% per year. Terrain analysis, forestry, and civil engineering are the top applications. In addition to accurately measuring and defining the bare earth, identifying and classifying hydrology, and tree measurement, high-density lidar is being combined with ancillary data, such as color/infrared/hyperspectral imagery and terrestrial lidar data to model the characteristics of individual trees. Software has been developed for analysis, 3D visualization, and model building for input in a GIS (for example, GeoCue's LP360© with Esri's ArcGIS©).

Lidar is widely accepted as the technology of choice for creating Digital Elevation Models and feature extraction (National Academy of Sciences Report, 2011). The US Geological Survey has produced a *Base Specification for Elevation for the Nation* based on lidar acquisition and processing to assure consistent data collection and post processing.

The next breakthrough for the forestry community is to be able to quickly and inexpensively process the full waveform of the lidar pulse. Every lidar pulse is composed of a waveform of light, but to capture the full set of waveform returns increases the file size by about 32 times (big data sets!). Most of the waveform processing is currently being conducted in the research community—a few equipment providers have waveform software available.

The advantage of full waveform data is that 3D values can be captured every 15 cm, so you can collect 10-20 returns per pulse. A typical pulse in a mature forest would yield returns near the tree top, within the canopy and on the ground. For "mapping" the live canopy, estimating fuel loads, separating understory from overstory, identifying wildlife habitat, etc., these rich data sets are ideal.

Flash lidar

Flash lidar began commercialization in 2010 and is being operated by a small group of US firms. This technology is quite different from scanning lidar systems currently in wide use. Flash lidar is an array of "lidars" similar to a Charged Coupled Device, or CCD, array of pixels, i.e., a raster configuration of lasers. The most common flash lidar being used has an array of 127 x 127 lasers (that is, 16,200 lasers). When a pulse of energy is sent to the sensor (30 times per second), the lasers "flash" and 500,000 pulses per second are emitted. The lidar returns are very similar to traditional systems with a point cloud of returns and intensity data. The greatest advantage of flash lidar is that there are no moving parts in the system, and since the geometry of the focal plane has been measured and defined, the data can be processed very quickly. In addition, flash lidars are small, lightweight, and portable. Today, there are two new flash lidars being developed at 228 x 228 lasers, and 329 x 329 lasers. A new prototype flash laser is in development at a relatively low cost and may be incorporated into a mobile, handheld device (see Figure 2).

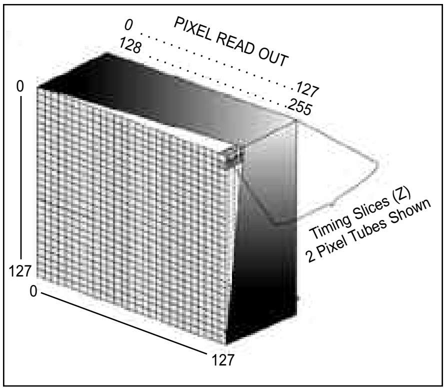

Figure 2. An example of the flash lidar data cube.

Another laser application is the Spike© Laser Smartphone App that is a 3 oz attachment to the phone. The system includes a laser rangefinder, 3D compass, and Bluetooth chip that is linked to the phone's camera and GPS. This app captures a photo of the object and the hardware measures distance, direction, and volume. The data is sent to the phone via Bluetooth.

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Figure 3 is a demonstration of the Spike App.

These technologies are useful to the forestry community. It is likely that having an sUAS coupled with a laser sensor and an imaging system that is portable and reliable could provide information quickly and inexpensively.

Big Data

Did you know that 90% of the world's data has been created in the last two years (*Inside Quality Insider*, 01/14)? The data sets we use every day in our GIS, image processing, and lidar analysis are getting larger and more complex, and traditional storage, retrieval, searching, sharing, transferring, analysis, and visualization is a growing challenge. In mapping, we hardly ever throw anything away. At this rate of data creation, we will have created 2,300 times more data in the next five years.

For production resource mapping, the cloud is likely not fast enough to support efficient processing, but the cloud is well suited to data archiving. However, the cloud is not free and the cost of using the primary cloud services (e.g., Google, Amazon, Cisco Systems) can be cost prohibitive. Big Data management will continue to challenge our storage capacity/retrieval operations. ArcGIS Online is a relatively successful model for storing data and building project files.

Figure 3. A demonstration of the Spike App on a smartphone.

For the mapping and forestry community, the one common thread is that our data is identified with a spatial characteristic.

Satellite remote sensing and georeferencing

The availability of very high resolution Earth Observation Systems is quickly becoming a reality with a new generation of private firms. The traditional launch process is being replaced with firms such as Space-X. For wide-area coverage, one-meter resolution imagery at a competitive cost would be useful for area-wide assessment, such as a national forest or a tree farm.

Google's Loon Project is based on high altitude balloons with Internet connectivity at a 20-mile altitude. Adding Earth Observation to this project is being considered.

Conclusions

I believe that as practitioners in the geospatial sciences we live in a very special era. We can perform the work we love and have proven technologies that support our requirements for base accuracy (maps, digital earth models, spatial relationships) with thematic data (vegetation, land management decisions, resource information, and legal requirements). We can organize all of this data and information in a spatial environment to be accessed on the desktop or in the field. And, we have systems available that are scalable by size and cost. One can only wonder what emerging technologies will be developed and shape our future. ◆

Michael Renslow has 48 years of experience in the geospatial sciences. He has worked as a surveyor, cartographer, photogrammetrist, and teacher. He currently is the technical editor for Photogrammetric Engineering and Remote Sensing *and teaches a lidar class for Penn State University's World Campus. He is an ASPRS Certified Photogrammetrist and an Oregon Registered Professional Photogrammetrist. He can be reached at renslow76@comcast.net.*

How to Make the Most of Your Mobile Technology Choices

BY KERRY HALLIGAN

Mobile technologies are everywhere in our personal and professional lives. According to Pew Research Center (2014), 43% of American adults own a tablet and 58% own a smartphone. Numbers are even higher for specific age groups, with 83% of adults aged 19 to 30 owning smartphones. The rapid advancement of mobile technology has brought with it a dramatic expansion of computing power, display capabilities, and software options. In the past, foresters' requirements for mobile technologies (e.g., local database support, GPS integration) were drivers of mobile technologies. Today, these requirements are common capabilities of mainstream consumer devices.

Despite these advances, mobile technology choices still pose significant challenges due to the constant barrage of new devices, the ever-changing landscape of mobile operating systems and applications, data and device management costs, and security concerns. Additionally, the rate of technology advancement, combined with inexpensive devices and users' expectations of device upgrades, mean that forestry managers can no longer expect that an investment in any particular mobile technology will be a long-term investment.

As forestry consultants, Mason, Bruce & Girard (MB&G) is often asked to help our clients navigate the mobile technology landscape by recommending operating systems, devices, applications, back-end technology, and workflows for mobile computing. As a general rule, we recommend a requirements-driven, rather than a technology-driven, approach. A requirements-driven approach begins with careful consideration of the anticipated uses

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of mobile devices and the full life cycle of mobile applications and data. Mobile technology requirements can be grouped into three major categories: device, application, and data management (see Figure 1). While each of these categories could warrant a full-length article, the sections below address some of the key requirements and considerations for getting the most out of your mobile technology investments.

In forestry, device requirements often take precedence over other considerations. If a mobile device isn't reliable and easy to use in the field, it may result in poor quality data or data loss, or it may simply go unused. The best way to begin is to clarify how mobile devices will be used and by whom. For example, will users need to operate this device all day in the rain, or will it be mainly used inside a vehicle where battery life, water resistance, and sunlight readability are not an issue? How large (or small) does the device need to be in order to meet application tasks while still being sufficiently portable?

In general, mobile devices can be broken into three major categories: (1) consumer-grade devices; (2) moderately rugged devices; and (3) certified rugged and/or waterproof devices. Consumer-grade devices are the standard mass market mobile devices sold to the general public. Consumer-grade devices offer a greater range of devices, lower prices, and the most recent technology. These devices may be limited, however, in their suitability for the harsh working environments common in the forest industry.

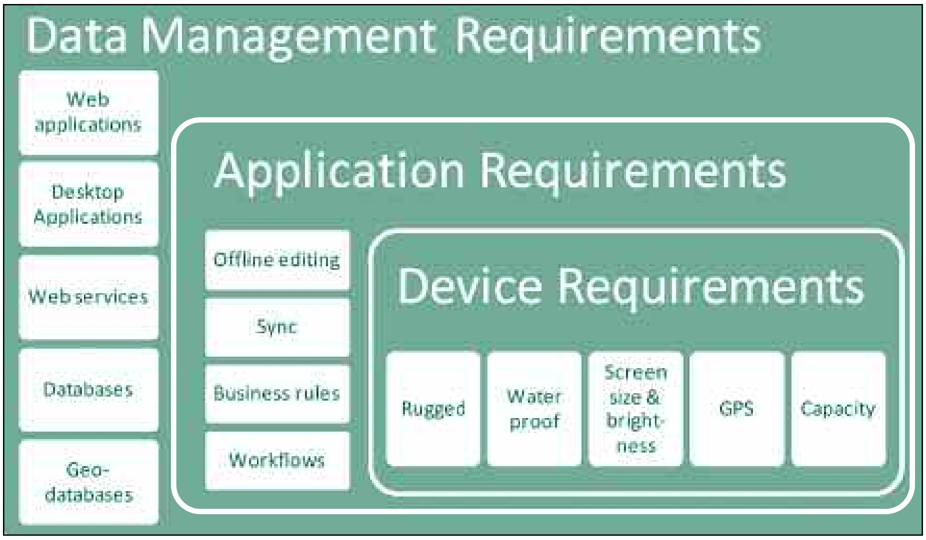


Figure 1. Data Management Requirements. SOURCE: MB&G

The topics of ruggedness and water resistance often dominate discussions regarding mobile devices for forestry. When devices will be used mostly for intensive field applications such as timber cruising, a rugged device is likely needed. In wetter regions, water resistance, if not complete waterproofness, may be required for field operations. However, device costs are two to three times higher for rugged devices and device capabilities (e.g., processor, memory, operating system) are typically one to two years behind those of consumer-grade devices. Given these drawbacks it is important to consider what level of ruggedness and water resistance is really needed. Limited ruggedness, for example, can be achieved through aftermarket cases. Some cases for popular devices are even waterproof, as are a few consumer-grade devices. Even where rugged or waterproof devices are mandatory for some foresters, there may be other staff who perform much of their mobile device activities in or near their vehicle, or who conduct most of their field work when it isn't raining. One strategy, therefore, is to deploy multiple devices such that users who truly need rugged or waterproof devices have access to them while other users take advantage of cheaper and more capable devices.

Another common device requirement is GPS. Today, nearly all mobile devices support GPS, and many support GLONASS. However, inferior antennae and less sophisticated software can limit GPS accuracy in mobile devices. For many forestry applications, onboard GPS will be sufficient for providing location awareness, tracking travel paths, and collecting plot data. Where more accurate GPS is needed, Bluetooth GPS units ranging from inexpensive "pucks" to survey-grade systems can be easily connected.

A final, but often important requirement is support for external storage, typically in the form of MicroSD cards. This capability extends the storage capacity of devices and plays an important role in efficient data management by allowing users to quickly copy large datasets to mobile devices.

In forestry, a major requirement for mobile applications is the ability to operate offline. A wide range of applications that support generalized data collection and mapping functionality when online are available. Choices rapidly dwindle, however, for highly specific and complex field data collection activities or when large quantities of data must be visualized and edited while working offline. A primary requirement for forestry mobile applications is the ability to easily move data to and from the device using data synchronization for operational data and external storage for base maps and other large datasets. Applications should also store and quickly display a large volume of data, including high resolution aerial imagery, lidar and lidar-derived data (e.g., elevation, hillshade, contours), roads, streams, stand boundaries and inventory data, and assets (e.g., gates, culverts, equipment). Applications should support data collection using robust user interfaces that enforce data rules, such as required fields, selecting values from pre-defined lists, restricting values to specified data ranges, and tracking of users and edit dates. Mobile applications for forestry should also provide analytical capabilities such as the ability to search for features and measurement of distances and area. Finally, they should support a range of navigation functions, such as providing the distance and azimuth to a selected feature and tracking of your travel path.

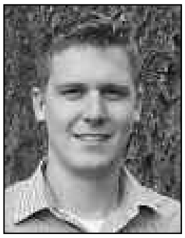
The main reasons for investing in mobile technologies include improved efficiency in the field, higher quality data, reduced data preparation and data processing time, and better access to data throughout the entire organization. For these goals to become a reality, mobile technologies must be backed by robust data management capabilities. This means that data should be stored in enterprise databases and published using web services. Enterprise databases provide scalable multi-user data storage that helps to ensure data integrity, while web services, a prerequisite for data synchronization, enable data access to mobile, desktop, and web applications. For spatial data (e.g., stands, inventory plots, harvest boundaries), this can be achieved using Esri's enterprise geodatabase technologies (ArcSDE) coupled with ArcGIS for Server or ArcGIS Online.

When foresters have access to sufficiently rugged devices, easy access to all of the supporting data they need, and efficient field collection applications they will gladly bring mobile technologies into the field and will collect more detailed and accurate data. When they can effortlessly sync these data with enterprise databases they can receive up-to-date information, more easily collaborate with their coworkers, and provide operational insight to their managers. Under this increasingly common scenario, organizations are able to reap the often-touted rewards of mobile technology for the forest industry. ◆

Kerry Halligan is a software developer with Mason, Bruce & Girard, Inc., a natural resources consulting firm in Portland, Ore. He builds and supports a range of desktop, web, and mobile applications and is the lead developer of MB&G's MobileMap offline mobile GIS software. He can be reached at khalligan@masonbruce.com.

Selecting the Best Forestry Related App for Your Phone or Tablet

BY TYLER GAKSTATTER



Millions of smartphones and tablets are in the hands of people across the world. It would be foolish not to utilize these devices because they are available and cheap. By contrast, a typical rugged handheld device will run from $1,000 to several thousands of dollars. For many of us, we already have a smartphone or tablet running either the Apple iOS or Android operating systems, so why not utilize it?

Android and Apple iOS are successful operating systems because they provide a software environment that can run applications written by a large number of potential programmers. These two environments have armies of third-party programmers wanting to develop new applications. As time goes on, more people will adapt to using smartphones and tablets in the field for GIS and forest inventory data, and all kinds of different apps ranging from niche functionality to full-featured do-it-all programs will be available.

Most people start the process of implementing a data collection system by choosing the hardware first, which usually isn't a good idea. It's better to start by determining the type of data to be collected. Here are the questions to ask yourself when making your decision to purchase and implement a data collection system:

- What type of data do I need to collect?
- Which app(s) will collect that data?
- What platform does the app run on?
- Which device best suits my needs (phone, tablet, big screen, weatherproof)?
- What is my budget?

It is important to spend time determining the type of data you want to collect. Maybe you want GIS data such as points, lines, or polygons. Some users want point data collected with an extensive amount of attribute data. Some apps are limited on how much attribute data can be recorded. For other users, the data requirement is tree measurement data for forest inventory or timber cruising.

Following are several forestry-related apps available for a variety of devices and platforms. These apps are the most commonly used GPS, inventory, and mapping applications in use by foresters at this time.

Fulcrum is a digital data collection platform for the web, iOS, and Android that allows you to rapidly deploy custom forms and mobile apps for conducting surveys, inventories, and inspections.

The Fulcrum app is a barebones platform that uses custom-made apps (similar to forms) to collect GIS data. These apps are created on the web and then pushed out to any number of devices. Fulcrum is a great solution for enterprise businesses; however, there are limitations. Fulcrum is unable to collect lines and polygons in the field and the background imagery cached is quite limited when a data connection is not present. Fulcrum is Sold as a Service (SaaS) with a monthly subscription. See http://fulcrumapp.com/features/.

iCMT GIS is inexpensive (less than $100 on the iOS app store) and is full featured. This app was designed for collecting data in a shape file format (points, lines, polygons) for any iPad or iPhone. It works well with internal GPS receivers or external GPS receivers. This is a great piece of software for collecting extensive attribute data. Attribute fields can even be added after creating the initial attribute table. iCMT GIS is in the cloud or can be used completely independent from the cloud. All of the data is stored on the iPad/iPhone until the user wishes to export it via email. Visit https://icmtgis.wordpress.com/19-2/.

Wolf-GIS is another app that can be independent of the cloud. Wolf-GIS is offered in two different versions: basic and pro. Wolf-GIS pro is a powerful GIS collection tool. Users can collect points, lines, and polygons along with attributes (including photos). See http://wolfgis.com/Default.aspx?tabid=90.

iGeoTrak is an Apple iOS only GIS data collection program that is adaptable to different kinds of projects. Like Fulcrum, iGeoTrak is heavily focused on the use of forms. Think of iGeoTrak as a GIS platform that seamlessly handles GPS, provides a nice user interface, and utilizes forms as data collection templates. Users create forms that are setup to collect a specific set of data. The ability to push forms out to multiple users is a huge plus for enterprise users. There are two versions of iGeoTrak: Collector and Professional.

ArcGIS Collector works with iOS and Android platforms. While commonly referred to as a free app, it does require that the user have an online ArcGIS account and there are fees associated with an account. Collector opens maps published to an ESRI enterprise account. This allows maps to be published online and made available to any number of devices tied to that account. Deploying editable maps to multiple users is a great solution for companies big or small with field personnel. Users can collect points, lines, and polygons, and also work offline.

When deciding on a platform, decisions often come down to the preferred hardware by the individual user. If the user already has an Apple iPhone or iPad, that may dictate the starting point for this process. Some apps have been released on both Apple and Android platforms. In this case, there is usually very little difference regarding functionality and ease of use when using the app on one platform or the other.

Apple iOS devices (iPhone, iPad) provide a very stable operating system. They are noted for high reliability throughout the Apple product line. Android is an open-source operating system that is designed to run on many different devices that use different types of hardware. While this feature allows for more hardware options, it can also introduce inconsistencies between Android devices. The hardware in one device can be different than the hardware in another device, yet the operating systems need to provide the same user experience. Apple iOS doesn't have this problem because it only runs on a minimum number of device models that are designed and manufactured by Apple. Thus, Apple has control over both hardware and software, which helps produce reliable products. Does that mean that Apple is better than Android? Not at all. It just means that these operating systems use different approaches.

In conclusion, users should thoroughly investigate their data collection needs as well as the available apps related to those needs. The list of apps presented here is a tiny fraction of the total available. Existing apps are continually being updated and new ones are being written. ◆

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If you have not renewed your SAF membership for 2015, this will be your last issue of the *Western Forester*. Not sure of your membership status or want to renew? Contact the SAF membership department at membership@safnet.org.

Lidar Sheds New Light on Forest Inventory

BY PETER GOULD AND
JACOB STRUNK

Peter Gould (left) and Jacob Strunk

Lidar (light detection and ranging) is an impressive technology that has a number of applications. The first question many people ask when they acquire lidar data is: "What am I going to do with all of those points?" In our work with the Washington State Department of Natural Resources, we are focused on turning lidar point clouds into products that our foresters and planners can use to protect and manage our forestlands. The tools and techniques necessary to get started are accessible to anyone who can commit some time to learn how to use them; there are even helpful tutorials available on the US Forest Service website at www.fs.fed.us/eng/rsac/lidar_training/.

Lidar is essentially a distance measurement tool. In this article we will discuss airborne lidar, where the lidar system is housed in an aircraft and looks down as the aircraft flies over the forest. There are also applications in forestry for ground-based lidar, where the system is placed on a tripod, truck, or other platform and looks up and side-to-side. An airborne lidar system includes a laser, a sensor that can detect reflected laser strikes, and supporting electronics including a GPS receiver and an inertial measurement unit. The general concept of airborne lidar is similar to that of a handheld laser rangefinder. The amount of time between when a laser pulse exits the unit and when part of the laser pulse returns to the sensor after striking a target is used to measure the distance to the target. However, airborne lidar systems are able to determine not only the distance to the target, but the location of the target by knowing the location of the aircraft and where the laser is pointing in relation to it.

The first product of a lidar acquisition is a point cloud, consisting of all of the returns measured in an acquisition. Each point has an X, Y, and Z (elevation) value describing its location and an intensity value which is a measure of how much energy is reflected from the target. A common density today is 8 pulses per square meter; that's more than 32,000 points per acre. Acquisition costs per acre decrease as the area of the acquisition increases so there are incentives to make the acquisition as large as possible and find partners. Lidar point clouds are typically divided into 1 km tiles to make the computer files (.las file format) more manageable. There is also a compressed file format (.laz format) that can decrease the size of the files. Regardless of formats, it is easy to fill up hard drives with point cloud data.

Lidar is impressive—it is fun to look at the point cloud and recognize roads, stream corridors, and trees. While it is easy for us humans to see objects in the point clouds, a lot of computer processing is needed to create the products we use in natural resources management. One of the most valuable products from lidar data is the bare-earth digital elevation model (DEM). Most lidar contracts require the vendor to deliver a DEM along with the raw point-cloud data. The bare-earth DEM consists of a surface created from lidar points that hit the ground. These "ground-returns" are identified with an algorithm that can remove trees, some buildings, and low-stature vegetation. Bare-earth DEMs are enormously valuable to forest managers and geologists. DEMs are very accurate representations of the ground surface and are often created on 3- or 6-ft grids that can reveal details like roads, streams, historic sites, and unstable slopes. Bare-earth DEMs are used to layout roads and timber sales, among other uses.

With the DEM in hand, we can then obtain lidar heights from the point cloud by subtracting ground elevations. These lidar height measurements are used to measure forest structure. Before we can begin to make use of height information, we must decide how to group lidar points. Two common strategies are to: 1) group points into "tree-objects;" or 2) group points into grid cells like pixels in a GIS raster. The tree-object approach attempts to group the points into irregular objects that represent trees (or groups or parts of trees) and the area-based approach groups the points on a regular grid. The grouping approach will affect how we translate lidar measurements into the forest metrics we use every day like volume, basal area, and trees per acre. The second step in either case is to calculate lidar metrics that characterize the groups of points and relate them to forest metrics.

The remainder of this discussion will focus on the area-based approach. The area-based approach is the simpler of the two as it does not require an algorithm to distinguish tree objects. It also provides raster outputs that are con-

SCREEN SHOT COURTESY OF PETER GOULD

You've acquired lidar data, now what can you do with all of those points?

venient for a variety of GIS analyses. A key tool in the WA DNR toolchain is the FUSION software package developed by Bob McGaughey with the USFS Pacific Northwest Research Station. FUSION can be used to assign point clouds to grid cells and then calculate statistics from the point cloud (the lidar metrics) for each grid cell. Lidar metrics are intended to capture attributes of forest structure that can be related to field-measured forest attributes. Common metrics include maximum height; percentile heights (e.g., the height at which 90 percent of points fall below and 10 percent above); and cover (the percentage of points that strike vegetation instead of ground). FUSION also summarizes intensity values (the amount of reflected lidar energy) that can be used in some cases to differentiate between hardwoods and conifers. FUSION can provide both tabular csv files and raster files.

Now that we have our lidar metrics, we move into the final step: translating them into our familiar forest metrics. In this step models are created and used to predict forest metrics from one or more lidar metrics, typically with linear regression. This step is perhaps the most challenging. Developing predictive equations requires boots-on-the ground to measure ground plots within the extent of the lidar acquisition and a specialized software toolchain to obtain precise plot locations using a high-quality GPS receiver. Picking among the many lidar metrics to use in the models is another challenge and requires a fair amount of experience to select the "best" models. With the appropriate models, lidar metrics can be translated into highly detailed maps of forest basal area, volume, quadratic mean diameter, and other metrics. These data can also be aggregated to the stand, stratum, or any other resolution. The ability to map these metrics with a high level of detail is impressive and we expect it to change the way that foresters plan their activities. For example, foresters can spot features like legacy trees and gaps before going into the field and then can customize their activities based on the different conditions found within a stand, rather than on the stand as a whole.

It is a safe bet that lidar is here to stay and more products from lidar will find their way into our daily work flows. While the lidar point clouds are interesting on their own, the real power of lidar in forest inventory is unlocked by translating the point clouds into highly detailed maps of forest conditions. This process is computer intensive, but doable with the tools and techniques that are available today. ◆

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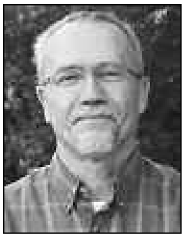
Case Study: Use of Web Portals to Better Manage Wildfire

BY JIM WOLF



Fire season will soon be here—again. While no one knows what the 2015 season will bring, the trend is that the complexity of managing these fires and the associated economic, social, and ecological impacts will continue to increase. Today's fire managers are utilizing improving technology to collaboratively gather, analyze, and share information to better manage wildfires. This article describes how several agencies are taking advantage of smartphones and tablets, cloud computing, and geoservices to better manage wildfires in the west.

Creating situational awareness and improving decision support for managers and fire fighters alike is the purpose of these technological tools. It's why we monitor weather, check the daily status sheets, and brief the crew before tooling up. Improving situational awareness with today's technology choices requires systematically thinking through what information we want to keep track of and how we intend to acquire, review, verify, share, and utilize that information.

An exponential increase in available data has occurred through improvements in data integration and cloud computing. Important information once stuck in a filing cabinet, cab of a pickup, on someone's PC, or on hundreds of different websites is now becoming available and sharable through the cloud. Information portal applications are powerful technology tools that allow us to electronically gather, assemble, and share disparate pieces of information about an incident. Portals provide a Common Operational Picture (COP) to support wildfire operations, planning, and mitigation.

Examples

Several wildfire portal apps are being utilized by fire managers and responders; use of these portals range in scale from local to state to national. Each has been developed to meet specific needs and eliminate the need for each user to buy and use GIS software. They all have the following standard characteristics of a COP:

- they integrate different types of data sources;
- they are real-time; and
- they allow responders and command-and-control to share the same view.

National Wildfire Coordination Group

Fire managers at all levels need to spend less time searching for wildland fire data and more time using it. That's what the National Interagency Fire Center (NIFC) Enterprise Geospatial Portal (Fire EGP) is about. It provides users with multiple ways to access, view, and analyze wildland fire data that NIFC maintains or identifies as an authoritative source. The Fire EGP provides a common operational view with layers organized by "work spaces" for wildland fire response and mitigation (see Figure 1). Over 40 layers of data from internal and external sources are available to provide decision support. Examples include:

- Active Incidents: fires and perimeters, active resource locations, satellite fire detection.
- Aviation: aircraft locations, temporary flight restrictions, retardant avoidance areas, obstructions.
- Intel/Predictive Services: weather radar, special imagery and infrared imagery requests, fire danger, fire weather, weather watches and warning, RAWS data, and fuel moistures and conditions.

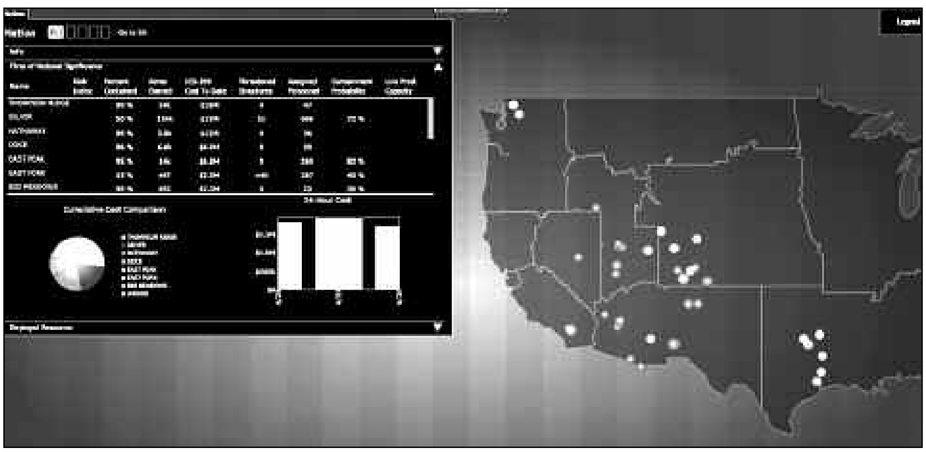
The Fire EGP combines this traditional common operational picture with collaborative mapping tools, geospatial and imagery analysis, and analytical reporting. It is intended for use by National Wildfire Coordination Group (NWCG) partner agencies and other authorized viewers. The Fire EGP requires a password.

State of Colorado

The State of Colorado is currently using two complementary portal applications to meet their needs.

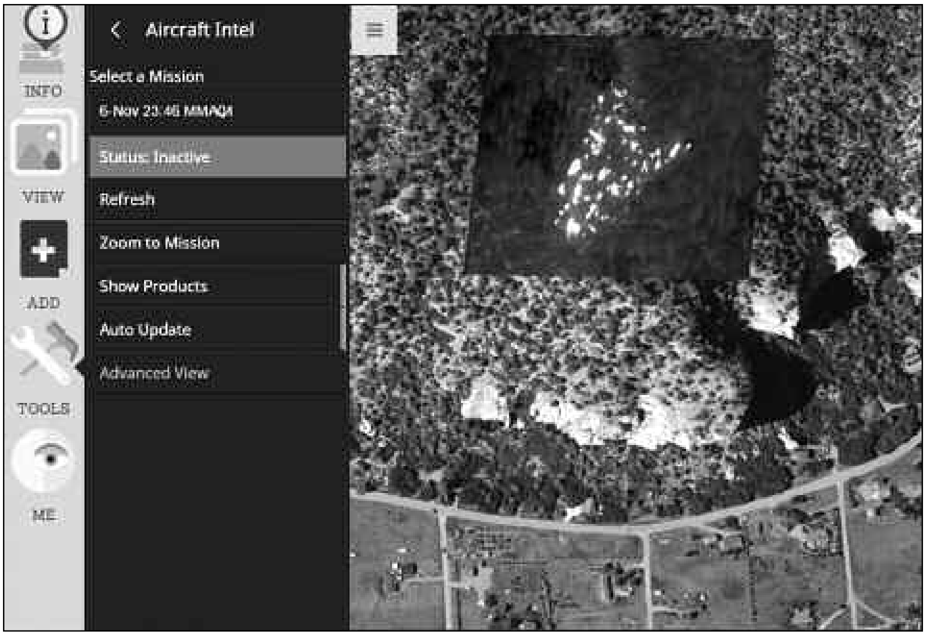
COWRAP. The Colorado Wildfire Risk Assessment Portal (COWRAP) is the primary mechanism for the Colorado State Forest Service to deploy risk information and create awareness about wildfire issues across the state. It provides a small state agency with the ability to support mitigation and fire prevention efforts across the state with tools tailored to meet the needs of the public, local community groups, private landowners, government officials, hazard-mitigation planners, and wildland fire managers. Features include:

- A *Public Viewer* provides the public a view of their wildfire risk and links to information to help them mitigate it. It



SOURCE: INTTERRA

Figure 1. A screen shot of NIFC Fire Enterprise Geospatial Portal (EGP) that depicts a map of active large fires with summary analytics from several sources for the select region, including a list of incidents, % contained, acres, cost to date, structures threatened, and number of personnel.



SOURCE: INTTERRA

Figure 2. Screenshot of CO-WIMS for the State of Colorado displaying near-real-time infrared imagery taken from Sierra Nevada Corporation's Multi Mission Aircraft over an incident near Durango, CO in 2014. The infrared camera sees through the smoke giving fire managers a clearer picture of the situation.

is designed to "*explore + identify + engage.*"

• A *Professional Viewer* supports fire protection planning. In addition to providing a picture of wildfire risk, it includes tools to:

– let professional users draw or upload an area of interest (AOI);

– generate a detailed report describing and mapping wildfire risk that is editable by the user to meet their needs (i.e., community wildfire protection plans, forest owner management plans, county hazard mitigation plans); and

– download GIS data for the AOI for users with GIS capability.

These tools can save weeks of GIS and writing work for each plan downloaded.

CO-WIMS. The Colorado Wildfire Information Management System (CO-WIMS) is a decision support system recently developed for the Colorado Department of Fire Prevention and Control (DFPC) using modified off-the-shelf software. CO-WIMS provides an up-to-date picture of the wildfire situation across the state and access to near-real-time photos and heat (IR) imagery from Colorado's Multi-Mission Aircraft (MMA) (see Figure 2).

• The DFPC has acquired two aircraft equipped with color and thermal image cameras for fire detection and mapping; monitoring spread rates, fire progression, and spotting distances; monitoring evacuations; and other all-risk mapping. Mission Sensor Operators also have mapping tools for adding hot spots, heat perimeters, and fire and retardant lines. As aircraft intel products are processed, rectified, and sent from the aircraft to the cloud, CO-WIMS displays these products to fire managers and responders in near-real-time.

• CO-WIMS provides the following collaborative mapping tools and allows for sharing of map information immediately to all system users, including the MMA: reporting a new incident and mapping and tracking incidents, fire perimeter, ICP location, evacuation zones, and resources. Users can map special risks and collect structure triage information.

• CO-WIMS also leverages much of the same data and capabilities of the Fire EGP. Several key fuels and risk data sets from COWRAP are integrated.

CO-WIMS is accessible on PCs, tablets, and mobile devices. It is available at no cost to DFPC partners, including state public safety personnel, local fire protection district staff, sheriff's department staffs, county and local emergency management personnel, incident management teams, fire management officers, and interagency dispatch centers. CO-WIMS also requires a login.

Klamath County, Oregon

The Klamath County Wildfire Decision Support System (KC WFDSS) provides a fully integrated wildfire information management system that unites many sources of data, forms, geospatial processes, communications, and management workflows associated with all phases of wildfire preparedness and management.

It includes many of the capabilities described in the previous examples. In addition, this portal has the capability to collect data from the public.

• The KC WFDSS enhances the existing community wildfire protection plan by providing an interactive web-based information system that communicates wildfire risk and mitigations to homeowners. From the *Ready, Set, Go* website at www.kcrsg.org, residents can "*Go to the Map*" and review the fire agency's risk assessment, change risk factors to see how it affects their score, submit changes for approval by the fire agency, report special needs (i.e., respiratory ailment, mobility impaired, single working parent), and sign up to receive emails and text messages with information updates.

• During incidents, fire officials can

(CONTINUED ON NEXT PAGE)

Why COPs?

Common Operational Pictures, or COPS, come from battleground technology and follow the military definition of "a single identical display of relevant information shared by more than one command. A common operational picture facilitates collaborative planning and assists all echelons to achieve situational awareness."

Commercially available COPs are making their way into the market and are designed to overcome some of the weaknesses of single silo software that only allows you to see portions of critical information. COPs are GIS-based and usually custom designed to bring geographic, textual, database, resource, and incident data together in one application.

draw on the map and generate detailed and summary reports for the homes and special needs homeowners in the area. A text or email message tailored for their special need or interest can be sent to residents who have signed up.

• Public information officers can use the KC WFDSS to publish a public map of the fire perimeter and evacuation areas to a publicly accessible website that can be linked from websites and social media.

Home risk assessments are completed and updated using an app that utilizes smartphones and tablets for data collection—both online and offline. The app utilizes the device GPS for a location, a camera to take a photo of the structure, and forms for recording the information.

The KC WFDSS also includes mapping tools for collecting and displaying wildfire preplan information such as water sources, gates, fuel treatments, and hazardous conditions. Similar mapping capabilities exist for supporting preplan activities for structures. Work spaces and tools customized for all-risk incidents such as floods and hazmat have also been configured.

The KC WFDSS was developed for and in collaboration with the Keno Rural Fire Protection District and Klamath County partners. The system is being made available for use throughout Oregon. It requires a login to access the agency-only data and tools.

Final thoughts

Many practicing foresters started their careers with slide rules, Biltmore sticks, prisms, and sling psychrometers. The "good old days" included hand-coloring paper maps and Mylar overlays. Over time, technology increased our ability to visualize and do complex spatial analysis, but the information was, for the most part, sitting in "silos" inaccessible to those needing it. Sophisticated GIS software and trained users were required to access the information. At a minimum, users needed to visit numerous websites and were not able to see all the information as one picture.

Advances in technology and data integration have now created opportunities to greatly increase the availability and use of data for decision support through portal applications. An investment of thought and finances was required to build and maintain the applications described in this article. However, the ability to see a common picture and make better decisions—whether for a fire manager, a firefighter, or a landowner—can be priceless.

Additional information about these technologies can be found in the NFPA Geospatial Technologies Study released in December 2014 at http://bit.ly/1GgNGSP. ◆

Jim Wolf is Wildfire Program manager for Intterra Group in Medford, Ore. He can be reached at jim.wolf@intterra-group.com. Jim is an SAF member.

GIS Mapping Helps US Forest Service Take the Sting Out of Burn Conditions

BY BARBARA LEIGH SHIELDS

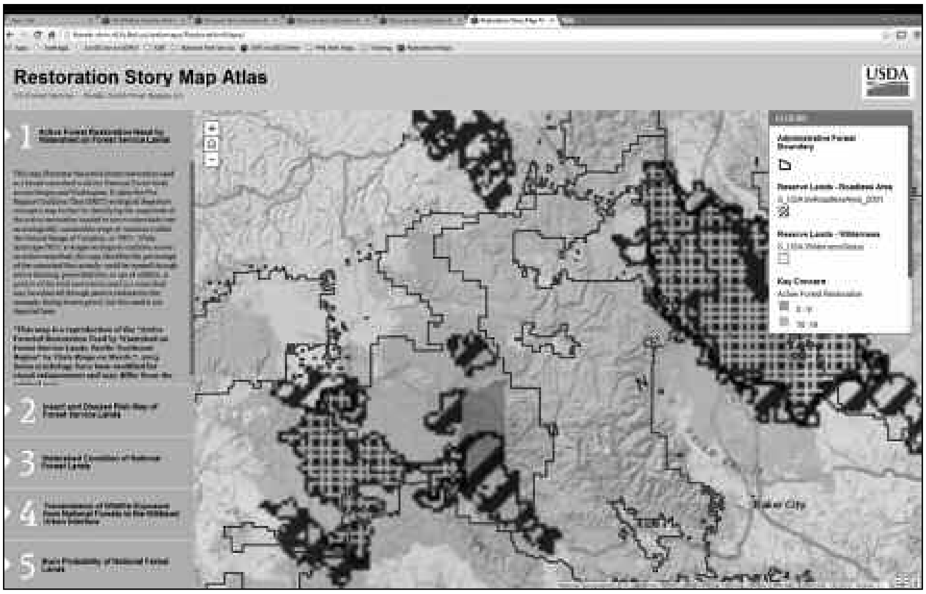
Wildfires caused by insect infestation, arid climate, and poor watershed conditions have inflicted vast amounts of destruction throughout the west. The USDA Forest Service (USFS) goes to extraordinary lengths to diminish the threat of wildfires, and geographic information system (GIS) technology is one of its main weapons. GIS allows the USFS to analyze forest conditions contributing to wildfire, plan forest restoration, and focus resources on areas most susceptible to fire.

For years, the USFS has been using Esri's ArcGIS platform to address many forest concerns. GIS is mapping and analytic software that helps foresters and land managers visualize forest inventory data. They can combine this information with other types of data for further analyses.

For instance, forestry scientists use GIS to analyze carbon sequestration, biomass availability, and pollutant effects. GIS mobile apps are useful for getting geographic information to contractors and foresters via their phones and tablets. Businesses can use it to reach out to stakeholders with interactive, online maps. Timber managers use GIS for forest inventory, harvest planning, and operations management.

USFS Region 6 uses ArcGIS to decrease the likelihood of wildfires consuming forests in its jurisdiction, which includes 17 forests in Washington and Oregon and one grassland in Oregon. Specifically, forest researchers are using GIS to study the conditions of four national forests in eastern Oregon. Restoration activities were already underway in the Malheur National Forest. To verify that these efforts were indeed on target, Region 6 technical analysts designed a forest condition study to rate fire risk in different areas of the forest.

To begin the study, they chose target areas that forest ecologists had identified as having seriously degraded forest conditions. A team of USFS GIS analysts worked with various subject matter experts and decided on core conditions that most impact forest health. The experts provided data about these five conditions: need by watershed, watershed condition, insect and disease risk, transmission of wildfire exposure from national forests to the wildland urban interface, and burn probability.



The watershed map locates and ranks areas needing restoration. Policy makers use a GIS web app to better understand and talk about forest concerns.

Unfortunately, not all the experts were using the same software to format their data and create their maps. Some of the work was outsourced. The team was able to rectify the differences. By using a grid for each map, analysts matched the areas. One GIS analyst rearranged the symbology of the different maps into one symbology set. For instance, he colored healthy areas green and affected areas red. In this way, satellite and aerial images became part of one story rather than five separate stories.

Next, the team set up a geospatial analytical model to calculate the burn probability of the forest. These maps included data about variables and conditions. Experts used the variables to calculate burn probabilities, and the GIS showed the areas most vulnerable to wildfire along with a color-coded range of burn probability. By layering these different maps and looking for where they interconnected, analysts could see the total number and areas of the region that are in need of restoration.

The GIS team mapped the prevalence of each core condition in the Malheur forest. Upon seeing the level of these conditions displayed in GIS, forest analysts were surprised to discover the current restoration activities were not overlapping areas where conditions were actually degrading the forest. The scientific findings revealed that the forest management policies in play were not making a huge difference in reducing wildfire threat. This

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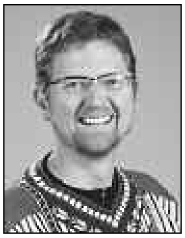
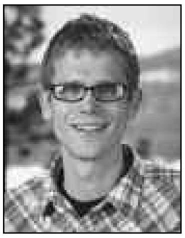
The Buzz About Drones

BY LEE VIERLING AND JAN EITEL



Lee Vierling



Jan Eitel

Whether it's the high-pitched sound of small motors and rotors or yet another story in the news media, there is a lot of buzz about drones these days. Drones, often called by their more technical names of UAVs (short for Unmanned Aerial Vehicles) or UASs (Unmanned Aerial Systems), have indeed taken the airwaves by force. But remote controlled model airplanes have been around for decades, so why all of the sudden attention? And what might this technology mean for mapping and managing forests?

The development of UAVs to view the earth from above has a rich history. Photographic pioneers took cameras to the skies beginning in the 1850s using manned hot air balloons. In the 1880s came an innovative kite with an automated camera onboard. By the dawn of the 1900s, automatic cameras were small enough to put on the first "steerable" platform: homing pigeons. These dutiful birds became such an important tool for aerial photography that several prominent countries invested heavily in pigeon reconnaissance for wartime intelligence gathering.

Some say that the birth of our modern-era UAVs occurred with the first radio-controlled airplanes in the 1940s. Continued innovation in power, communication, and imaging systems, coupled with ever lighter and stronger aircraft construction materials have led to reliable, affordable flying machines. Imagine the innovations that have led to today's smartphones and you have an idea of why UAVs are quickly moving beyond niche markets to attract interest from all sectors of the economy.

The forestry applications of imagery acquired by UAVs are many. At the fundamental level, UAVs offer a new tool for acquiring imagery of forested areas that was previously the domain of manned aircraft and satellites. This imagery can be used for qualitative assessments or analyzed to quantify a wide range of forest structural and functional attributes. For instance, changes in reflected light from forests can indicate stress from a variety of sources including drought, insects, or disease.

The detail to which forest structure and function can be quantified often comes down to the spatial, spectral, and temporal resolution of the data, together with calibration using ground data. The spatial resolution of UAV-acquired data depends on the optical characteristics of the camera acquiring the imagery, combined with the flying height. Traditional aerial photography of forests required large cameras with long focal lengths to achieve high spatial resolution imagery. However, because UAVs can safely fly at altitudes much lower than manned aircraft, the size and weight of a UAV-mounted camera can be much smaller while achieving resolution similar to or better than traditional aerial photography. As a result, UAV imagery can make it possible to identify not only individual trees, but even individual branches and leaves. A trade-off to this high resolution is the spatial coverage of UAV-acquired imagery. That is, while very high resolution imagery is possible to acquire, the time and effort necessary to cover large areas will be greater than with traditional aerial photography.

Spectral characteristics of UAV systems are also important to consider. Imagers can range from basic red/green/blue (RGB) "broad-band" cameras to more sophisticated imaging systems. RGB cameras have the advantage of being low cost, while providing three broad bands (one band per color) that can be used to break images down into their component parts using open source software such as MultiSpec© (https://engineering.purdue.edu/~biehl/MultiSpec/). These bands can be analyzed in ratio form in order to normalize individual pixel brightness values and produce a relative assessment of canopy color, which can indicate the status of pigments important for forest function.

Another relatively affordable and accessible broad band option is to incorporate infrared (IR) photography. IR bands can provide additional information about foliage density, while the "red edge" band spanning the region between the red and near-IR regions can provide non-visual insights on foliage health. Thermal IR sensors, while lower in spatial resolution than their RGB/IR counterparts, can provide data on canopy surface temperature that can indicate water stress. Higher cost "narrow-band" imagers, recording up to hundreds of spectral bands instantaneously, may also be of

PHOTO COURTESY OF LEE VIERLING

Foresters view a tethered quad-copter demonstration during a University of Idaho workshop.

interest for advanced applications.

The temporal frequency of image acquisition is another area where the flexibility of UAVs is an asset. Flying more frequently may be of interest to monitor the status of dynamically changing situations such as management operations, insect attacks, or invasive species outbreaks. This flexibility may also be of use during controlled burns or even wildfires, when frequent image capture may be of interest but would otherwise be too costly or dangerous using manned aircraft.

Beyond the spatial, spectral, and temporal specifications common to any remote sensing application for forest mapping and management, UAVs offer several other tantalizing prospects for the future of forestry. One of the most exciting prospects is acquiring three-dimensional structural information of forests using UAV technology. Similar in principle to creating forest canopy surface models using stereo-pair aerial photogrammetry, the many images acquired of a forest canopy by UAVs can be stitched together using computer vision software to render and map targets in 3-D. Another emerging technology is the development of UAV-deployable, lightweight lidar (light detection and ranging) systems that can directly measure the 3-D positions of trees. While image-based 3-D mapping can be limited in areas of dense canopy cover (due to the inability to see the ground to calculate tree heights), lidar-based approaches can be effective even in dense canopies.

With this wave of advancements and potential applications, the future of UAVs in forestry is bright. However, there still remain some very real and practical issues that must be addressed for United States-based applications. For example, the Federal Aviation Administration (FAA) requires that UAV operators maintain a continuous line-of-sight visual contact with flying UAVs. For obvious reasons, this policy will present challenges for forest-based applications. In addition, as any UAV forestry application will likely be regulated by the FAA, it is incumbent upon landowners and forest managers to be in compliance with all current policies and regulations when acquiring or contracting data to be flown (see www.faa.gov/uas).

The history and evolution of UAVs continues at an ever rapid pace. Innovations in sensors, flying platforms, and software will surely make some aspects of today's state-of-the-art technology obsolete by the time the next generation is practicing forestry. As a result, realizing effective forest mapping and management using UAVs will take a community approach, involving managers, service providers, governmental agencies, researchers, educators, and others communicating with and learning from each other. By achieving this sort of collaboration, it may not be long until the sky is no longer the limit. ◆

Lee Vierling is the executive director of the College of Natural Resources McCall Field Campus and McCall Outdoor Science School and associate professor with the Department of Forest, Rangeland, and Fire Sciences, University of Idaho, in Moscow. He can be reached at leev@uidaho.edu. Jan Eitel is a research assistant professor with the Department of Forest, Rangeland, and Fire Sciences, University of Idaho, located at the McCall Field Campus. He can be reached at jeitel@uidaho.edu.

We Remember

Richard "Dick" Posekany
1926-2015

Dick Posekany, 88, passed away on Jan. 18, 2015. He was born Aug. 20, 1926, in Keystone, Iowa.

At the age of four, the family moved to North Dakota, then back to Iowa in 1936. Dick attended a one-room grade school in Irving, then high school in Belle Plaine where he graduated with the class of '44. At that time he enlisted in the Army Air Force serving in Germany as a cryptographer. He was honorably discharged as sergeant and came back to Iowa to use the GI Bill to attend the College of Forestry at Ames, Iowa.

He graduated from Iowa State University in 1951 and moved to Reedsport, Ore., where he was employed by Long-Bell Lumber Co. and I.P. Co. at Gardiner. The family moved to Mill City for employment with Frank Lumber Co. as timber and land manager. After retirement he continued in the forest industry as a consultant and advocate.

Dick served as president of the Oregon Logging Conference in 1972 and helped write the original Oregon Forest Practices Act in 1971-72. He was a member of the Oregon SAF, American Forest Resource Council, World Forestry Center, and the Oregon Garden. He was a member of the Masonic Order and an active member of the Presbyterian Church in Reedsport and Mill City, Westminster in Salem, and Stayton United Methodist Church.

Dick loved working out at the gym with his "buddies," raising daffodils and other flowers to bring joy to others, keeping yards neat, hunting, watching sports, reading, farming, writing letters and history, promoting education about forestry, spending time with family, traveling with wife Phyllis, and helping others. He gave 20 gallons of blood to the Red Cross.

Dick is survived by his wife Phyllis; sons Rick and Robert (Carol); daughters Kim and Jean (Derek) Lockhart; stepsons Thom Wright (Julie), Bob Wright (Denise), Larry Wright; 20 grandchildren; 17 great-grandchildren; brother Lawrence (Jackie); sister Diana Castell; and many loving nieces and nephews.

Remembrances may be made to Union Gospel Mission in Salem, World Forestry Center, or Willamette Valley Hospice.

John M. Phillips
1919-2015

John M. Phillips, 95, passed away surrounded by family on Jan. 11, 2015. He was born in December 1919 in Pasadena, California.

He studied forestry at UC Berkeley, but his education was interrupted by the war. In 1941 John enlisted in the Air Corps and went on to teach radio and radar in Florida. After completing Fort Sill OCS in artillery, he married his childhood sweetheart, Dorothy Babcock, in August 1943. Following further training he was sent to serve in the South Pacific. By the time he returned home he was a first lieutenant and a battery commander. He returned to school and completed his BS degree in forestry and worked in the Sierras before moving to Eugene, Ore., in 1949. John worked for Snellstrom Lumber Company as a forester and logging engineer. In 1965 he began teaching at the Eugene Technical Vocational School while going to OSU to obtain his Master's degree in education with a minor in trade and industrial education, graduating in 1967. He continued to teach forestry and surveying at Lane Community College when the Vocation Technical School became LCC.

John was a member of many forestry organizations and worked with the Boy Scouts and youth at St. Mary's Episcopal Church where he and his family attended services for many years. He enjoyed fishing as well as target practice with guns and bows. He had a Malay pirates cannon mounted on the railing of the deck at his home on Fern Ridge Lake, the shooting of which caused great consternation to the family dog as well as the water skiers passing by his dock. He was also an avid sailor, hosting many parties and picnics at the lake house. He managed several small tree farms for himself as well as for LCC.

In 1972, John was selected as one of two United States community college educators to represent the nation in a world consortium on Forestry Education and Training in Stockholm, Sweden. He was voted one of LCC's outstanding vocational educators in 1978.

John retired from teaching in 1982. During his retirement he enjoyed fishing, sailing, traveling, reading, going to garage sales, and selling at Piccadilly Flea Market. He was very interested in Native American culture and became quite knowledgeable in identifying and evaluating Native American artifacts.

He is survived by his wife of 72 years, Dorothy Phillips; his brother Richard Phillips; his children Mike, Kathy, Claire, and Alan; ten grandchildren; and ten great-grandchildren (soon to be 11).

Roger Ward
1941-2015

Roger Allen Ward, 73, passed away from hypothermia after falling through the ice while ice fishing on Feb. 6, 2015. Roger was born Oct. 16, 1941, to Oscar and Naomi in Kokomo, Indiana.

His passion for fishing began at a young age and as did his desire to move west. He wanted to be near the mountains and forests. After graduating from Kokomo High School in 1959, he went on to Purdue University where he graduated with a degree in forestry. He moved to Philipsburg, Montana, and worked as a forester.

Roger's desire to serve his country overrode his dreams of the west. He joined the US Navy and attended US Navy Officer Candidate School. Roger served his country as a lieutenant on the USS Bon Homme Richard in Vietnam. Following his service, Roger returned to the forest that he dreamed about. He went to Elk City as a forester for the US Forest Service. Later, Roger was transferred to Priest Lake, Idaho, where the fishing was much better.

He heard rumors of a great fisherman and wanted to meet him. Little did he know that he would fall in love with the man's daughter, Kathryn Bierman. Kathy and Roger were married Feb. 5, 1972, in Spokane. It wasn't long before their family started to grow.

Roger was a Fellow of the Society of American Foresters. While on a study tour with them, he was able to tour New Zealand and Australia.

While working full time, raising a family, and fishing, Roger managed to continue his education. He received his Master's degree in silviculture from the University of Idaho. Roger transferred to the Kamiah office and the Ward family made Kamiah their home. He worked at the Kamiah office for several years before transferring to the Grangeville office, where he retired in 1998.

After retirement, Roger stayed busy. He was a master at Dutch oven cooking. He enjoyed cooking for others and teaching classes with his son. Roger was a fourth-degree black belt in Goju Shorie karate and attended Ron Reed's School of Karate. He loved to fish, camp, hunt with his wife, and float the river with his family and friends. He was known to sharpen your knife when he stopped by. He liked to watch NASCAR and football, smoke fish, and was a fine woodworker. Roger was a friend to all who knew him.

He is survived by his wife, Kathy Ward; daughter Ashley (Andy) Pigott; son Rob (Sherri); grandsons Frankie, Everett, and Fredrick; sister, Sandra Rupright; brother Samuel Rodgers; brother-in-law Jim Oaks; and nephews Chip Clester, Patrick Clester, Daniel Thornton, and David Thornton.

Memorial contributions may be made to the Kamiah EMTs, Kamiah Veterans of Foreign Wars Post No. 5407, or National Museum of Forest Service History in Missoula, Mont. ◆

Calendar of Events

Western Forestry Graduate Research Symposium, Apr. 27-28, Corvallis, OR. Contact: Adrian, 925-354-6772, http://calendar.oregonstate.edu/ event/101758/.

Logger Education to Advance Professionalism (LEAP), Apr. 28-30, Moscow, ID. Contact: Chris Schnepf, 208-446-1680, or Randy Brooks, 208-885-6356, www.uidaho.edu/extension/forestry/content/calendarofevents.

Oregon SAF and Oregon Chapter of The Wildlife Society joint annual meeting, Apr. 29-May 1, Eugene Hilton, Eugene, OR. Contact: Dale Claassen, 541-954-6953, dale@sperryridge.com, or Fran Cafferata Coe, 503-680-7939, fran@cafferataconsulting.com, www.forestry.org/oregon/2015meeting.

CESCL: Erosion and Sediment Control Lead Training, May 6-7, Tukwila, WA, or May 19-20, June 9-10, or July 21-22 in Bellevue, WA. Contact: NWETC.

Pacific Salmonids: Spawning Habitat Restoration, May 13-15, Portland, OR or Oct. 21-23 in Bellevue, WA. Contact: NWETC.

Starker Lectures: Capstone Field Trip, May 14, Location TBD. Contact: 541-737-1585, http://starkerlectures.forestry.oregonstate.edu/.

Professional Timber Cruising with SuperACE, May 20-21, Beaverton, OR. Contact: Diane Sandefur, dsandefur@atterbury.com, http://atterbury.com/calendar.html.

PNW Forest Biomass: Demand, Supply, and Policies, May 21, Wilsonville, OR. Contact: WFCA.

Managing Change in Our Community Forests: A Toolkit for Action, June 4, World Forestry Center, Portland, OR. Contact: Oregon Community Trees, http://oregoncommunitytrees.org.

Management and Remediation of Contaminated Sediments, June 11-12, Bellevue, WA. Contact: NWETC.

Collaborative Negotiations and Conflict Management for Environmental Professionals, June 16-17, Bellevue, WA. Contact: NWETC.

Advanced Insect and Disease Field Session: Identification, Life Cycles, Control and Silvicultural Regimes, July 6-9, Hood River, OR. Contact: WFCA.

Forest Insects and Disease Field Day, July 24, Coeur d'Alene, ID. Contact: University of Idaho Extension Office in Kootenai County, 208-446-1680, www.uidaho.edu/extension/forestry/content/calendarofevents.

Environmental Forensics—Site Characterization and Remediation, July 29-30, Tigard, OR. Contact: NWETC.

Who Will Own the Forest? 11, Sep. 15-17, Portland, OR. Contact: Sara Wu, swu@worldforestry.org, http://wwotf.worldforestry.org/wwotf11/.

Planning and Preparing an Ecological Risk Assessment, Sep. 16-17, Bellevue, WA. Contact: NWETC.

Forest Inventory and Analysis Science Symposium, Dec. 8-10, Portland, OR. Contact: Sharon Stanton, sharonmstanton@fs.fed.us, http://fia.fs.fed.us/symposium/.

Contact Information

NWETC: Northwest Environmental Training Center, 1445 NW Mall St., Suite 4, Issaquah, WA 98027, 425-270-3274, https://nwetc.org.

WFCA: Western Forestry and Conservation Association, 4033 SW Canyon Rd., Portland, OR 97221, 503-226-4562, richard@westernforestry.org, www.westernforestry.org.

Send calendar items to the editor at rasor@safnwo.org.

Bringing Growth-and-Yield Online

BY DAVID DIAZ

The wealth of new digital forestry tools and technologies has not been broadly shared. Digital mapping, geospatial data, growth-and-yield models, and multi-objective optimization algorithms have become common tools of the forestry trade, but the power of these new technologies remains largely confined to those able to pay for expensive software licenses, hire a specialist GIS or growth-and-yield forester, or are willing to learn a new technical language.

As a first big step toward bridging this digital divide, Ecotrust has launched a free web application called Forest Planner (www.forest-planner.ecotrust.org) covering Oregon and Washington.

What Type of Forestry Can Forest Planner Simulate?

Each ecoregion across Oregon and Washington has 20-25 regionally-relevant silvicultural prescriptions to choose from that were developed in consultation with several Extension foresters and consulting foresters, and cover a spectrum from common industrial forestry practices to non-active management. On the Pacific Coast and Western Cascades, the choices include even-aged 40-, 60-, and 75-year rotations, with options for mixed-species or plantation re-planting, and pre-commercial and/or commercial thinning, as well as uneven-aged or repeated thinning options. In the Klamath Mountains and east of the Cascade Range, the silvicultural options are more heavily tilted toward uneven-aged treatments including a variety of thinning options (e.g., from below, throughout a diameter distribution, diameter limit, etc.), but also includes a few 50- and 80-year even-aged rotation options.

Ecotrust is a Portland-based non-profit, a hybrid organization with deep roots in forest conservation and management in the Pacific Northwest since its establishment in 1991. Beginning in 2011 with support from the USDA Natural Resources Conservation Service, Murdock Charitable Foundation, and Sequoia Foundation, Ecotrust set out to bridge this technological gap and improve access to useful information on the outcomes and tradeoffs of a spectrum of forest management approaches. The result, launched in 2014, is a first-of-its-kind free and open-source forest planning toolkit that combines forest modeling, mapping, and decision-support technology with an easy-to-use online interface focused on serving non-industrial forest owners.

An intuitive user interface for a simple scenario planner

Trying to manage a forest for all the values a landowner cares about can get very complicated, very fast. Each strategy may involve tradeoffs in timber stocking and yields, wildlife habitat, fire or pest risks, management costs and revenues, and carbon sequestration, among many other variables. To make sense of this complexity, foresters commonly turn to growth-and-yield models to compare management options using the metrics they care about (and hopefully the model is wired to measure everything you want to manage for). Forest Planner was designed to make this complex modeling technology more intuitive, widely available, and easy-to-use for woodland owners and those who work with them.

In the simplest terms, Forest Planner is a gigantic user-friendly lookup table containing millions of growth-and-yield simulations. It is web-based, so there is no software to download, and can be accessed from any computer with an internet connection and a web browser. Users are guided through four main steps on the website.

1. **Mapping a property boundary.** A place-based search bar, tax lot boundaries (when available from each county), Public Land Survey System grid, aerial imagery, and road maps make it easy to find and draw the boundary of a property.

2. **Delineating stands.** Map layers including soil types, streams and wetlands, riparian buffers, steep slopes, and aerial imagery can help divide a property into manageable units, which can then be selected to show each stand's area, slope, and aspect.

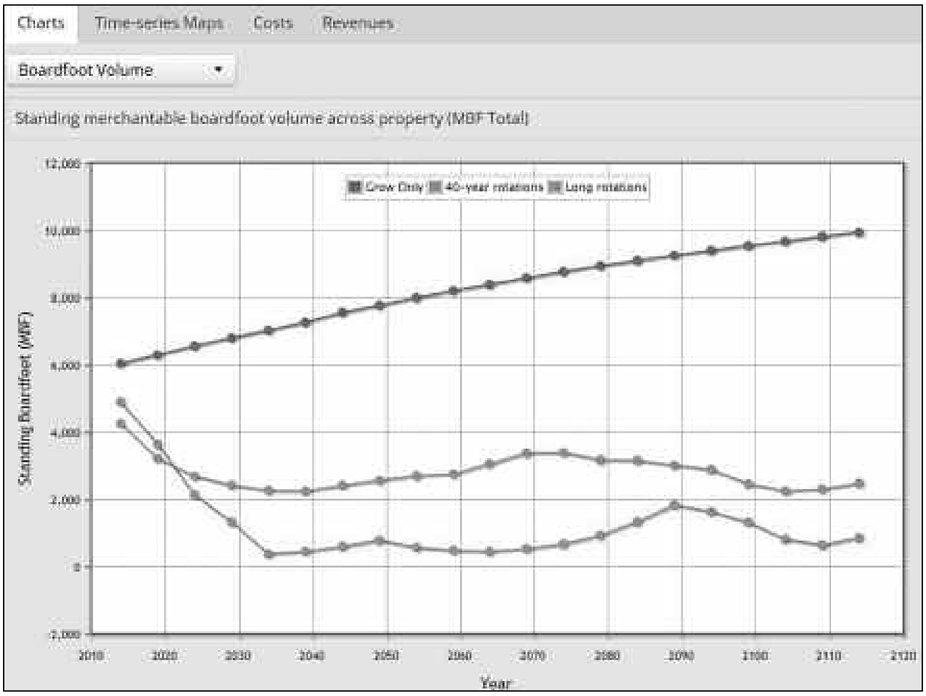
3. **Assigning forest types.** By filling out a stand table describing the composition a forest type in terms of species, general diameter class (e.g., seedling, sapling, pole), and trees per acre, users can then assign the stands mapped with the forest type they contain. If detailed inventory or stand exams aren't available, the user will need to make an informed guess in order to move onto scenario planning.

4. **Creating customized management scenarios.** By answering 4-5 questions, the user is guided down a simple decision-tree to choose from a spectrum of silvicultural prescriptions and create a menu of management options to apply. Specific silvicultural prescriptions can then be assigned to each stand on the property in any chosen combination and saved as a customized management scenario.

Once you've created one or more scenarios, the power of the gigantic lookup table becomes apparent. Property-level graphs show how each scenario performs over 100 years, with a variety of metrics to choose from, such as standing and harvested timber volume, harvest and transportation costs, ratings of fire and several pest hazards, carbon storage in the forest and wood products, and basal area, to name a few. A side-by-side map view can be used to flash-forward in time to see how each stand evolves under each scenario using any of these metrics.

What happens behind the scenes

While the user is going through stand mapping and scenario creation, Forest Planner crawls through a database containing millions of pre-simulated growth-and-yield runs. This approach avoids common challenges with running growth-and-yield models such as troubleshooting cryptic error



The Forest Planner website provides free graphs (shown here) and maps to compare management scenarios customized by the user.

messages and unexpected growth behavior, and perhaps of equal importance, allows for near-instantaneous visualization of modeling results through graphs and maps. To ease the complexity of data entry required for the user, this approach also incorporates several important assumptions including site productivity, log values and markets, and others that are described in detail on Forest Planner's Documentation page.

To prepare the database of growth-and-yield runs, Ecotrust modeled a spectrum of silvicultural prescriptions in each ecoregion using thousands of inventory plots from the Pacific Northwest Forest Inventory and Analysis Integrated Database. We used the US Forest Service's Forest Vegetation Simulator (FVS) to conduct the modeling, although Forest Planner can also be tailored to visualize outputs from any growth-and-yield model that is formatted appropriately.

Once a user defines the type of forest in each stand, Forest Planner goes to work scanning through a database of inventory plots to identify the best match. A "nearest neighbor" process considers the stand age, species, and diameter classes specified by the user, as well as the slope, aspect, and coordinates of each stand. Negative weighting penalizes results with species or diameter classes not found in the user's stand. The outcome of this process is a one-to-one match where each stand created by the user is paired with an inventory plot from the database.

As the user continues to define what types of silvicultural prescriptions to be applied to each stand, Forest Planner simply pulls the appropriate rows of the database that cover the chosen prescription for each inventory plot, comprising all the outcomes for that run over the next 100 years including timber stocking or yields, carbon storage, and more. Although it may seem subtle, it is important to be clear that results displayed by Forest Planner are from stands that represent the closest avail-

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Applying Forest Planner to Support Carbon Certification

Forest Planner is being actively developed and applied for forest carbon initiatives in Oregon and Washington offering grouped carbon certification (carbon aggregation) with non-industrial private and small public landowners. In January 2015, the USDA Natural Resources Conservation Service awarded $820,000 through the Regional Conservation Partnership Program to include cost-share funding for forest management planning, carbon inventory, and carbon assessments for landowners in northwestern Oregon and along the southern edge of Puget Sound in Washington. Find out more at www.ecotrust.org/helping-small-landowners-break-into-carbon-markets.

Policy Scoreboard

Editor's Note: To keep SAF members informed of state society policy activities, Policy Scoreboard is a regular feature in the Western Forester. *The intent is to provide a brief explanation of the policy activity—you are encouraged to follow up with the listed contact person for detailed information.*

OSAF to Review Riparian and Old-growth Forests Position Statements. Oregon SAF has nine active position statements on important forestry issues (see www.forestry.org/oregon/policy/position/), which are used to articulate a professional perspective to decision makers and the interested public. These statements are periodically reviewed and updated, and in 2015 the positions on "Managing Riparian Forests" and "Managing Mature and Old-growth Forests" will be examined. Both topics remain timely given current riparian rulemaking by the Board of Forestry and ongoing concerns about federal forest management. OSAF members are encouraged to offer comments about these position statements to their local chapter leaders or the OSAF Policy Committee. Contact: Paul Adams, OSAF Policy chair, adamspaulw@gmail.com.

Federal Forest Policy Workshop and Position. A workshop for Northwest SAF leaders and interested members was held in January at the Oregon Garden to discuss current issues of federal forest management and ideas for legislative concepts from the profession. The goal is to be more proactive with leadership at the front end of forest policy development versus simply reacting to legislative proposals developed by others without a broad base of professional input. Over 30 participants from Oregon and Washington contributed to a lively discussion, and in early February WSSAF leaders shared an advanced draft of a related WSSAF position statement that may become the basis for a regional or parallel position with OSAF. Contact: Paul Adams, OSAF Policy chair, adamspaulw@gmail.com; Harry Bell, WSSAF Policy chair, harry@greencrow.com.

WSSAF Update on Federal Lands Position Statement. WSSAF recently submitted Version 9.1 of a position statement on "Management of Federal Lands under the Northwest Forest Plan in Washington State" to the national office to ensure that it is in alignment with current SAF legislative activities.

Version 9.1 builds on the concept of attaining a balance of social, economic, and ecologic benefits by using silvicultural tools to achieve the broad overarching goal of providing habitat diversity at all forest successional stages, clean water, a perpetual wood supply, and revenue to cover management costs. It also includes many legislative change suggestions developed by the OSAF. Contact: Harry Bell, WSSAF Policy chair, harry@greencrow.com. ◆

GIS Mapping Helps US Forest Service

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realization caused forest managers to question priorities and reassess where to focus restoration investment.

GIS decreases the time it takes foresters to create maps. The USFS posts PDF maps to the federal website .gov, which is open to everyone. However, this is not the best means for publishing forestry information. PDFs do not give the Forest Service the amount of flexibility it needs to update maps efficiently. Creating just one PDF map can take the cartographer between one and two days, depending on the scale and coloring. It is a costly process. GIS has made the USFS internal workflow more efficient and effective. If the data is ready to go, creating a web map application takes about 15 to 20 minutes.

GIS web applications are also easier to edit because the user only needs to change that bit of data in a table. GIS automatically processes those changes and instantly shows them on the map. When these web apps are made available on a GIS server, the user can easily access and see the most current map that everyone else is seeing.

The USFS enterprise GIS platform gives foresters their own space to access data, perform analysis, and post internal applications. The platform is used in conjunction with the Esri ArcGIS Online platform to create a richer user experience. It includes basemaps and a massive geographic data library.

The USFS Region 6 GIS team has published its restoration maps on ArcGIS Online for the public to access and use. By hosting an external map service on the Esri cloud service, the USFS fulfills its federal transparency obligations. Also, if the public needs to be involved in the public policy process, the platform provides tools, maps, and data to help them clearly understand issues and further explore possibilities.

Because GIS information is science based, it makes a case for nonfavoritism. The eastside restoration is a sensitive issue. The forest area covers two states: Washington and Oregon. Some believe that funding is inequitable between the east- and westsides and argue that this is a biased distribution of funds. However, the fire potential map makes it easy to see that the weather pattern and fire probability on the eastside is greater than on the westside and that funding is indeed based on need rather than politics.

Using Esri tools and templates on ArcGIS Online, the Region 6 GIS team continues to build applications that help ecologists assess forest health and forest managers write forest management plans. Its GIS online platform is a virtual location wherein forest stakeholders can communicate and collaborate. Finally, its GIS-enabled websites and mobile apps help the public enjoy the forest better. ◆

Barbara Leigh Shields is a writer for Esri. She can be reached at 909-793-2853 or bshields@esri.com. *Special thanks go to USFS Region 6's Kent Connaughton, regional forester (now retired); Zahid Chaudhry, GIS program manager; and Leo Chan, GIS specialist for GIS applications and for the information in this article. For more information, please contact Zahid Chaudhry at zschaudhry@fs.fed.us.*

Bringing Growth-and-Yield Online

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able fit to the user's; the results are not from the direct use of a user's own detailed inventory in the modeling (but this is a new feature we are developing).

How we recommend using Forest Planner

The statistician George Box put it well when he said: "All models are wrong. Some are useful."

Although Forest Planner puts cutting-edge technologies for forest modeling into the hands of forest managers on any budget, it is not a comprehensive forestry operations tool and cannot replace the need for a qualified forester to advise or direct the implementation of specific harvests or other management actions.

Forest Planner makes it easy to visualize and communicate tradeoffs among alternative management strategies so that you can get a first pass at growth-and-yield modeling with less than an hour of work. It is informational and educational, a convenient and easy-to-use calculator that landowners and foresters—and their children—can use. I encourage you to give it a try at www.forest-planner.ecotrust.org. ◆

PHOTO COURTESY OF SAM BEEBE

Camille Johnson works with her father Mike, using Forest Planner at Clackamas Tree School in 2014.

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Nautiz X8 Data Collector and GPS Unit Just Released

Handheld USA from Corvallis, Ore., has just released the new Nautiz X8 data collector and GPS unit. It replaces the Nautiz X7, which reached end of life last year. The new Nautiz X8 sports a dual core, 1.5 GHz processor and a large 854 x 480 pixel screen. An 8 Mega Pixel camera, 802.11 b/g/nWi-Fi, and Bluetooth are standard with all models.

The Nautiz X8 represents a new generation of data collectors with a capacitive touch screen. This type of screen is similar to most new cell phones in that it requires human touch or a capacitive stylus. These screens are very responsive to use with a bare fingertip. Users can also use a capacitive touch stylus for increased control while typing letters from the virtual keyboard. Numbers can easily be entered through the 10-key pad built into the Nautiz X8.

The built-in GPS engine is a new u-blox® design. GPS accuracy is quite good under tree canopy. With its built-in Bluetooth, the Nautiz X8 can receive high accuracy GPS data from an external GPS unit. It also works well with laser rangefinders for offset GP points.

At this time models with Windows Embedded 6.5 are shipping. A version with the Android operating system will be available soon.

For more information, contact Jon Aschenbach with Resource Supply, LLC at 503-521-0888. ◆

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