EVERGREEN

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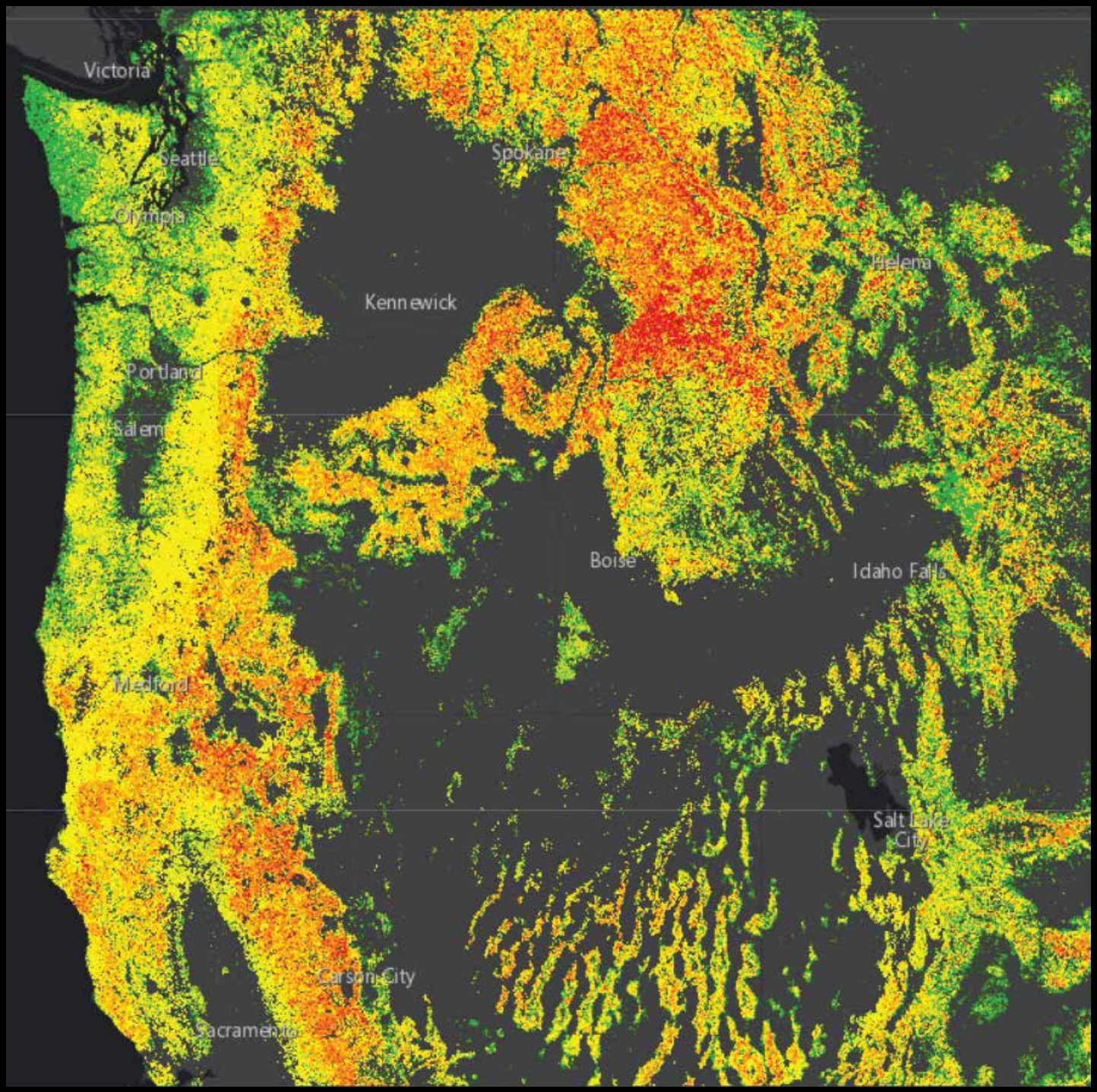

FIA: THE GOLD STANDARD

IN THIS ISSUE

In this special *Evergreen* report, we summarize the results of our year-long appraisal of the U.S. Forest Service's Forest Inventory and Analysis Program. Our website[1] holds all of these essays plus many more links to a vast FIA data treasure trove. Simply click "FIA" on the tool bar.

Two introductory essays appear only on our website: "Ivan Doig walked these halls," traces FIA's formative years in the Pacific Northwest and "FIA: The Gold Standard," puts the FIA story in historic context.

We have been using FIA data in our in-depth reports from America's national forests for more than 30 years. The technological advancements in data collection and management that we have witnessed are simply dazzling. Forest information once available only in dreary columns of numbers in lengthy reports is now a mouse click away on our laptop computers. Using an impressive array of visualization tools, FIA's five technical groups - statistics, analysis, remote sensing, information management and data acquisition - have done a spectacular job of transforming endless columns of numbers into colorful interactive maps that display forest values and conditions in all 3,142 counties, boroughs and parishes in these United States.

Storytelling has been our business since 1986 so it is our hope to begin telling the stories behind these fascinating maps this fall. Teaching others how to accurately interpret and use FIA's data is also on our bucket list.

Our report is divided into five parts: an interview with the very engaging Greg Reams, FIA's National Program Leader, plus reports detailing data collection and research work underway at FIA's Northern, Southern, Intermountain and Pacific Northwest stations.

1 Reams holds a PhD in forest biometrics, but in his administrative capacity he sees FIA as a baseball team he manages.

We visited all four stations – Portland, Ogden, St. Paul and Knoxville – during our year-long investigation. Although they share common goals and elements of FIA's big research programs – carbon accounting and remote sensing being the largest of the new programs – they also have distinct personalities that reflect forest types and customer needs within the respective regions.

Herein, we probe commonalities and differences that are brought together in an ingenious organizational structure that ties FIA to its Forest Service internal partners in research and development [R&D], state and private forestry [S&PF] and the national forest system [NFS], and FIA's external partners such as the National Association of State Foresters and University researchers in providing a working repository of our country's private and public forests. Simply defining the internally used acronyms that are subsets of this four-way partnership is a chore. Tracking the intersects that lend shape and substance to these partnerships is daunting. We were fortunate to locate FIA's strategic plan. It does an excellent job of explaining its program elements. This is the plan link.[2]

The executive tier includes three state foresters, the four research station directors, two NFS regional foresters and one national director from each of the three partnerships: R&D, S&PF and NFS. This team typically meets annually. The management tier includes four FIA regional program managers, the FIA national program leader and association, a national representative from Forest Health Monitoring, a national representative from NFS and three state representatives. This team meets quarterly. The technical tier is composed of representatives from statistics, analysis, remote sensing, information management and data acquisition. They meet as needed.

Operational implementation occurs through the four FIA stations. The research stations share and contribute to national program data bases: the FIA data base [FIADB], the National information Management System [NIMS], the National Woodland Owners Survey [NWOS] and the National Assessment and RPA [Resource Planning Act] database [NARPA]..

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How anyone can remember these acronyms is beyond us but they are the sum and substance of a language that is commonly understood among FIA staffers.

What is also commonly understood is that despite its plethora of advanced technological tools, the Forest Inventory and Analysis Program is still deeply rooted in its nearly 90-year old forest and tree census, but the program was expanded in 1998 to include Forest Health Monitoring after Congress became concerned about the increase in mortality in national forests.

The integration of the old boots-on-the-ground survey plots and the new Forest Health Monitoring program created a three-phase colossus that includes 9.431 million aerial photo points, 377,210 survey plots and 23,760 Forest Health Monitoring plots that are a subset of the FIA field survey plots .

Of the six national programs administered by the four FIA stations, the best known is the National Woodland Owners Survey [NWOS] which we discuss in detail in our Northern Region report from St. Paul, Minnesota. The first survey was completed in 1953 as part of an effort to determine how many forest owners there were in the U.S. Since then, the survey has plumbed the depth of numerous topics, none more interesting that landowner management objectives.

Of the 766 million acres of forestland in the United States, 58% is privately owned by some 11 million individuals, families and corporations – with mostly families whose main management objectives are the creation and maintenance of wildlife habitat or to protect aesthetic values.

Periodic timber harvesting is a component in most management plans, but many of the 6,000 or so forest owners who are randomly selected annually

FIA's GEDI [Global Ecosystem Dynamics Investigation] relies on data collected in partnership with the National Aeronautics and Space Administration's Space Station orbiting 254 miles above Earth. Here is the link to the GEDI website [3] which contains colorful schematics, additional information to explore, and important mission details.

report that revenue from harvesting is not a primary management objective. For others who "farm" trees for a living, harvesting is the way they can recover their investments in thinning, reforestation, fertilization and road maintenance.

Of the growing array of space age programs in FIA's toolbox, none are more dazzling than GEDI and OBI-WAN, FIA partnerships with NASA and University of Maryland and led by Sean Healey, a research ecologist at the Intermountain station in Ogden, Utah.

GEDI [Global Ecosystem Dynamics Investigation] relies on data collected by the NASA Space Station orbiting 254 miles above Earth. Healey has Scotch-taped the first message it sent back to Earth in March. My quick and dirty translation of what looks like the linear readout on a heart monitor goes something like this:

"Yoo-hoo everybody down there, I am passing high over a forest in Africa. I see lots of trees and they are all about 30 meters tall."

OBI-WAN [Online Biomass Inference Using Waveforms and Inventory] uses GEDI's plot/model/LIDAR [Light Detection and Ranging using pulsed radar] plus LANDSAT [Land Satellite] archival data stored on a Google Earth engine to generate custom biomass reports for, say, carbon stocks in forest reserves. But much more. Healey has posted a fascinating PDF that explains how the pieces fit and what they do. PDF [4] You can also spend days trolling FIA's website.[5]

Eyes in the sky and boots on the ground. Star wars and more. The public is going to love this story as it unfolds. And we'll be pleased to bring it to you.

Onward we go,

Jim Petersen

Cover: Our nation's wildfire pandemic is concentrated in western national forests. It is fueled by the mostly unchecked advance of insects and disease over the last 30 years. The full wildfire map appears on Pages 4-5. FIA has been monitoring forest health on all public and private land ownerships in the nation for decades.

This is the link to a tutorial file: [6] Click on "Demo" to access different forest values FIA monitors and presents in its interactive "story maps."

The link to the National Interagency Fire Center [7] at Boise Idaho, yet another excellent background source:

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Greg Reams: FIA National Program Leader

https://www.fia.fs.fed.us/ [8]

Editor's note: Greg Reams is National Program Leader for the U.S. Forest Service's Forest Inventory and Analysis Program, a post he has held for 15 years. Before moving to the Washington office, he was with FIA's Southern Research Station (SRS) in Asheville, NC (now located at Knoxville, Tennessee) for five years, a six year stint as Project Leader of SRS's Institute of Quantitative Studies in New Orleans, LA and three years as Project Leader of National Forest Health Monitoring in Research Triangle Park, NC.

Reams was an Assistant Professor of Research at Oregon State University before joining the Forest Service. He worked closely with two Evergreen colleagues: The late Con Schallau, a PhD forest economist and long-time Evergreen Foundation board member and the late Ben Stout, a PhD forest ecologist and Evergreen contributor. Reams holds a PhD in biometrics from the University of Maine.

Evergreen: Dr. Reams, what do you want our readers to know about the Forest Inventory and Analysis Program?

Reams: In the broadest sense, FIA exists as the Nation's Forest Census delivered as a partnership between two branches of the Forest Service: Research and Development and the National Forest System. The National Association of State Foresters is also a partner. FIA and key partners are collectively charged with working with the public to maintain America's forest census. FIA can be thought of as providing vital inventory and monitoring information designed to track the health and productivity of America's forests.

Evergreen: And in the narrowest sense?

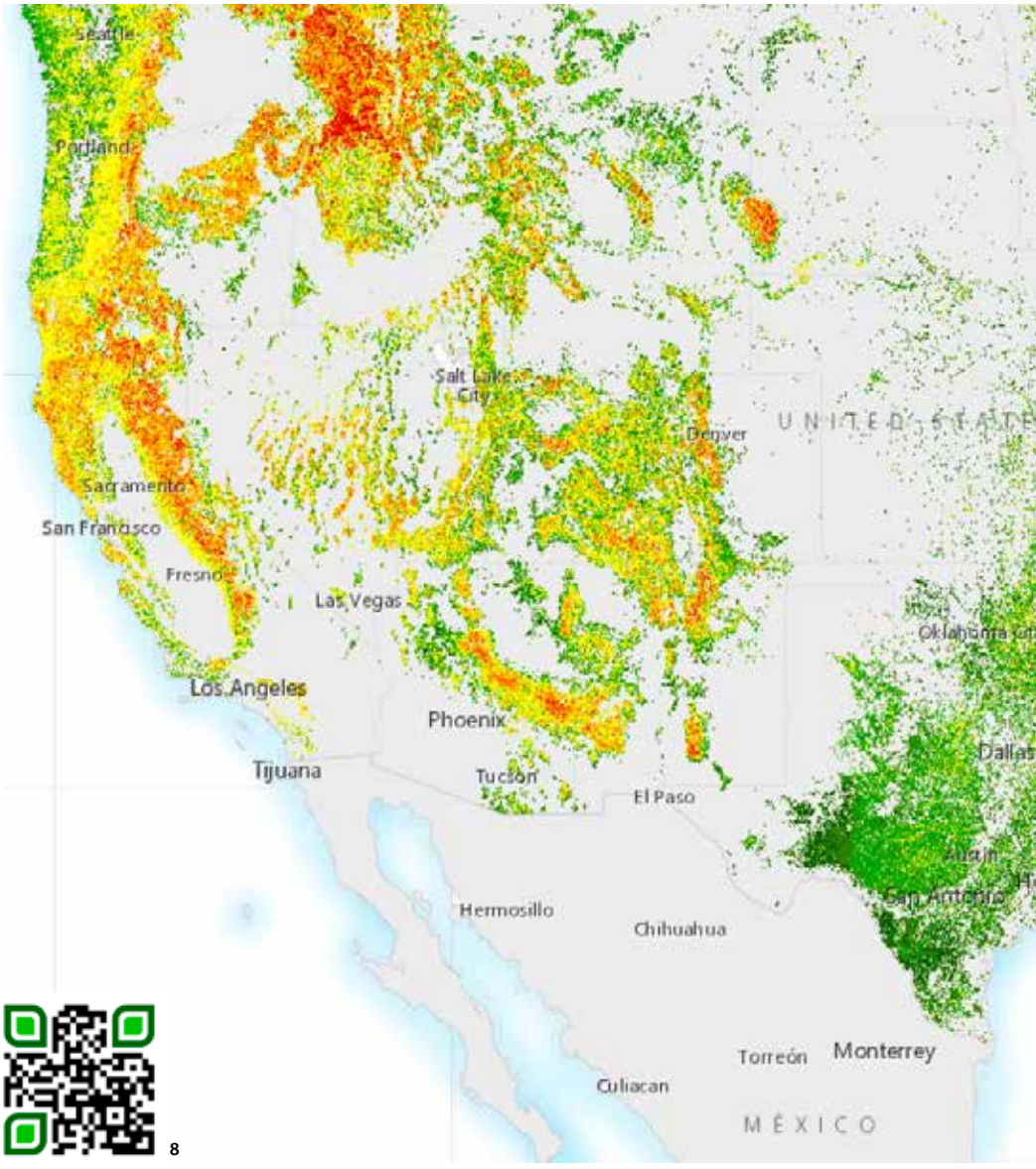
Reams: FIA is the nation's forest land area and tree census. The Census Bureau counts people and provides data concerning our economy. FIA measures and counts forest land and trees in our country's public and privately-owned forests and assesses their status and trends in condition. FIA is also charged with sampling and reporting on mills and other primary wood using facilities, and we also conduct social surveys of forest land owners that provides information on attitudes, behaviors and demographics.

Evergreen: Big job. How long has FIA been counting America's trees?

Reams: FIA was mandated by Congress within the 1928 McSweeney-McNary Act, not long after President Calvin Coolidge met with Dr. Yrgo Ilvessalo, head of the Finnish national forest inventory program. Our first on-the-ground survey was completed in Washington County, west of downtown Portland, in 1930. Our program began in western Oregon and Washington because it was the most important timber producing region in the nation in the 1930's. Charles McNary, who co-sponsored our enabling legislation, was a U.S. Senator from Oregon. Interestingly when FIA moved to an annual forest inventory in the late-1990s our scientists worked with Finnish forest inventory specialists in designing the FIA annualize system.

Evergreen: Trees were the name of the game then, weren't they?

Reams: Yes and to a great extent they still are, though our counting and



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assessment work involves far more than simply counting trees for timber supply.

Evergreen: How so?

Reams: We are more focused on forest conditions and land use than we were in our early years. We can tell you a great deal about growth and mortality, wildlife habitat conditions, watershed health, wildfire risks, the spread of insects and pathogens, and how land use changes and the impacts of carbon accumulation both above and below ground. Our National Woodland Owner Survey informs the public about what motivates private citizens and entities to be forest landowners.

Evergreen: Would it be accurate to say the forest survey work FIA does today is pretty much all inclusive?

Reams: We can never know all there is to know about forests but we know far more than we did even 20 years ago and we're learning more as our assessment techniques improve. But we aren't project oriented on individual pieces of land in the way most private and state landowners are. Our focus is on the bigger picture of all forest lands and ownerships categories in the United States of America..

Evergreen: Your toolbox includes an impressive array of technologically advanced instruments including remote sensing systems and high altitude satellites that are a far cry from your earliest on-the-ground surveys.

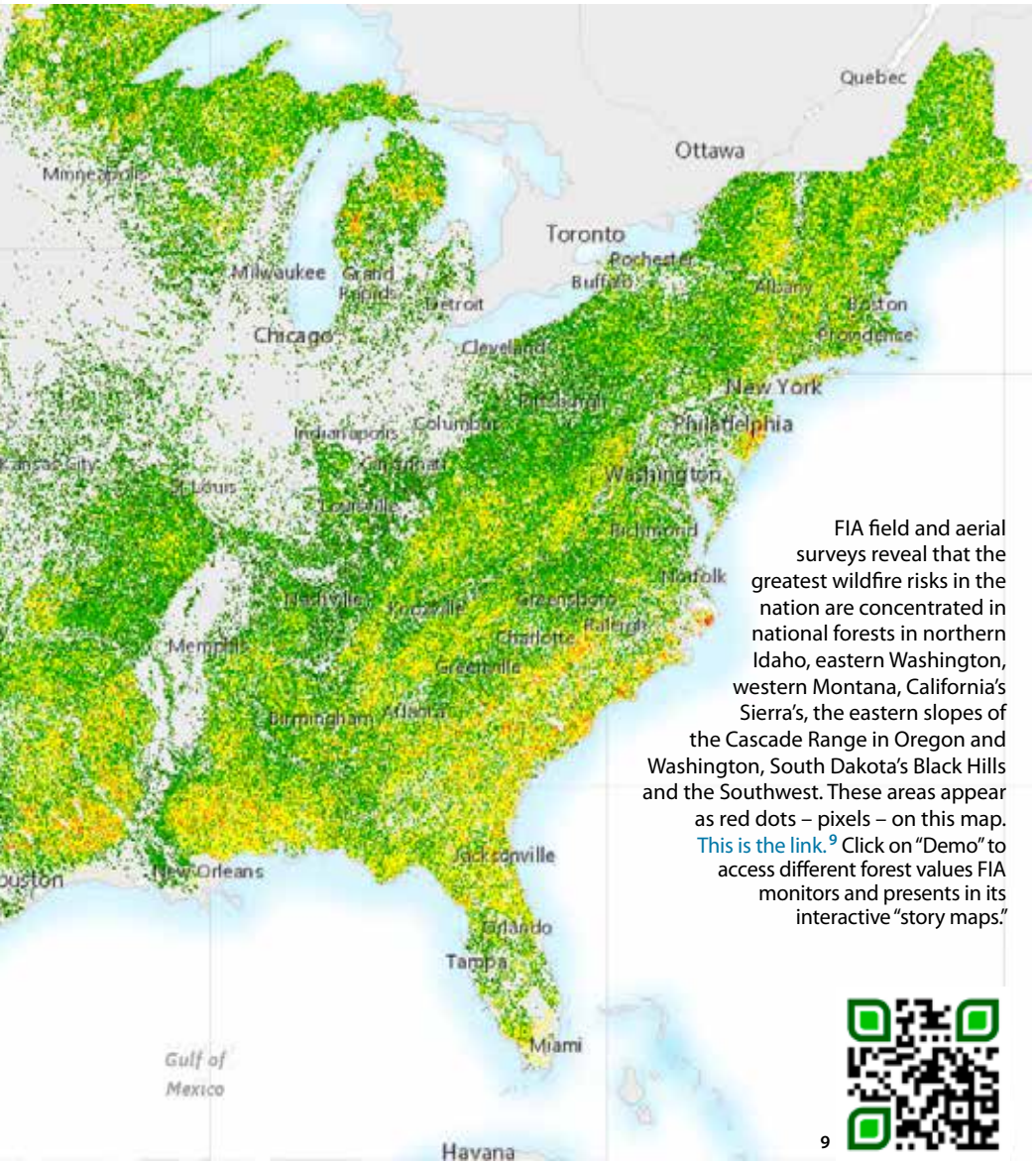
Reams: That's true but there is still no substitute for eyes and boots-on-the-ground. Remote sensing is a big help because it lets us cover vast areas very efficiently, and our classifications of forest and non-forest land categories from remote sensing is key information for improving our inventory and change estimates. However, there is no substitute for detailed information of what's happening in a forest. You need both remote sensing and many boots on the ground – eyeballs looking closely at trees. This why highly skilled field foresters are the life blood of FIA….. measuring the land and trees over time to track forest changes and conditions. The two sets of information go hand-in-hand in modern and highly informed forest inventory systems.

Evergreen: How about drones. Are they a help?

Reams: Drones aren't of much value to us as one might think. One big issue is because many private landowners consider them to be an invasion of their privacy. Global Positioning Systems are a big help as this information allows us to use high resolution imagery and satellite data paired with our boots-on-the-ground field inventory plot business.

Evergreen: FIA is organized in four regions: the Pacific Northwest based in Portland, Oregon; the Interior West, based at Ogden, Utah; the East based at St. Paul, Minnesota and the South, based at Knoxville, Tennessee. How are these regional offices alike and how are they different?

Reams: Our focus differs a bit from region to region due to land ownership patterns. In the East and South we work more closely with state agencies in maintaining access and relevance with private landowners. There isn't as large a concern for western states where a greater percentage of forest is publicly owned, mostly by the federal government. In west we work with the National



FIA field and aerial surveys reveal that the greatest wildfire risks in the nation are concentrated in national forests in northern Idaho, eastern Washington, western Montana, California's Sierra's, the eastern slopes of the Cascade Range in Oregon and Washington, South Dakota's Black Hills and the Southwest. These areas appear as red dots – pixels – on this map. This is the link.[9] Click on "Demo" to access different forest values FIA monitors and presents in its interactive "story maps."

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Forest System to a much greater degree than in the east. That being said, we do have significant partnerships with Colorado, Alaska and California. We're looking forward to the possibilities of this trend continuing.

Evergreen: We've traveled a good deal in the South and it seems to us that there is more of an entrepreneurial bent there than in the West. Are we correct?

Reams: You are. Most of our nation's wood processing capacity now resides in the southern states. There is great interest in the region's wood supply, which is mainly privately owned. We work closely with the states and other organizations to make sure that landowners and manufacturers have the information required to do their long term planning work.

Evergreen: And in the West?

Reams: The West has fewer mills than in the past as many western forests are federally owned and the management emphasis isn't on timber production the same way it was 30 years ago. The Forest Service answers to a more diverse mix of stakeholders whose visions and values differ depending on the values of local communities.

Evergreen: We have been using FIA data for more than 30 years, and I would argue that the West's need for unbiased high quality data concerning forest conditions is every bit as great as the South's.

Reams: I agree. FIA is a data and information provider. How FIA information for forest management is used varies as some landowners and managers may emphasis timber production, and others may emphasis wildlife habitat for example. FIA information can be used for assisting in monitoring publicly as well as privately owned forests for the many intrinsic assets they hold.

Evergreen: How are the four FIA regions you oversee alike?

Reams: I think our DNA is pretty much the same wherever you go. Quality and accuracy are the watchwords. Most of us are technology geeks whether we recognize it or not. We are constantly looking for new and more relevant ways to collect and display our datasets. From our super rugged field data recorders to our online visualization tools, using technology has become very important to us. Columns of numbers have little or no public appeal but colorful maps that display numerical data in interactive layers are exciting and instructive, especially now that we have this data available throughout the country at the county level.

Evergreen: Hobie (Charles) Perry demonstrated the system you reference for us in St. Paul and I must say we were dumbfounded when he called up a set of interactive maps for our neighborhood in Dalton Gardens, Idaho.

Reams: A great deal of hard work by highly skilled people is starting to come together in ways that are publicly very relevant. What you saw in St. Paul reflects the convergence of work by FIA's five technical groups: statistics, analysis, remote sensing, information management and data acquisition.

Evergreen: It was very impressive, but we suppose not everyone at FIA was excited about the prospect of the public having instant access to so much data.

Reams: That's true. Among our production and science teams there is concern for the misuse of data and information that took a great deal of effort and money to collect. Periodically, we as an organization have to remind ourselves that the public paid for this data and information. It's theirs, not ours.

Evergreen: But you have an obligation to answer questions concerning your data.

Reams: Yes we do, but we steer clear of forest management and policy issues, which is to say we run a very transparent organization and we don't cook the inventory books for the benefit of anyone in government or the private sector.

Evergreen: The built-it-and-they-will-come approach.

Reams: That's a nice way of putting it. We lead our customers as deeply into our data sets as they want to go and we answer their questions about the meaning of the data, but the manner in which they use what we provide is their choice. Some do misrepresent our work but I'd rather that our work be publicly accessible, even if it is misused, than unavailable for public consideration.

Evergreen: In our experience, those who have agendas and misuse data are eventually exposed.

Reams: But it isn't our job to expose them. Our job is to provide transparent data of the highest quality and help people learn how to use it accurately.

Evergreen: The National Forest System has been slow to embrace FIA data in their forest planning process. Are you rivals?

Reams: No. In fact, the Northern Region (Region 1), based at Missoula, Montana and the Southwest Region (Region 5), based in Vallejo, California, are making excellent use of FIA data. Other Regions are as well, but these Regions are good examples. There is great interest in merging FIA and NFS data sets in ways that assist NFS land managers to do their work. FIA data and information can assist NFS in understanding how our National Forest lands compare to adjoining state and privately owned lands. In the end this may be a way to understand what management objectives and decision-making will lead to what some would call "desired outcomes" across the landscape. It's an evolving process. Over the last 15 years, I've learned a great deal about the art of patience

Evergreen: How is FIA doing budget-wise?

Reams: All things considered, pretty well. We need more people to complete all the tasks Congress assigned to us in the last two Farm Bills, but when I became Program Leader our annual budget was $20 million. Now its $77 million. I think the increase reflects congressional understanding of the fact that we have delivered and they expect a great deal more from us. We aim to continue our delivery in a timely and efficient manner.

FIA: Pacific Northwest Research Station

www.fs.usda.gov/pnw/ [10]

PORTLAND, OR. - The fifth-floor hallways of the old Gus J. Solomon Courthouse in Portland are lined with filing cabinets, each carefully labeled as to contents.

The cabinets hold thousands of documents – some decades old – that describe and quantify ever-changing forest conditions in the U.S. Forest Service's Pacific Northwest [PNW] Region. The region, which includes California, Hawaii, Oregon, Washington and Alaska, spans approximately 24.7 million acres - an area larger than the combined size of 25 of America's 50 states.

If you are an information junkie or a history lover – I am both - this is the Mother Lode. But it is also the tip of the iceberg. Most of the research data these cabinets hold was completed before the Internet, desktop computers, laptops, tablets, smart phones or remote sensing systems, like LIDAR, which relies on pulsed laser light, or LANDSAT, which assembles images and data beamed to earth by high altitude satellites.

Light Detection and Ranging [LIDAR] and Land Remote Sensing Satellite [LANDSAT] and a half-dozen more acronyms embody the whistles and bells that are transforming the time-honored ground-truthing forest surveys stored in these filing cabinets into colorful and easily understood displays of layered forest data that move as maps across the Internet at the speed of light.

Yet for all of its maps, which bring together data sets that measure an endless array of forest values, the Forest Service's Forest Inventory and Analysis [FIA] Program has had a hard time putting itself on the map. So it is that FIA's science teams in Portland, St. Paul, Ogden and Knoxville hope that the same technologies that power their research programs can land them on the public's radar screen.

"We are a build-it-and-they-will-come organization," Program Manager, Sharon Stanton, says of the exceptionally talented pool of scientists and technicians that work for the Pacific Northwest Forest Inventory and Analysis Program. Her team brings several hundred years of experience to their many research assignments.

But putting a more public face on the FIA Program is challenging. The many public's FIA serves hold often conflicting social, economic and environmental values that don't square with the FIA's research findings. To its great credit, FIA has chosen to maintain its historic neutrality rather than enter forest policy debates more appropriately left to congressional delegations.

To strengthen public access to its research, FIA is harnessing technologies unavailable even five years ago, repackaging its research in smaller and more approachable bites enhanced by a bevy of interactive maps - such as BIGMAP [11] and story maps - that let users select from a long list of preferred forest values of interest or concern to them: timber growth and mortality, forest change attributable to wildfire, insects and diseases, carbon loading in forests, fish and wildlife habitat losses, land use changes and forest landowner management objectives.

"We need to stay out of the policy weeds," says Andy Gray, a research ecologist whose current work has him reconstructing carbon storage trends through time by linking forest inventory and satellite data sets. It is a bit like walking back through time in order to better see and understand the future.

Gray's stroll through time passes by many graveyards including "a water bucket overflowing with dead trees." A forest can only support a certain amount of live tree biomass, so as young stands get older, eventually the bucket fills up and additional growth overflows, and shows up as mortality. Most dead trees are simply a consequence of stands getting older

The fifth floor of the historic Gus J. Solomon federal courthouse in downtown Portland, Oregon is the headquarters for the Pacific Northwest's Forest Inventory and Analysis Program. The PNW Region spans 24.7 million acres in California, Hawaii, Oregon, Washington and Alaska – an area larger than 25 of America's 50 states. *Julia Petersen photo*

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"Is that a bad thing?" Gray asks rhetorically. "I don't know but I can tell you that what we are seeing is the result of public policies that favor growing older trees. As a research organization, we can outline some different options or scenarios people might consider for reducing the flow of dead trees but that's as far as it goes with us."

Gray is careful not to reveal his own frustrations, but they do surface once in the course of our two-hour conversation. When no-harvest late succession reserves were created for northern spotted owls nearly 30 years ago, adjacent adaptive management areas – so called "matrix lands" - were designated for researchers and managers who wanted to try alternative approaches to management goals. But inflexible rules and a lack of buy-in from agencies, regulators, and the public made it difficult. Long-term studies that could have quantified the pluses and minuses linked to various management strategies were never fully developed.

"It was all too political," Gray says. "A marvelous research and management opportunity lost."

We pause. Silence. Perhaps we are both thinking about how different the world might look had key agencies been able to explore new approaches to forest management. Nearly 30 years after the owl's threatened species listing, owl population numbers are still in a free fall even though older forest habitat is increasing. Predatory barred owls get some of the blame, but it now appears that some of our original thinking about owls and their needs was wrong.

Blessedly, Gray breaks our self-imposed silence.

"We aren't just a plot data outfit anymore," he says of FIA's remarkable evolution. "Remote sensing technologies allow us to blend the here and now with our long years of on-the-ground forest survey work. We are blending two stories, one old and one new, using data sets that are more current and more accurate than ever before. It's a bit like trying to catch falling knives."

FIA has indeed come a long way since field data collection began in the Pacific Northwest in the 1930s. Nowhere is the organization's journey more dramatically displayed than in an August 2018 press release from the National Aeronautics and Space Administration, specifically its Advanced Planning Group, which is led by Michael Pasciuto.

"While NASA's job is to develop the Earth Science technologies to help understand and protect our home planet, these technologies can be transferred to our partner agencies," Pasciuto said of NASA's new partnership with the Forest Service. "In this case, we are helping the Forest Service perform an important mission in support of firefighting that helps protect our natural resources and perhaps even save lives."

It takes a moment for me to wrap my head around the very idea of a marriage uniting rocket jockeys with people who have turned ground-pounding into an artform. But then I remind myself of the enormous responsibility Congress has placed on FIA's broad shoulders: 9.431 million aerial photo points, 377,210 field survey plots and 23,760 forest health monitoring plots – all part of a 766 million acre forested landscape that is 58 percent privately owned by some 11 million individuals, families and corporations.

Now the FIA-NASA marriage takes on an air of practicality, but to further understand its significance, I call Hans Andersen, an FIA research scientist stationed at the University of Washington and ask how the NASA connection developed and what it contributes to the forest survey work Andersen and his colleagues are doing in the difficult to reach Alaska Interior.

"Alaska is a very big place with limited road access," Andersen says. "We have been trying for decades to use remote sensing at a much larger scale. Several costly plans for moving crews by helicopter from one 6,000-acre plot to the next simply weren't feasible. Things changed quickly after a fortuitous 2012 meeting with several NASA scientists."

NASA had developed a portable airborne imaging system called G-LiHT and was looking for places to test it. Given its remoteness, Interior Alaska seemed like the perfect place. G-LiHT simultaneously maps the composition, structure and function of terrestrial ecosystems.

The technology blends LIDAR – laser imaging, ranging and detection - with imaging spectroscopy and thermal measurements to provide three-dimensional images of foliage, canopy elements, species composition and biophysical variables with information concerning heat and moisture stress.

"To test G-LiHT, we designed a pilot project that augmented FIA plot data with airborne strip samples on 2.5 million acres in southeast Alaska," Andersen said. "The data proved to be very precise. Now we're expanding into an area about the size of Arkansas and we have funding from Congress to complete a survey of all of Interior Alaska."

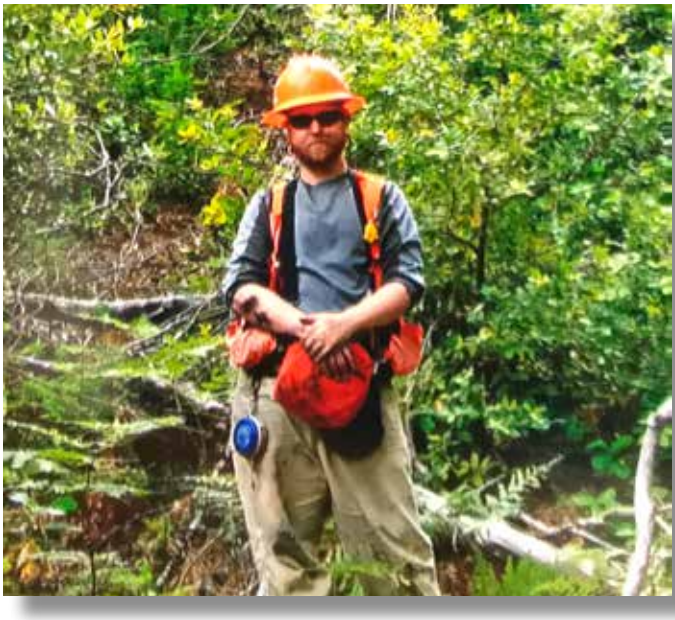
NASA flies hexagonal routes above FIA survey plots in a twin-engine aircraft. Hexagons because they match the curvature of the earth. Field crews then visit the plots to see if G-LiHT images match what they see on the ground. Results to date strongly indicate that FIA has found a remote sensing technology capable of addressing the Forest Service's need to more efficiently collect accurate fine-scale field survey data in Interior Alaska.

"Imaging sensitivity is very important to us," Andersen says. "G-LiHT turns out to be a very promising tool for identifying the components of remote forests."

In keeping with Sharon Stanton's "Build it and they will come" business model, Portland FIA has constructed a forest landscape simulation called "BioSum" that enables users to examine the results of various forest restoration treatments without ever cutting a tree.

The chief architect of this remarkable tool is Jeremy Fried, a PhD forest economist and independent thinker, whose research straddles the blurred line separating the Forest Service's emerging fire culture from its historic forestry culture.

Because Fried is a forester first, he relishes the opportunity to showcase the art and science of forest management. BioSum does it in a way that is both timely and relevant to the public's ever-widening focus on the pluses and



Top Left - Andy Gray; Top Right - Hans Andersen; Middle Left - Johnny Carson; Middle Right - Glenn Christensen; Bottom row, left to right: Jeremy Fried, Katie Rigsby, Sharon Stanton and Summer Dunn

minuses associated with removing excess and mortality-prone trees from forests that pose a wildfire risk.

The BioSum story begins in 2002 when the Portland FIA Team was tasked with estimating how much woody biomass feedstock might feasibly be generated for use in energy development and wood manufacturing by a biomass management program implemented over large forested landscapes in southwest Oregon, northern California, Arizona and New Mexico. All states that are actively working to address the wildfire crisis that is ravaging western forests.

The "biomass summarization" [BioSum] model that Fried and his colleagues developed relies on forest stand data gathered from many thousands of FIA plots, so many that the results accurately reflect detailed forest conditions at state and sub-state levels.

Adding fire behavior metrics – including torching and crown fire indexes - allowed them to compare fire hazard metrics pre and post-treatment. The result is a user-friendly decision support software, complete with spreadsheets, that can compare hundreds of alternative management sequences, evaluates fire resilience results achieved, tracks habitat conservation objectives, weighs carbon dynamics, calculates treatment costs and the dollars associated with transporting woody biomass to existing and proposed wood processing facilities.

"Basically, BioSum identifies and evaluates the low hanging fruit," Fried says of what is clearly another triumph for the Portland shop. "We grow trees in a computer, then we ask ourselves lots of questions about different treatment impacts through time, finding answers that can affirm or refute what we think we know. Sometimes we come to conclusions that aren't very popular."

FIA research quantifying carbon sequestration rates in young versus old growth trees is one such source of public heartburn. It turns out that young fast-growing forests take up [sequester] far more carbon than old growth forests that eventually cease accumulating additional carbon altogether.

Although policy formation is well beyond FIA's purview, or even its desire, Fried believes science has an obligation to explain the effects of alternate management and no management scenarios to those who work in forest policy formation.

"It's what BioSum is really all about," Fried says. "It's a decision support tool. It says if you do this, here are some of the things that may happen, and if you do that, here are some other things that may happen. Either we decide or Nature decides for us."

Fried is among a cadre of forest scientists and economists who have combed the remnants of the Biscuit Fire, a half-million-acre colossus that swept across the Rogue River-Siskiyou National Forest in July of 2002, leaving some five billion board feet of standing dead timber in its wake.

FIA steered clear of endorsing competing post-fire assessments that argued for or against salvaging Biscuit fire-killed timber, instead remeasuring its burned survey plots and studying fire effects on forecast recovery time. Could salvage and replanting have accelerated recovery time or was it best to allow Nature to gradually heal the damage?

The question is unanswerable because proposed study areas – areas in which BioSum could have pro-

Pacific Northwest Region

Regional map: E.T. Hinchcliffe

PNW's Portland Forest Sciences Laboratory holds a treasure trove of documents exploring every imaginable aspect of the region's forests. *Julia Petersen photo*

duced visual answers before trees were removed - were later blocked by the courts.

"There is a lot to know that got swept away in the yes or no debate about salvage," Fried said. "Not all burnt trees die so evaluating their survivability is important information for our growth models. So is post-fire evaluation of soil. Measuring the depth of litter tells us how hot the fire was. The study list is long. All pieces of the wildfire puzzle that we need to put in place for future reference."

Jeremy Fried is hardly alone in his belief that BioSum can provide answers to many of forestry's more vexing questions. His Portland FIA colleague, Glenn Christensen, believes it holds the power to put FIA at the forefront among numerous organizations struggling to answer questions about carbon sequestration. He could be right.

"There is so much interest and concern related to carbon," Christensen says, suggesting a rhetorical 'how can we miss' question that seems both timely and reasonable given unprecedented global media interest in climate change.

Few seem to realize that without carbon there can be no life on earth. Fewer still understand the relationship between sequestration and photosynthesis, the process by which the free, non-polluting energy of the sun transforms complex sugar molecules into cellulose, wood's primary building block and Nature's carbon storage box.

But Christensen , a forester and one of Fried's co-authors on several BioSum reports published by the prestigious Journal of Forestry, starts from an even simpler beginning point: How much carbon is stored in forests in FIA's Pacific Northwest Region Forests?

It is a question that can be answered using FIA survey plot data, which is exactly what PNW-FIA did in its California Forest Ecosystem and Harvested Wood and Carbon Inventory, completed in February and posted on the Internet in April by the California Board of Forestry.

The voluminous report and its' even more voluminous appendix deliver two sobering take home messages. The California goal had been to annually sequester five million metric tons of carbon in forests statewide, but FIA plot data reveals that forests in the Golden State are sequestering 29.2 million metric tons of carbon, nearly six times the state's initial net five million metric ton target but less than the earlier, more ambitious 34 million metric ton estimate.

Christensen gingerly frames two reasons for the decline. First, live trees moving into the standing dead tree carbon pool and, second, an overall decline in gross growth in live trees.

"Neither of these effects are surprising given the widespread drought California forests have recently experienced," Christensen explains. "For us at FIA it is exciting to see the effects of drought showing up in our inventory estimates."

What Christensen doesn't say is that the official unofficial estimate of the number of standing dead trees in California has now surpassed 130 million. He doesn't say it because the data strikes at the heart of a contentious public debate concerning possible solutions. Does California harvest some of its dead timber or does the state let nature do the harvesting?

Nature isn't waiting, which leads to other data sets in the 2017 California carbon report, including one that estimates wildfires are annually releasing a minimum of about 9.5 million tons of carbon into California skies as carbon dioxide, methane and nitrogen oxide – the latter two being far more toxic greenhouse gases than carbon dioxide. All in a day's work for Christensen and his colleagues.

"Our measurements aren't controversial – or shouldn't be," he says quietly. "We are purveyors of measurable process-neutral data going back decades. We see carbon data as a tool for engaging the public in problem solving, but we don't do the policy stuff. We simply say here it is and here are some implications you might want to consider."

In other words, don't shoot the messenger.

Christensen believes FIA can also answer the question that swirls around the opposite side of the atmospheric carbon discussion. How much carbon released into the air by wildfires could be stored in useful wood products? Products made from trees harvested before they burn. The question has a long and interesting pedigree beginning with the formation of The Consortium for Research on Renewable Industrial Materials [CORRIM] in 1976.

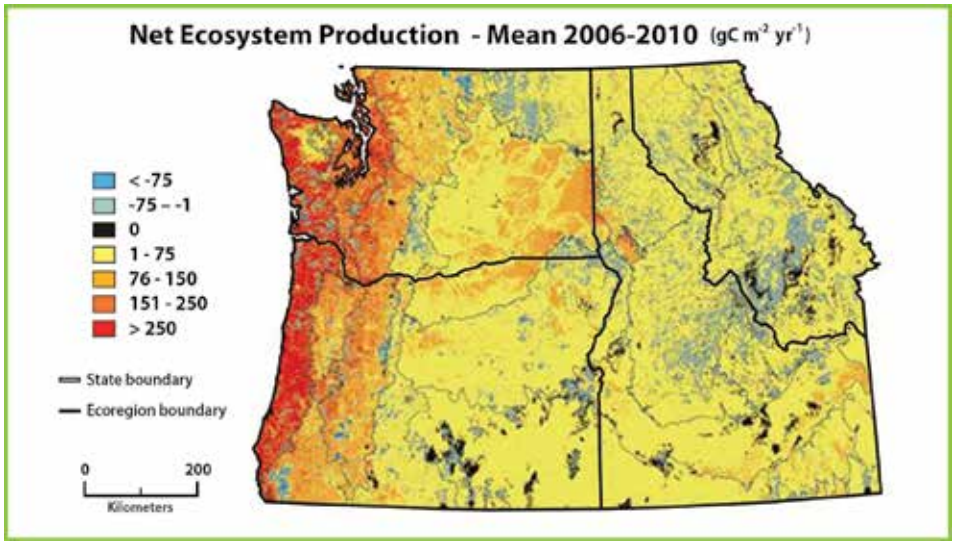
CORRIM's research teams, funded mainly by the federal government, were tasked with comparing the environmental impacts of steel, concrete and wood in their manufacture and use. Wood won hands down.

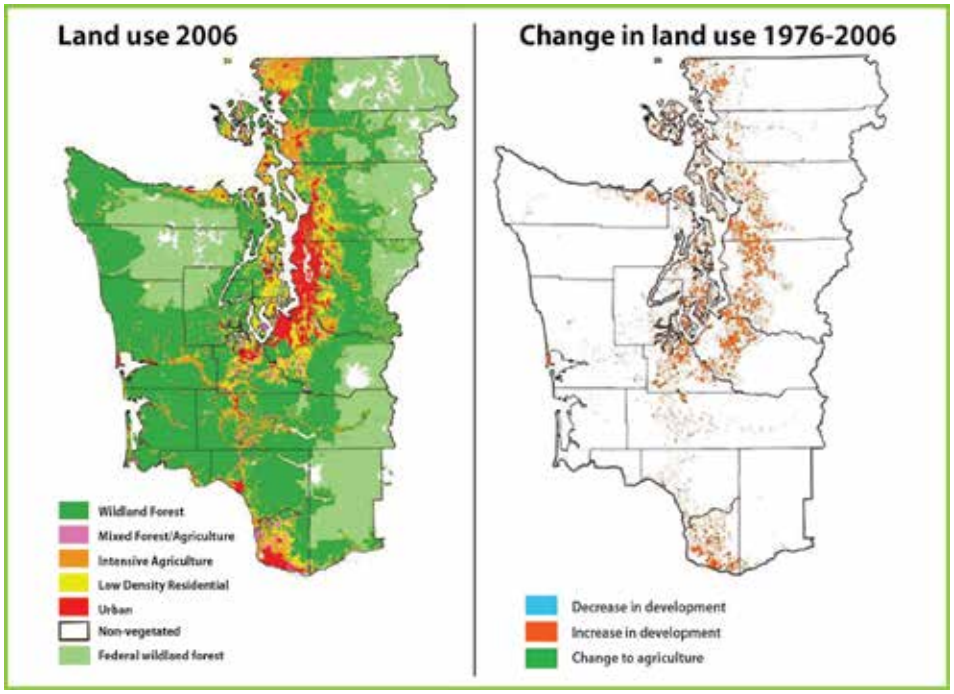
Over the years, CORRIM expanded its wood-related evaluations to include engineered wood products: glulam, laminated veneer lumber and a wide variety of sheeting products. It also expanded the scope of its research to include cradle-to-grave life cycle assessments that followed building materials from their manufacture to eventual disposal, often in landfills.

"All of this makes FIA very relevant," Christensen says of CORRIM and other organizations now similarly engaged in evaluating the environmental impacts of competing building materials. "It will be very interesting to see how our work dovetails with work being done at the Forest Service's Forest Products Lab at Madison, Wisconsin and how we relate to other groups."

Interesting to say the least. The architectural world has greeted the newest engineered wood marvels – mass panel plywood [MPP] and cross-laminated timbers [CLT] – with thunderous applause. Although talk of building skyscrapers from wood seems premature, MPP and CLT manufactured from small diameter trees are being used in the assembly of commercial buildings 20 stories tall. Many a thinker has noted that the use of small diameter trees in such dynamic venues provides privately-funded markets for trees the Forest Service would like to remove from forests that pose a significant wildfire risk.

For all of its newfound technological prowess, FIA Portland is still grounded in a field survey system sketched out by Thornton Munger, PNW's first director,





Cloud computing is allowing FIA's research stations to create interactive "story maps" composed of multiple layers of complex data sets. Anyone with a laptop computer or cell phone can access these maps in moments. Click here for maps and the associated reports. [12]

These are the links to a great deal of information about forests in California, Oregon, Washington and coastal Alaska:

Forests of California, 2017 [13]
Forests of Oregon, 2016 [14]
Forests of Washington, 2016 [15]
Forests of coastal Alaska, 2014 [16]
A link to a data treasure trove of state statistics assembled by FIA/PNW [17]

in the 1930s. Its protocols are laid out in a well-illustrated 480-page how-to field manual held together by a spiral binder. Field Instructions for the Annual Inventory of California, Oregon and Washington is divided into 15 chapters, at least 50 sub-sections, 23 Appendices [A through W] and a Glossary. It is the surveyor's bible.

I do not know if field survey crews commit the manual to memory but it must be something close because, when I interviewed a wildlife biologist who was doing survey work on the Idaho Panhandle National Forest a few years ago, he was able to describe his work process in fine detail. Everything was counted or measured: live trees, dead trees, diameters, tree heights and species.

His survey area was so large that traveling to and from work on a daily basis was impossible, so he camped out from Sunday night through Thursday night. Fridays were office days. There were report summaries to tally before he emailed his work to his supervisor.

"Do you like your job," I stupidly asked. If he thought I was an idiot – and he probably did – he gave not the slightest hint.

"I get to camp five nights a week, work at my own pace, fish for trout for dinner every evening and fall asleep watching the stars," he said matter-of-factly. "What do you think?"

Crew performance is graded for accuracy and completeness. In Portland, quality assurance falls under the watchful purview of a biological scientist named Johnny Carson. Yes, there really is a Johnny Carson roaming the hallways at Gus Solomon and, yes, he is incredibly gracious with strangers who cannot resist imitating Ed McMahon's nightly refrain: "Here's Johnny!"

"We audit the work of 10 percent of our field plots every year," Carson explains. "They are picked at random and we go into the field to see if what we see on the

12 13 14 15 16 17

ground matches with the data they report."

And does it?

"Out-of-compliance surveys are rare," he replies. "It happens, but not very often. Sometimes we get reports from survey plots that were established in the 1940s, not long after the system was developed. It's very cool to know we are part of a lineage that began almost 90 years ago."

Katie Rigsby, another biological scientist with Portland FIA, coordinates field survey crews working in Washington, but she got her start in southeast Alaska, where her crew traveled the region's roadless expanses by boat or helicopter. Her four Washington crews surveyed 480 plots in 2017 and could have done more but their work was disrupted by yet another miserable wildfire season.

Rigsby, a Boise, Idaho native, projects refreshing, welcoming enthusiasm. "We put a face on FIA" she says of her community outreach. "I do lots of classroom work in schools around here, explaining what we do and how we do it. I want to be a role model."

Summer Dunn is equally enthusiastic about her work as FIA-PNW's connection between survey crews and stakeholder groups: organizations like the Portland-based Oregon Forest Resources Institute, state agencies, conservation groups, forest landowners and "ordinary people who stumble upon us."

Dunn sits on FIA's national communication committee – and for good reason. She is high-spirited and tireless – and she brings a creativity to her outreach that any privately-held company would love to have. Among her innovations: a newsletter and a portfolio packed with step-by-step community engagement projects and templates for anyone in FIA to use as a tool for communication, education, and outreach.

"We are in the business of changing hearts and minds," she says of the great utility value she sees in FIA's Portland portfolio. "We are public servants in the business of providing ecosystem services – all of the bits and pieces of a forest plus the outdoor recreation assets that our stakeholders value. My goal is to bring all of it down to the individual level. There is no other way to develop real and lasting connections with the many publics we serve."

The perennial challenge facing FIA is the same as it is for many federal agencies: funding and capacity. In the last two Farm Bills Congress handed FIA new responsibilities, but not sufficient funding to sufficiently increase capacity.

How do we persuade Congress to increase funding for a government agency most people have never heard of? When we ask FIA's Portland staff what they suggest to raise public awareness their answers are as varied as their personalities, and deeply connected to their work and their passion.

"My self-serving answer is to do a better job of positioning our products and services in the research literature," Andy Gray says. "The policy folks rarely see our stuff. Strengthening our credibility would help because our data sets are often misrepresented or misinterpreted by other researchers who cherry-pick what we provide free of charge. It's very frustrating."

Glenn Christensen sees carbon as "a sales tool – a conversation starter with publics who would use our research in their own outreach if they knew more about who we are and what we do."

Jeremy Fried is much less circumspect in his assessment. "We aren't good at promoting ourselves. We aren't even connected to national forest staffs that need to be using our research. We need to fix that."

"In the wider world, what people see is a lot of very expensive research that is free for their use, Fried says. "It's a 'so what' for most of them because they don't appreciate the significance or applicability of our work. We can only do so much to change this and we are already understaffed."

Portland FIA Project Manager, Sharon Stanton, sees the Internet, cloud computing and FIA's push into urban centers as keys to increasing visibility and support for the program.

"All of our research – what you see in filing cabinets in the hallways and what we store almost daily on our servers - is useless if it isn't being used by a larger and larger pool of stakeholders who then integrate it with their own knowledge and experience," Ms. Stanton explains. "It's a chicken and egg story. We need more visibility, which costs money and we need more money for research, which can only come with greater visibility."

Our non-profit Evergreen Foundation has been a steady consumer of FIA data for nearly 30 years. Likewise, our colleague, Mike Cloughesy, Director of Forestry for the Portland-based Oregon Forest Resources Institute [OFRI], another non-profit with deep roots in Oregon's forests.

"We use FIA data because it is the best and, in many cases, the only data available to describe the forests of Oregon and how they change through time," Cloughesy said when I asked about OFRI's use of FIA data. "We could not do our job of educating Oregonians about our forests without FIA data."

Although OFRI derives most of its annual revenue from a tax on the harvest of timber from privately-owned forestlands in Oregon, it functions as a state agency whose mission is to keep Oregonians abreast of forestry and forest conditions across the state. Every two years, OFRI publishes a well-received "Forest Facts" reference booklet filled with FIA data.

"We produce this booklet to update policy makers," Cloughesy says. "Forest Inventory and Analysis data is a primary source for our facts. We also periodically produce an economic analysis of Oregon's Forest Sector and we are working on an update with forest economists from Oregon State University and the University of Idaho. FIA data is again an important source."

The U.S. Forest Service was only three years old when it sent 25-year-old Thornton Munger west to investigate ponderosa pine mortality near Bend, Oregon in 1908. His work so impressed Raphael Zon, the legendary head of the Forest Service's Division of Silvics, that he named Munger the PNW station's first director in 1924. Under his leadership, the nation's first forest inventory was completed in Oregon in 1932. Although Munger preferred the solitude that research offered, I think he would be both astonished and very proud of Portland FIA's reputation and record of accomplishment.

Onward,

Jim Petersen

FIA: Rocky Mountain Research Station

www.fs.usda.gov/rmrs/[18]

OGDEN, UTAH – Gifford Pinchot was Chief of the Forest Service when the agency selected Ogden as its District 4 headquarters in 1908. Pinchot picked Ogden over Salt Lake City because the Union Pacific Railroad passed through here on its way northwest to Promontory Summit, where the eastbound Central Pacific and the westbound UP were joined to form the first transcontinental railroad in America.

Leland Stanford, one of Central Pacific's four investors, dropped the ceremonial golden spike – a 17.6 karat copper-alloyed gold shaft - into a pre-drilled hole on May 10, 1869. The spike is now on display at the Cantor Arts Museum at Stanford University, which Stanford and his wife, Jane, founded in 1885 in memory of their teenage son, Leland Jr., who died of typhoid fever in Italy in 1884.

Ogden was also the first permanent white settlement in what is now Utah. Then known as Buenaventura, it was founded by a trapper named Miles Goodyear in 1846, about a mile west of the present downtown area. It was later renamed Ogden, after Peter Skene Ogden, a Hudson's Bay Company brigade leader.

We do not know where the Forest Service's first District 4 office was first located in Ogden, but we do know that in 1902 - three years before the Forest Service was formed - a former cattle and sheep man with no formal forestry training surveyed the Forest Reserves that would become Utah's six National Forests.

We know this because Albert Potter's 140-page report to Gifford Pinchot was found in 2004 in the basement of the present day offices of the Rocky Mountain Research Station at the corner of Twenty-fifth Street and Adams Avenue in Ogden Completed in 1934, General Services Administration Building UT00010ZZ was one the of the first federal buildings completed under the aegis of the Works Progress Administration, a colossus created by the Roosevelt Administration to take men out of Depression-era breadlines and soup kitchens.

The Forest Service's Rocky Mountain Research Station and its FIA staff are housed in a beautiful old General Services Administration Building in Ogden, Utah. Built in 1934, the structure stands on the corner of 21st and Adams. It was one of the first completed by Franklin Roosevelt's Works Progress Administration. *Julia Petersen photo*

In classic understatement, a brick sign with metal lettering Twenty-Fifth Street announces that this marvelous Art Deco structure is the "Forest Service Building." It is four-stories tall and includes a rarely-seen basement where Potter's 140-page report was found 102 years after it was submitted to the Bureau of Forestry office in Washington, D.C. The four-volume document, typed on onion-skin and bound in ribbon, included Potter's boundary recommendations and hand-colored maps for five proposed reserves: Logan, Wasatch, Gunnison, Aquarius and Sevier.

Pinchot, who was then Chief of the Bureau of Forestry, hired Potter in 1901 to handle some sheep grazing problems in the forest reserves. He admired his quiet demeanor, his business acumen and the fact that he seemed to know everyone in the Southwest – personal assets that, in Pinchot's opinion, far outweighed the fact that Potter had no formal training in forestry.

Pinchot's instincts were spot on. The following summer Potter rode some 2,000 miles on horseback through Utah's canyons and rangelands, recording everything he saw and every person he visited in his diary. His notes indicate that he took more than 400 photographs but only 67 were found in the basement in Ogden.

There were only 200,000 people living in Utah in 1901. It had only been a state since 1896, the year before Butch Cassidy and Elzy Lay held up an employee of the Pleasant Valley Coal Company in broad daylight at the train station in Castle Gate, Utah. No wonder Potter and most of the Forest Service's early rangers wore sidearms and carried rifles in the scabbards on their saddles.

Since it was completed in 1934

18

– six years after Congress put the U.S Forest Service in the tree counting business - GSA's iconic Building Number UT00010ZZ has been the headquarters for the agency's former Intermountain Forest and Range Experiment Station. The counting continues, but much more goes on in this building than Congress could have even imagined when it ratified the McNary-McSweeney Act in 1928. It is all well beyond Albert Potter's wildest imaginings.

FIA's offices are on the third and fourth floors, up flights of stairs built by Murch Brothers, a St. Louis, Missouri construction company that erected the building based on designs and engineering plans developed by Hodgson and McClenahan, an Ogden architectural firm remembered for designing several of the small city's historic downtown buildings including the Bigelow Hotel, the Ogden Municipal Building, Ogden High School and the Eccles Building, completed in 1913.

My friend Jim Menlove works on the third floor of the Forest Service Building. He is an FIA analyst for the Interior West. Although we have never met, I have been emailing him my questions concerning the declining health of national forests in the Intermountain West for about 15 years. I am delighted to be able to finally put a face with his name.

Jim warmly greeted Julia and I at the front door on a blustery Thursday morning last April. He was younger than I thought he'd be and not as big as the man I had pictured in my mind's eye. It's strange how we form these mental constructs of people we've never met.

I used our opening moments to explain to Jim that the late Con Schallau introduced me to both FIA and the Forest Service's Resource Planning Act [RPA] assessments nearly 30 years earlier. Con was a widely respected PhD forest economist then stationed at the Pacific Northwest Research Station on the campus at Oregon State University. Jim's reply amused me.

"You won't see any trees here that remind you of western Oregon. Mostly, we have rangeland. Our only timber producers are in Idaho, western Montana and the northwest corner of Wyoming. Lots of sage and juniper, some trees, but nothing like what you see where you live in northern Idaho."

Having twice driven the length and breadth of Utah, I have seen what Jim described. Its' steep canyons and mostly treeless rangelands – the main characters in Albert Potter's 1902 account - are beautiful. So are Utah's five national parks, which hold some of the most breathtaking rock formations on earth. Poet and artist Everett Ruess was

Interior West Region

Regional map: E.T. Hinchcliffe

barely 20 years old when he vanished somewhere in a dazzling Escalante River Canyon in 1934, never to be seen again, his disappearance memorialized by singer-songwriter, Dave Alvin.

Jim ushers us to an upstairs conference room where our two-day visit begins with a round robin discussion that include Michael Wilson, FIA's Ogden Program Manager, Brett Wilson, a field survey crew leader, Tom Weber, who checks the accuracy of field survey data and Sean Healey, who would dazzle us later in the day with forest data beamed down to his computer from NASA's Space Station. It was only one of Healey's many space-age toys.

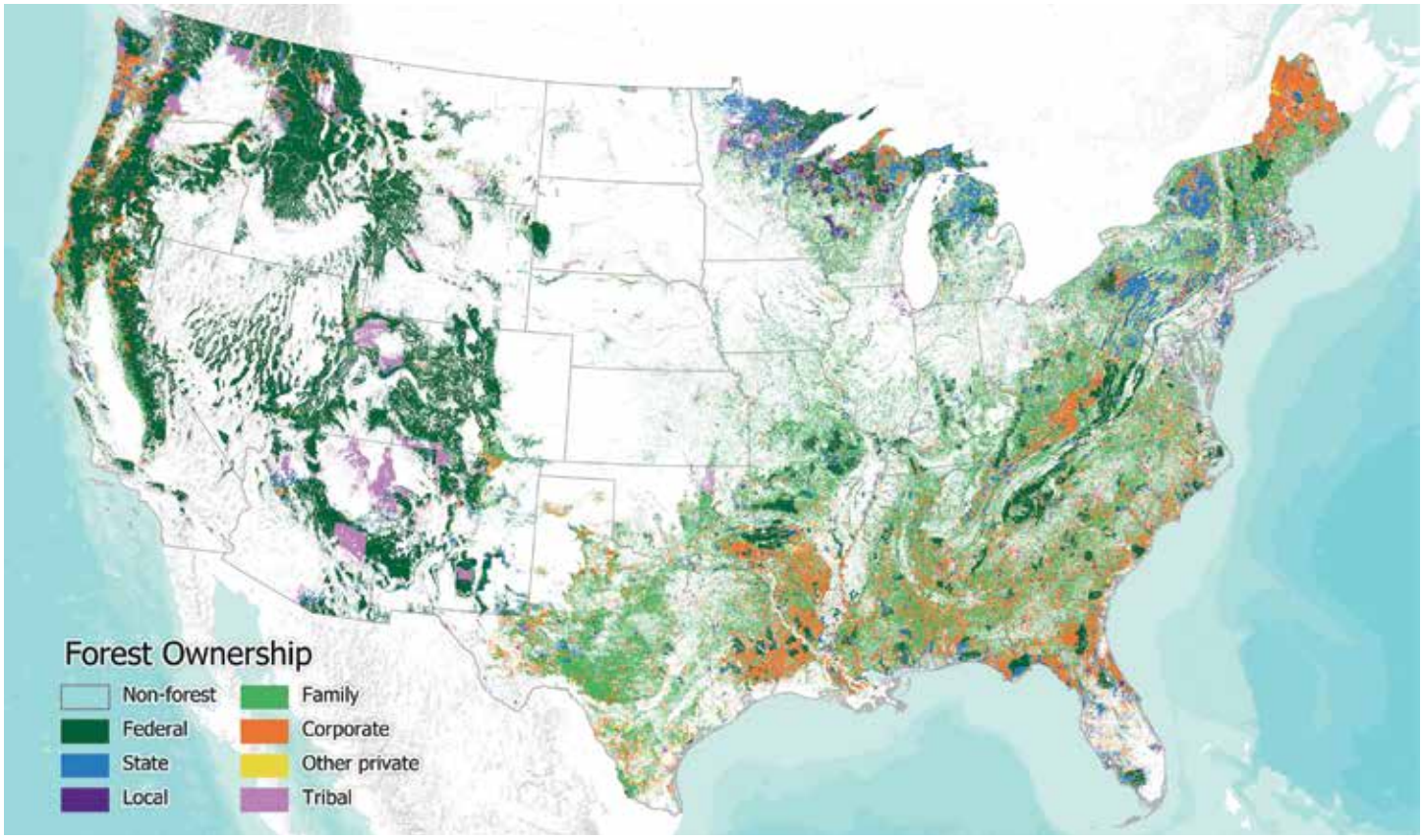
In the course of our morning conversation, which was punctuated by coffee and donuts, it became clear to us that, while FIA Ogden has the smallest staff of the four stations, its programmatic activities mirror those of St. Paul, Knoxville and Portland. Survey plot data collection is a big deal and so are carbon accounting and merging data sets in ways that allow for the creation of story maps [more later on these] now in vogue at FIA's other stations.

Owing to perceived differences in customer need, the emphasis in Ogden is a bit different than it is elsewhere. Portland has its new urban push, Knoxville is all about relationships with forest landowners and forest products manufacturers and St. Paul straddles forest land conversion worries and a need to do more to help cities and towns do a better job of managing the trees that grace their boulevards and parks.

But in Ogden the challenge and goal are to encourage National Forest personnel in Idaho, Montana, Nevada, Utah, Wyoming, Colorado, Arizona and New Mexico to increase their use of FIA data in their decadal forest plans. The job is enormous. All or parts of 50 national forests lay within this eight-state region. They comprise about 23 percent of the entire U.S. land mass.

The challenge necessitates the merger of FIA data with National Forest System data – no small feat on a good day and a task made somewhat delicate by the fact that Intermountain national forest personnel have sailed their own ships for decades. It isn't so much a matter of being unwilling to play as it is old habit and different measuring sticks. But it's coming.

"We've all had to get over ourselves," says Renate Bush, who oversees the vegetation and inventory management program in the Forest Service's Region 1 office in Missoula, Montana. She has been an FIA advocate since her earliest days with the Forest Service, some 25 years ago. "The goal is to create a more detailed and more accurate picture of our forests. FIA's data helps us do that but we have to integrate it into our more descriptive national forest system data sets. We're working now on common definitions and algorithms that will help us inte-



America's privately-owned forest lands are concentrated east of the Mississippi river and mainly in the Southeast. Public ownerships are mainly in the West and are cared for by the U.S. Forest Service. Private lands – Tree Farms - owned by families and family trusts provide the largest share of the nation's annual timber harvest. Interesting given that most of these owners report that maintaining or creating wildlife habitat is their primary management objective.

Credit: Jaketon H. Hewes, Brett J. Butler, and Greg C. Liknes, map produced by Bryan J. Hemmer, USDA Forest Service FIA; Fort Collins, CO: Forest Service Research Data Archive.

grate FIA's data with our own for every Region 1 forest plan."

I have been using growth and mortality data assembled by Jim Menlove and his team for at least 15 years. The reality of the Interior West's forest health/wildfire crisis is never far from my mind or his – in my case because the journalist in me knows this is the biggest story I will cover in my lifetime, and in his case because the death and destruction he and I are witnessing is happening on his watch and there isn't a damned thing he can do about it except report what field survey data collected over eight of the largest states in the United States tells him annually. My friend Jim is the consummate Forest Service professional.

"It is the perfect storm," he says of the convergence of insect infestations, pathogens, tree root diseases, prolonged drought in the Intermountain West, unprecedented woody debris buildups and our changing climate. And yet the press rarely calls his office. When Utah's largest newspaper, the venerable Salt Lake Tribune, wants a wildfire progress report it calls the National Interagency Fire Center in Boise.

Makes sense I guess, but the bar graphs we built from data Jim's crew assembled for us tell a frightening story of unwanted things to come. Our Colorado growth and mortality bar graphs scared the hell out of the state legislature, but we also assembled graphs for Idaho, Montana, California and Washington State east of the Cascades. It's ugly out there. Annual tree mortality exceeds annual growth in most of the West's national forests. We are in crisis mode and it is jarring for many, including Jim and me.

"Our work is mainly with state and national forestry in the Interior West and people like you," Menlove says of our long professional relationship. "The current wildfire crisis benefits FIA Ogden. People see dead trees and burnt rangelands and forests and they want answers. These are great teaching moments, especially with the large increase in national forest tourism in the West."

They are teaching moments for sure, but FIA stays out of the political weeds and so does Jim. "We don't petition Congress," he says of rising public worries about the West's wildfire pandemic. "Our customers do. We're in the data business. Our data is very transparent. Take it and use it. Let us show you how to use it."

We admire FIA's impartiality – its oft-repeated desire to stay out of the political weeds - but good lord, would I ever like to turn this crew loose in a congressional hearing or the offices of the Washington Post or the New York

Times. I suppose I should be grateful for the fact that they've finally noticed that the West is burning to the ground, but where are the investigative reporters with the hard questions?

Wouldn't it be grand if we could actually lure a few of these big league reporters to Ogden, or any of the FIA stations for that matter. I think they'd be astonished by the level of professionalism, to say nothing of the scientific and technological horsepower that resides within the research stations.

We start our press tour in the GEDI Guy's small office, upstairs from Jim's third floor office. His real name is Sean Healey and he is a research ecologist and an absolute delight. We nick-named him the "GEDI Guy" after sitting through his mind-bending explanation of the Global Ecosystem Dynamics Investigation [GEDI], an investigator-led NASA mission that FIA helped design and that is led by the University of Maryland. It beams precise measurements of forest height to Healey's computer [among many] from 254 miles above Earth.

The first message it sent back to Earth last March is Scotch-taped to the door of Healey's office. It looks like the linear readout on a heart monitor. His quick and dirty translation goes something like this: "Yoo-hoo down there, I am now passing over a forest in Africa. I see lots of trees and they are all about 30 meters tall."

Top Left - Jim Menlove; Top Right - Gretchen Moisen; Bottom Left - Sean Healey; Bottom Right - Kristen Pelz

No wonder Healey swears up and down he has the best job in the Forest Service.

"GEDI was launched about four months ago - December 5, 2018," he explains. "It's a two-year mission. We got our first height measurements back about two weeks ago. The laser can penetrate forest canopies and give us three-dimensional pictures at billions of locations around the world. So far we have about 300 million footprints."

Boy do I wish Albert Potter could see this stuff.

And then there is OBI-WAN and, yes, whoever named these two programs must have watched Luke Skywalker flying down Beggar's Canyon, around Dead Man's Turn, past the Stone Needle and through Diablo Cut in George Lucas's epic 1977 space opera. My then 10-year-old son and I were on the edges of our seats at the old Liberty Theater in Kalispell, Montana.

OBI-WAN - Online Biomass Inference Using Waveforms and Inventory – uses GEDI's plot/model/LIDAR [Light Detection and Ranging using pulsed radar] plus LANDSAT [Land Satellite] data stored on Google Earth engines to generate custom biomass reports for, say, carbon stocks in forest reserves or most anything else you might want to know that these technologies have unlocked. The government released its entire LANDSAT archive to the public in 2008, so FIA now has free access to millions of formerly costly images gathered from 1984 forward.

And then there is G-LiHT, a NASA technology fully explained in our FIA PORTLAND essay but footnoted here to emphasize the fact that FIA's big research programs are staffed and shared by all the stations, Ogden included. G-LiHT blends LIDAR with spectroscopy and thermal imaging to provide three-dimensional images of foliage, canopy elements, species composition and biophysical variables with information concerning heat and moisture stress. It is testing well in mostly roadless Interior Alaska, which is expensive to survey – to the point of impracticality – because it can only be reached by plane or boat.

Healey explains how these pieces fit. "We are able to monitor large-scale landscape changes through time in a way that wasn't possible until now," he says. "And we can illustrate these changes on maps that show changes in various forest values that are important to the public."

But people see different things on the same maps. Some will see big clearcuts in western Oregon. Others will see millions of acres of newly planted Douglas-fir. It all depends on you value in forests. Knowing this, Healey and others are layering data sets in a way that allows users to mouse-click from one forest value to the next. The latest generation of the wildfire-forest health maps we have been using at Evergreen for many years are products of this algorithmic layering. The main difference now being that we can click from one forest value to the next on the same map and track what's happening with tree species, age classes, growth and mortality, insects and diseases, biomass, watershed health and wildlife habitat.

FIA and the National Forest System are beginning to develop "story maps," short narratives that explain what you see as you click your way through county-level data sets now available for every country, borough and parish in the nation. My guess is that these vignettes will do wonders for FIA's low public visibility.

Kristen Pelz is tasked with encouraging national forests in Regions 3 [Arizona and New Mexico] and 4 [southern Idaho, Nevada and Utah] to make better use of FIA data in their forest planning processes. Her job is much the same as Renate

FIA Ogden is developing impressive interactive story maps for each of the eight states in its region: Idaho, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah and Nevada. Here is the link to the Nevada map[19] illustrating both forest and rangeland. Identical maps for every state at this link.[20] Additional maps and reports for other states can be found at this link.[21]

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Bush's job in Region 1 – which is to say a good deal of diplomacy is required when dealing with national forest staffs accustomed to doing things their way.

Pelz, who has a PhD in forest ecology, understands the overly-cautious approach she is seeing among some national forest staffers.

"There is a lot of hesitation about using our data because it is more spread out than many would like," she explains. But it is some of the only field data that gets measured consistently across large areas. I see push back and enthusiasm from national forest to national forest. My plate is full helping those who are enthusiastic and want help."

The list of those who want help is long and will likely grow even longer as FIA's public visibility increases. Americans who are concerned about forest health and conservation don't yet realize that the answers to most of their questions are no further away than their cell phones and laptop computers. The challenge facing all of us lies in understanding what these data sets mean. Clearly, big technology, cloud computing and a bevy of social media platforms are laying unprecedented opportunities and challenges on FIA's doorstep.

Day 2 in Ogden begins in John Shaw's impossibly crowded office. I sit on a hardback chair next to his desk and set my morning coffee cup on a book box that functions as my work table. It is one of many stacked between filing cabinets and at the end caps of book cases. This is a corner office, but you'd never know it for the thousands of reports stacked here, there and everywhere.

Shaw says he is "the Andy Gray" of Ogden FIA. Gray works in the Portland office. "Andy calls himself the old geezer. I am the old geezer here. We are jacks of all trades and possibly masters of none, but we have been around long enough to have seen and participated in our share of academic food fights."

Shaw's sense of humor compliments his outgoing personality. There isn't much about him that hints at the fact that he holds a PhD in forest ecology. In fact, he will be the first to tell you that the forestry mantle allows its practitioners to piece together their own self-study programs: silviculture, geology, dendrology, soil science, whatever. Shaw has dabbled in all the whatever's.

"It is urban legend that the national forest system can't use our data sets," he begins. "We're doing it now but it has taken us about 20 years to get here. There is very little we can't do with data now."

It would seem so but Shaw reveals that the basement in this building – where Albert Potter's 1902 forest survey was found – still holds "tens-of-thousands" of old photographs waiting to be digitized plus more than 20,000 core samples taken from trees over many decades.

"This stuff is invaluable in our research," Shaw explains. "The photographs we have digitized are high resolution, so that's good. And when the core samples come with location data we can go back and take another sample – if the tree is still standing - and learn something new about the effects of climate change."

Repeat photography from numerous academic sources confirms the anecdotal evidence we have about forests in the Interior West. Tree density has increased significantly, Shaw informs us. Climate change and greater density equal more disease and fire. "It's kind of a no-brainer, isn't it," he asks rhetorically.

Increasingly, Shaw's work is focused on long-term changes in forest and rangelands across the Interior West. He has become a geomorphologist of sorts, probing how earth's big drivers – air, water, wind, fire and ice – have influence very large landscapes through time. "Basically, figuring out what the past can tell us about the future," he says.

And what is Shaw learning? "Things change," he says. "Often in unpredictable ways. This is a long-haul story with natural and human influences. Sometimes we're too optimistic and sometimes we're too pessimistic. Right now, things aren't looking good with all of our big wildfires and their underlying human and natural causes. But we are seeing less disease in live trees. The fallout that is still with us is in trees that were already sick or dead."

"That's a good thing too, isn't it," I ask.

"It is a good thing," Shaw replies. "But these big wildfires don't care if the trees are green or dead which is why we need to pay close attention to what our data is telling us about what we should be doing and not doing to reduce risk."

Like Shaw, Justin DeRose spends a lot of time trying to understand why some trees are surviving what he calls "the great drought-induced die off in the West." Are there genetic factors involved here? "Possibly," he says. "We are hunting for factors that improve survivability in times of great stress. Those are the trees we need to help regenerate."

There are conundrums wrapped inside enigmas here. Lots of them.

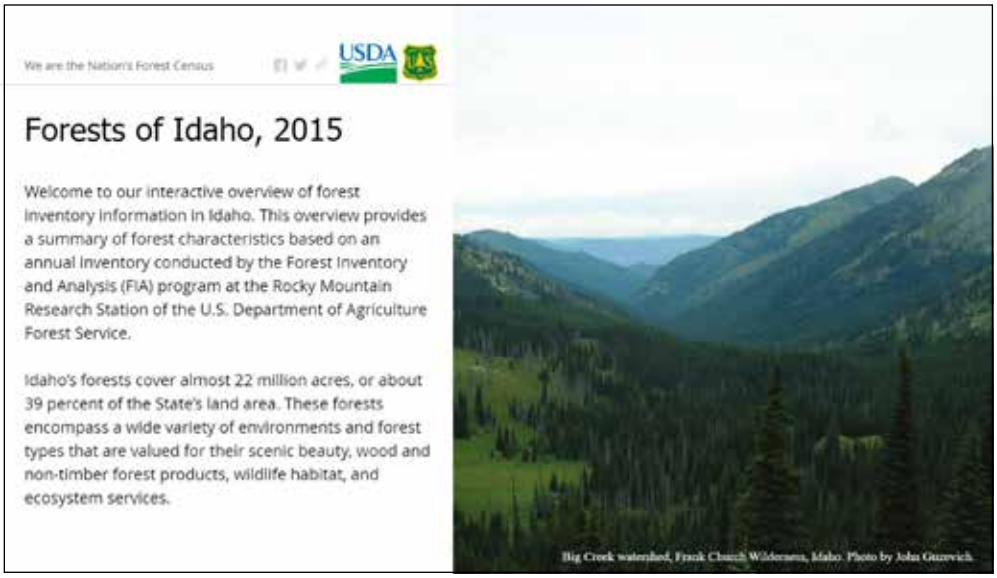
"When we say 65 million trees died in California last year it makes headlines," says DeRose, a research ecologist with FIA Ogden. "But if we say that's less than one percent of all the trees in California it doesn't make news. It's the same with growth and mortality. It is alarming, but for how long? We don't know, but it may not be as dire as we currently believe."

DeRose is right. We don't know how long "the great die off" will go on, but most of us don't like the devastation that wildfire produces and we're more than fed up with acrid smoke and we know enough about its chemical composition to be very concerned about its impact on our health.

"It's a process," he says of his research. "There are no quick or easy answers in science. Data rarely gives you one of those "ah ha" moments where you can say with certainty that you've found the answer, but we need to keep looking for reasons why some trees in our forests are surviving while many more are dying."

PhD statistician Gretchen Moisen has worked for FIA for 37 years. Many foresters barely survived Statistics 101 in in college. Moisen loved it. Seated across from her in her office – it quickly becomes clear that she still loves the relationships between responses and predictors that make statistics such a fascinating science. We can't hope to solve forestry's Rubik's Cube without statisticians.

"Things are evolving quickly as FIA approaches its one-hundredth anniversary," she says of her 37 years



This the link to FIA Ogden's Idaho story map.[22] Layer upon layer of informative and educational data that you aren't likely to see in the popular press, information you can use in your outreach to journalists, elected officials and family and friends who share your interest in our nation's forests.

with the Forest Service. "We have the technologies now that we've needed to pull together tons of historic data with current information that can help us answer questions that were, until now, unanswerable. Old survey data, old photographs, old imagery from satellites, increment bores from old trees – coupled with new technology. It's exciting."

It is indeed. Especially the tools part: LANDSAT, GEDI, OBI-WAN, G-LiHT and LIDAR, acronyms now indelibly burned into forestry's lexicon. But it is statistics, the black art, both cutting edge as well as plain old garden variety statistics, that gives research scientists a way to merge traditional forest inventory data with new technologies to understand relationships in forests. And once you have your ducks in a row you can develop statistically reliable land management planning and monitoring techniques. This is where forestry's rubber meets its road.

"In my time here, FIA has changed from being an organization that simply counted trees – the current status of the forest - to one more focused on change – either rapid events or long, slow trend," Moisen explains. "We have hundreds of thousands of sample plots. That's great. But now we have statistically reliable tools to use that rich dataset to focus on smaller and smaller areas. That's big."

So-called "small area estimation" is big. It allows scientists and land managers to squeeze more information out of FIA's sample survey. Historically, Phase 1 involved an intensive sample collected on remotely sensed data such as aerial photographs and digital orthoquads – digital images generated from photos. Now that phase typically consists of a large variety of wall-to-wall information from air and space. Field survey crews enter the picture in Phase 2. They work in survey plots - one plot for every 6,000 acres in all 50 states plus all U.S. territories and protectorates, about 2.3 billion acres in total.

If all this seems a little bewildering, you'll sleep better [maybe] knowing that the entire sample design and estimation system has been tested for its statistical validity. It passed. We thus know that the data Moisen and her colleagues run through their models is a statistically accurate representation of current forest and rangeland conditions in the United States.

But things in nature rarely happen in 200,000-acre increments where there are over 30 FIA plots to characterize the forest. Small area estimation allows foresters to work in smaller spaces. Say the smoke has just cleared from a 3,247-acre wildfire and you need an early response strategy. What to do? Can you salvage any of the dead timber? If yes, how much? What else is needed to speed natural recovery? Statistical estimators can help quantify the effects of different approaches and tell you which ones best meet your management objectives.

"We have a wealth of sample plots and remotely sensed auxiliary data across the country," Moisen says. "We can 'borrow strength' from this stockpile to give us defensible information over small areas in space, through an automated system. We can also do this to create small snapshots in time, bringing together data representing historic inventory, disturbance history and current conditions."

It is nearing five o'clock, snow is falling past the windows in Moisen's office, and we need to head for Butte, Montana in the morning. But we have one final question. It is one my wife, Julia, has been mulling since we started our FIA tour in Portland last fall. Julia has tons of experience with organizational systems and sees FIA through different eyes than I do.

"Do you think it is possible to teach people how to use FIA data," she asks Moisen. "Could we perhaps conduct seminars to teach people how to access and accurately interpret, say, FIA's story maps or other automated tools?"

Moisen answers Julia's question with her own question. "It's a really big job, but if you mean could we teach people how to teach other people how to better use FIA's data, the answer is yes."

Accuracy and credibility have been the watchwords at Evergreen for 33 years. This could be our big dance. I think we'll give it a whirl.

Onward,

Jim Petersen

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FIA: Northern Research Station

www.nrs.fs.fed.us/fia/ [23]

ST. PAUL MINN - Charles H. "Hobie" Perry greeted us warmly at the door of the Northern Research Station in St. Paul, Minnesota on a blustery winter morning last March. His PhD in forestry barely covers the many roles he plays regionally and nationally within the Forest Service's Forest Inventory and Analysis Program.

You can't travel very far inside the Forest Service without meeting someone who knows and likes Perry. He is unfailingly polite and very comfortable in his own skin. He'd already emailed us a copy of our two-day itinerary so we knew he had laid out a busy schedule designed to immerse us in the most important aspects of FIA's St. Paul station. But he still wanted to be sure we understood who we would be meeting and what their areas of research encompassed, so we grabbed coffee and headed for a conference room that would be our office for two exhausting but quite memorable days.

FIA's Northern Region staff is housed in a non-descript building on the edge of the University of Minnesota's St. Paul campus. Winters here are long, cold and snowy, but summer and fall are spectacular because of the mix of tree species. *Julia Petersen photo*

FIA's office at 1992 Folwell Avenue sits on the northern edge of the sprawling University of Minnesota's St. Paul campus. Though I have never been in this building before, I have been on campus twice before – the first time to interview the renowned Wilbur Maki, a PhD economist in the Department of Applied Economics and the second time to interview Jim Bowyer, who was then teaching in UM's Department of Bioproducts and Biosystems Engineering.

Day 1 began with a conference call with Brett Butler, an FIA research forester stationed at the University of Massachusetts Amherst. Butler is the ever-enthusiastic head of the Forest Service's National Woodland Owner Survey. I first encountered the survey in the pre-Internet days, when it was published in handbook form, one handbook for each region. What fascinated me most about the survey was my discovery that 11 million private forestland owners own more than half the nation's timberland, and many of them are not in it for the money. Most say they are more interested in forest beauty, privacy, protecting their natural realms and conserving the wildlife habitats present in their forests.

Habitat conservation is a growing national trend. The species list is long and varies by location: black bears, white-tailed deer, elk, squirrels, turkeys, beavers, muskrats, raccoons, fox, bobcats, mink, otters, porcupine, coyotes, opossum, rabbits and wild boars.

Butler takes his survey responsibilities seriously – and personally. He frets about the fact that millions of landowners are getting old and seem not to have made plans for what will happen to their forests after they're gone.

He is well-armed with survey statistics that back his assertions: Fifty-six percent of all U.S. forestland is privately held and two-thirds of it – about 246 million acres – is owned by families or individuals. Half of these 246 million acres are owned by people who own 100 or more acres. Based on the NWOS statistics, 95 percent of the owners are white, 81 percent are male, 66 percent are 55 years or older and 15 percent are 75 or older.

As landowners age, the importance of succession planning increases. Consultants customarily fill this role. "This is the legacy side of the conversation about owning and managing forestland," Butler says. "It's an important conversation in families that intend to pass their forests onto their heirs."

So called "land conversion" is a growing problem in FIA's 24-state northern footprint: Connecticut, Delaware, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Pennsylvania, Rhode Island, South Dakota, Vermont, West Virginia and Wisconsin.

"We are switching to an annual survey system," Butler says of FIA's effort to gather more up-to-date data on forest owners that can be used to help keep the nation's forests forested. Five thousand,

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Northern FIA Region

Regional map: E.T. Hinchcliffe

randomly selected landowners from across the U.S. will be surveyed annually, then resurveyed five years later.

Many lumber companies offer free, no-strings-attached management plans in hopes that landowners will allow them to harvest timber when the time comes. FIA doesn't offer such plans but its databases are chock full of information landowners can access. And there is the ever effervescent Butler whose Rolodex is exceeded only by his passion. We ask if he can paint us a picture of the typical private forestland owner by management objective. Not surprisingly, he can. They fall into four categories that mirror what we have observed in landowners in our coast-to-coast travels.

"Aesthetic considerations top the list of ownership objectives for people who fall into the 'woodland retreat' group," Butler explains. "Their forest is their backyard. They typically don't have a management plan, but they, as almost all family forest owners do, have a strong desire to be good stewards of the land. They want to do what's right, but they don't always know how. Enhancing wildlife habitat is a big deal with many of these folks."

Landowners who fall into Butler's second grouping have multiple forest management objectives in mind. "This is our 'working-the-land' group," Butler explains. "They like almost everything – timber, wildlife, aesthetics – but they don't always know how to get started. They're excited and exciting to work with but some of their objectives conflict with other objectives they'd like to pursue. Fortunately, there are thousands of professional foresters to help them."

Then there are the "supplemental income owners," people who own hundreds and sometimes thousands of acres and want to create a revenue stream by managing their timber more intensively. Many have a professionally prepared forest plan.

Last but not least are the "uninvolved landowners." Butler's greatest challenge.

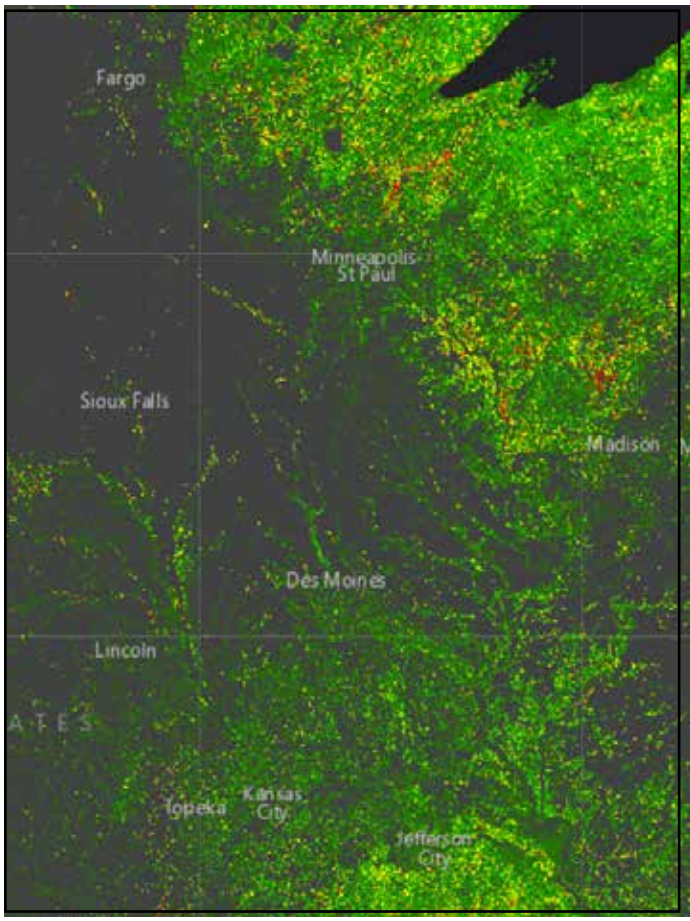
"Maybe they inherited it but they don't do anything with it because they have few emotional ties to it," Butler says. "If a professional forester can impress upon them the monetary value of their asset, they'll sometimes commit to management activities that improve and add value to their land, but you typically have to work pretty diligently with them to get things done."

Not so with the Tree Farmers scattered across the region, and the U.S. These are the landowners, often generational, with well-developed management plans and significant capital investments in their timber.

It is approaching 11:30 and we are 30 minutes behind schedule. Perry is patiently waiting his turn. I ask Brett if there is a take-home message in the expansive and revealing landowner survey we have been discussing since 9 a.m.

"Family forest owners rule!" he declares. "Forestry's goal and that of conservation is to keep forests forested," Butler says. "Once forests are lost to other uses all other forest-related issues are moot. If we are interested in the future of forests – and we are – we need to be interested in the people who own a plurality of this land, and those are the private owners."

Hobie Perry wears many hats within FIA's national and regional frameworks



and what he wants to show us this morning is simply jaw-dropping. But first, he wants to walk us to what may be the most important crossroad in its long history, the intersection of the tree survey and cloud computing.

FIA's five technical groups – statistics, analysis, remote sensing, information management and data collection – come together as bands that I see in my mind's eye as concentric rings that share a common center: Earth's ecosystem. Within this center, datasets developed and managed by the five groups are integrated to form a picture of us – all of us.

Yes, there are trees in this picture because counting trees is FIA's core business. But thanks to cloud computing, forest components, intangible values and trouble spots are recorded in this picture of us.

Why us? Because the decisions we make – the natural resource management policies we set in motion as a nation - impact everything else. FIA doesn't "do" the policy stuff. They just bring us the news about how our forests are doing and how our actions are impacting our natural resources. What we do with this news is up to us.

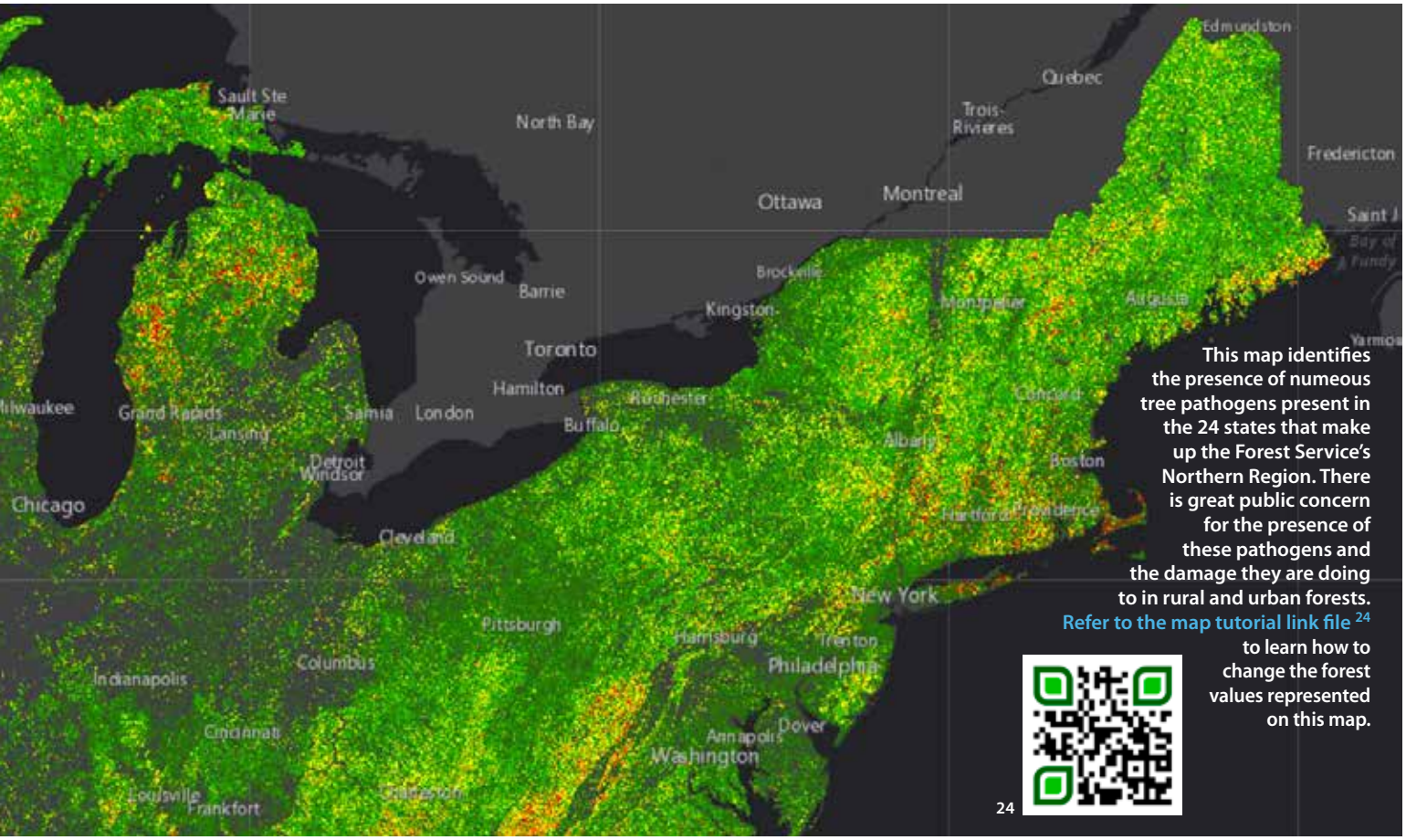
"Right now, it's too complicated," Perry tells us. "The public is overwhelmed by the enormous amount of data our technical groups are bringing together. We have the information our customers [that's us] require to make more informed policy decisions, but we have lacked a means to strip away the complexity."

Until now.

Now there are software applications – visualization tools – that allow FIA to turn datasets into colorful maps that illustrate just about any environmental component present in forests: green trees, dying trees, dead trees, insects, diseases, wildfire, carbon in the air we breathe, carbon in the soil, land use changes, urban sprawl, water quality, fish and wildlife habitat – all of the measurables that act as proxies for the big five: clean air, clean water, abundant fish and wildlife, a wealth of year-round recreation opportunity and immeasurable forest beauty.

Seated on either side of Perry, Julia and I watch in amazement as he uses his laptop's mouse to click through a series of colorful digital maps that quantify data in reds, greens, blues, oranges, indigos and yellows. He starts with a map of the United States, then homes in on the Intermountain West, then Idaho, then Kootenai County [where we live in the Idaho panhandle] and finally our neighborhood in Dalton Gardens! How is this possible? It is possible through the integration of boots-on-the-ground field data and remote sensing data collected using a variety of sophisticated tools including satellite imagery – FIA's partnership with the National Aeronautical and Space Administration [NASA] – aerial photography and Global Position System [GPS] technology.

Cloud computing brings all of these datasets together on the head of a pin – the pin being our neighborhood in Dalton



This map identifies the presence of numeous tree pathogens present in the 24 states that make up the Forest Service's Northern Region. There is great public concern for the presence of these pathogens and the damage they are doing to in rural and urban forests. Refer to the map tutorial link file [24] to learn how to change the forest values represented on this map.

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Top: Grant Domke; Center left: Mark Majewsky
Center right: Charles "Hobie" Perry
Bottom: Ty Wilson

Gardens or your neighborhood, wherever you live in these United States. There are datasets for all 3,142 counties, parishes and boroughs in the nation. Astonished? So were we. In our case, we could see that what we have long suspected. Canfield Mountain, a Coeur d'Alene landmark that rises behind Dalton Gardens and neighboring Hayden is in trouble. Although Perry doesn't say it, there is little doubt that we are only one or two lightning strikes away from a wildfire that will be next to impossible to stop.

"Our responsibility is to present the facts," Perry says of the well-defined limits of FIA's mission. "We build data sets, share information and we populate our visualization tools with this information. After that it's all about values that are defined in public policies that are beyond our purview."

In other words, managing the risks present in our backyard is our responsibility, not FIA's. The closest Perry veers to our nation's muddled forest policy situation is to quietly tell us, "The land faces serious threats." Not just "the land" in our Idaho neighborhood but - to varying degrees and for multiple reasons – ever increasing amounts of public and privately-owned forestland from coast to coast and border to border.

To emphasize his point, Perry clicks through a half-dozen forest values represented on the map before us. Nothing changes. For one or more reasons, our forests are in trouble because, as Brett Butler warned earlier, "When forests are lost to other uses all other forest-related issues are moot."

As one of the nation's leading soil scientists, Perry is the designated Soils Indicator Advisor for the United States for FIA's Phase 3 Forest Health Monitoring Program. He coordinates collection, analysis and dissemination of soil data from 23,760 forest health plots – 7,861 forest and 15,899 non-forest. Others are tasked with Phase 1 [9.4 million aerial photo points – 3.1 million forest and 6.3 million non-forest] and Phase 2 [377,210 field inventory plots – 124,463 forest and 252,747 non-forest].

Although Perry's soils work may seem mundane, my late father-in-law, who was a giant in forestry consulting circles, frequently reminded me that, while we could not save trees from their eventual deaths, we had a scientific and moral duty to "save the soil."

More carbon is stored in soil than in trees so, as you might imagine, our nation's fixation on atmospheric carbon and its connection to climate change, has landed squarely on FIA's plate. Perry and his colleagues are hard at work on a spatially explicit database for soil carbon storage that can be used to test and validate current cloud computing models.

Part of the riddle he and other soil scientists are working to unravel involves determining whether Phase 3 plot data [each plot represents 96,000 forested acres] is scalable at the regional level. It is possible that including other topographic, climatic or land resource attributes will make the model better. All in a day's work in St. Paul, Minnesota.

Ever a gracious host, Perry even has a lunch spot recommendation for us: Foxy Falafel on Raymond Avenue, a five minute Lyft ride away. It is so damned good we return for a second helping the

next day. We are back in our conference room in time for our 2 o'clock meeting with Ty Wilson, one of the rocket jockeys who integrates plot and satellite data – eyes in the sky and boots on the ground.

"Passive satellite sensors can't see through forest canopies," he explains. "But field survey crews and airborne LIDAR can. Field surveys are expensive and time consuming. Satellite imagery and LIDAR gives us more at less cost per acre and provides quick and easy access to remote areas, but what remote sensors can see is limited. Using all the tools helps us create a more complete image."

Ty Wilson is our introduction to a topic that will be emphasized again at the Southern FIA station in Knoxville, Tennessee. The subject is the Fort Knox-like confidentiality of plot data FIA collects from private forestland owners and managers. Real Estate Investment Trusts [REITs] that own land and Timber Investment Management Organizations [TIMOS] that manage pools of land for others are perennially nervous about data breeches – the possibility that their forest inventory data might accidentally be shared with a competitor.

"We do not freely share our plot locations with others because legally we are not permitted to divulge any personally identifiable information," he explains. "We don't even share the locations of our plots with landowners or managers because we don't want our plots to be treated any differently than the rest of the population they represent. But a plot is a plot is a plot. If it burns or is logged and replanted doesn't matter to us. It's just another point on the time continuum of a changing landscape."

Wilson's upstairs office is small and busy in the way you'd expect a research forester's office to look. He works at a large table dominated by three large monitors. I admire his skill because it is all I can do to keep track of the desktop icons on just one monitor. And why on earth does he need three?

"We work with multiple data sources, so it's useful to be able to see as many of them as possible at one time," Ty explains as his mouse glides from one screen to the next. Our eyes are flooded with colorful maps that instantly display whatever he calls down from cloud computers maintained by Amazon and Google. We are in one of hundreds of war rooms that FIA maintains and Ty and his colleagues are armed with technologies that, until recently, were military secrets.

"I do a good deal of work with time series of Landsat imagery," Ty reports. "Through time series analysis, we achieve greater precision in our model results. We can go through it pixel by pixel and season by season, watching forests grow, change, die and return. Cool stuff."

Cool indeed, but it wasn't available until the federal government released its Landsat archives to the public in 2008. Until then, the Forest Service paid dearly for whatever land-satellite imagery it could afford. Now it is free and a mouse click away, and thanks to Amazon and Google, no one, including the Forest Service, needs to buy the tools needed to use Landsat data.

"It's all made possible through the convergence of a vast archive of satellite imagery, cloud computing, and algorithmic advances such as machine learning and artificial intelligence," Ty says by way of explanation. "It's a huge one-two-three punch. It's a very exciting time to be working for FIA."

We suppose this to be the case, though every time we are introduced to new rocketry, Ty or someone else reminds us that "without ground plots monitored by field survey crews we have nothing."

"The boots-on-the-ground crews validate what our remote sensors are telling us," he explains. "We need all these tools to measure and assess reforestation, deforestation and afforestation."

Small wonder that FIA maintains such an extensive three-phase plot system. It takes all this data and an enormous amount of cloud computing horsepower to answer the steady stream of questions FIA gets from its customers in government and the private sector: states, counties, cities, other federal and state resource management agencies, private forestland owners and managers, the public's elected representatives, state and federal forest policy makers and forest stakeholder groups that are helping national forest staffs resolve some of their politically sensitive forest management problems.

In the 24-state Northern Research Station, the public frets mainly about land conversion, fragmentation and parcellation – in a phrase, urbanization and the loss of forests to other uses. The Minneapolis-St. Paul economy is booming as it is in most upper Midwest cities. McMansions are everywhere in the Twin Cities' suburbs, and while they can only be seen from the air, their presence is betrayed by the rush hour freeway crawl. It takes our Lyft driver 45 minutes to deliver us to our hotel in downtown St. Paul, 9.3 miles from the Northern Research Station's office.

Day 2 begins at 9 o'clock sharp with Mark Majewsky, a supervisory forester whose focus is on one of FIA's newest target audiences – the nation's metropolitan and urban centers, where interest in forests is high but knowledge is low. This is the sweet spot where political action and management necessity come together.

"Eighty percent of our nation's population lives in metropolitan and urban areas," Majewsky reports. "These are the social and cultural bridges we must build and cross to promote understanding of forests, how they function, what benefits they provide, and what they mean to the local population."

Majewsky is correct. There is a great need for social and cultural bridges linking city dwellers with their rural counterparts. We recently completed a series of unscripted on-the-street interviews in Portland, Oregon and Seattle, Washington. The topic was the West's wildfire pandemic that is filling their cities with smoke for weeks on end every summer. Everyone knew there was a problem but only a few knew what might be done about it.

"We have to quantify and share the story of the benefits that trees provide," Majewsky advises. "By understanding the benefits and value of trees in their cities, city managers and citizens can best advocate for tree maintenance and management over time. Generally speaking, urban forestry is a great traction point for sharing the benefits of traditional forest management as it occurs outside urban areas."

FIA survey data has been Evergreen's traction point for decades, but we had not read two studies Majewsky referenced – one revealing significant energy savings where trees are present in cities and linking the presence of trees with declining crime rates. Although he is a Midwesterner, his insights and observations mesh well with our western

experience, especially when the topic is tree mortality.

"It's hard to find a live ash tree in Lower Michigan," Majewsky informs us. "When people see dead trees they want to know why. The loss of trees is a great unifier. You see it out west and we see it here. This is a conversation starter. Regardless of where folks live they are passionate about their trees. In urban environments 'their' trees are not just the ones in their front or back yards but the ones they walk past on their way to work, in the local park, or the ones they see outside their office window."

FIA now has a presence in 35 U.S. cities but with more than 50 percent of the Forest Service budget allocated to wildfire, the agency needs funding partners to add cities. We hope to help them find some in neighboring Spokane, yet another community where urban forestry could be a traction point in the larger public debate concerning the West's wildfire pandemic.

"Quantifying the trends and benefits of all trees (both rural and urban) is what FIA is all about," Majewsky says.

"The opportunity is huge. We have the strategic level datasets municipal leaders and foresters can utilize to better understand and manage their trees and our goal is to make such information as widely available as possible while expanding our user base and promoting a better understanding of our urban forests."

Day 2 concludes with a fascinating two-hour conversation with Grant Domke, a PhD biometrician whose smile rarely fades from his face – the reason being that he "gets to play in a sandbox every day."

Biometrics – biological measurements – leans heavily on statistical modeling. Forest biometrics – traditionally known as forest mensuration – is a derivative of mathematics focused primarily on measuring lines, surface areas and volumes associated with tree growth. Of necessity the old science has spread its wings to include measuring terrestrial carbon pools – the amount of carbon stored above and below ground in forests.

In a manner of speaking, Domke's sandbox is indeed filled with carbon. Using the same measuring tools used in all FIA research work – boots-on-the-ground and remote sensing – Domke and his counterparts at the Southern, Intermountain and Pacific Northwest stations, assemble their findings in drafts that are passed to the EPA who coordinates expert and public reviews. Once finalized, the EPA passes the annual report to the U.S. State Department which delivers it to the United Nations as part of our commitment to the UN's Framework Convention on Climate Change.

"There is a well-defined process," Domke says. "The U.N. reviews our estimates and provides feedback on ways to improve. We're contributing to many such efforts now in the hope of improving consistency and scalability."

FIA has purposefully steered a wide berth around the global climate change debate and policy options to address its impacts – but the program's long history and its exacting standards periodically garner attention in unexpected and useful places. In January, the Wall Street Journal published a half-page, above the fold story featuring one of FIA's state-by-state tree maps.

Journal reporter Jo Craven McGinty did FIA a great favor in her detailed explanation of the forest survey system and its reliance on data gathered from 326,000 hexagons – each spanning 6,000 acres. FIA uses hexagons – think volleyballs – because their shape accounts for the curvature of the earth.

Wall Street investors seem destined to become students of FIA's hexagons.

Minus data, they have little or no basis for justifying capital outlays in startup businesses that aggressively tout their ability to reduce carbon emissions. How much money is available? J.P. Morgan Chase, Wall Street's largest investment house, manages $1.7 trillion in investor capital. And that's just one investment house in one industrialized country.

Do you invest in wind and solar technologies or electric cars – all requiring government subsidy - or do you bet on the hexagons – on photosynthesis and carbon sequestration powered by the free non-polluting energy of the sun?

Domke and his colleagues monitor carbon inflows and outflows from 326,000 hexagons, tracking annual estimates for aboveground and belowground biomass, dead wood, litter and soil organic matter. The organic layer stores more carbon [41 percent] than any other terrestrial source. Aboveground trees store another 34 percent, deadwood [12 percent], belowground biomass [7 percent] and biomass litter [6 percent].

"We live in interesting times," Domke says of FIA's balancing act. "Fortunately we have empirical information from the FIA program that we can rely on to estimate carbon stocks and fluxes from forest land, woodlands, and urban trees in the U.S. each year. These lands with trees offset about 11 percent of our nation's annual greenhouse emissions."

FIA's carbon researchers collaborated with scientists from the University of Michigan, Cornell University and Argonne National Laboratory in a 2018 study that estimated that U.S. soils are capable of storing 2.2 billion tons of carbon over the next century – but only if burnt and harvested forests are promptly replanted.

But the study also found that carbon sequestration in U.S. forests is declining slowly as land uses change and forests are permanently lost to development and new carbon storage slows to a standstill in aging federal forests.

None of these trend lines will be easily reversed given our society's myriad environmental wants and utilitarian needs, but there is no denying that our most reliable system for mitigating the effects of climate change in our country involves sequestering more and more carbon in forests and wood products We ask Domke if there is a six-second sound bite in the 2018 study.

"This is the first time empirical data has been used to estimate soil carbon changes on forest land across the U.S.," he replies. "The observed rates of carbon accumulation suggest great potential for additional increases if more land can be reforested and actively managed. We quantified how reforestation increases topsoil carbon stocks and the potential that reforestation holds for increasing soil carbon accumulation in the coming decades."

And the six-second sound bite? Domke smiles. "That's easy. To store more carbon plant more trees."

It is 5 o'clock and a light snow is falling in St. Paul. Our time here has ended.

On to Knoxville.

FIA: Southern Research Station

www.fs.usda.gov/srsfia/ [25]

KNOXVILLE, TENN – There is a reason why lumber manufacturers are flocking to the Southeast, investing billions of U.S. and Canadian dollars in state-of-the-art mills that produce lumber, plywood and dozens of engineered wood products.

Actually, there are two reasons: Southern hospitality and southern pine.

Southerners love their forest products industry. The social, cultural and political divides that distance rural western communities from major coastal population centers don't exist here.

Add the fact that the South's major pine species – loblolly, longleaf, shortleaf and slash – reach harvestable size in 25 years. That's about 10 years less than the time required to grow Douglas-fir to harvestable size on the most productive sites in western Oregon and Washington. Pulpwood? Try 10 to 15 years, a fraction of what it was in the Northeast during the paper industry's glory years.

Note, too, that southern pine competes head-to-head with Coast Doug-fir in every consumer market: dimension lumber, panel products, pulp, paper and engineered-wood products: laminated veneer lumber, oriented strand board and I-joists and beams.

Of immeasurable significance is the fact that virtually all of the South's pine forests are privately owned, mostly by non-industrial landowners whose forest management objectives generally revolve around the creation and conservation of wildlife habitat. Hunting and fishing are unrivaled cultural forces in the 13-state southern region.

No wonder U.S. and Canadian forest products manufacturers love the South. It has everything lovely that the rest of the North America doesn't have, including a welcoming political climate with deep cultural roots.

Because there are only 16 national forests in the South, the U.S. Forest Service doesn't have the visibility or influence here that it has in the West, where there are 84 national forests. Nevertheless, the Forest Service's Forest

The Forest Service's Southern Research Station at Knoxville also houses its FIA staff. The building is located in a well-treed urban area about 20 minutes south of downtown Knoxville. Southern forest owners and wood products manufacturers rely heavily in the wealth of research and monitoring work this station produces. *Julia Petersen photo*

Inventory and Analysis [FIA] Program, which operates from the Southern Research Station [SRS] in Knoxville, is a big deal in the South. And that big deal is the FIA's Southern Region Timber Products Output [TPO] report, a must read for manufacturers who purchase their logs from non-industrial landowners, Real Estate Investment Trusts [REITS] or Timber Investment Management Organizations [TIMOS].

Vertical integration has vanished from the South, just as it has the rest of the country. Gone are the companies that owned vast amounts of timberland that supported their manufacturing plants. Even the biggest players – Weyerhaeuser, Georgia-Pacific, Potlatch-Deltic – have spun off their lands for the tax advantages that REIT's provide, leaving mills they once owned outright to fend for themselves in highly competitive log markets.

Although the majority of firms are Canadian, some European and Chinese are adding and/or buying mills in the South. Like their U.S. competitors, they rely on gatewood – logs sourced from multiple landowners often unknown to all but company log buyers, independent wood brokers who negotiate log sales to the highest bidders and concentration yards that accept log loads, then sort them for quality, often with specific mills in mind.

To assist manufacturers in long-term planning, FIA's Knoxville station partners with the 13 southern states in the collection of field inventory data from some 90,000 survey plots scattered over 267 million acres of public and private forests and woodlands in the southern states, Puerto Rico and the U.S. Virgin Islands.

So vital is the South's forest products industry – and so great is its need for easily digestible information [think six-second sound bites] - that FIA's southern TPO program also publishes colorful, four-page documents for each southern state. The well-illustrated documents track annual production by product: pulpwood, saw logs, veneer logs, composite panels, poles, posts and manufacturing byproducts: bark, shavings, sawdust, coarse residues and bark.

Standardized software has replaced graphic artists in Knoxville and its sister stations in St. Paul, Ogden and Portland. The program assembles documents from data, creates its own pie charts and bar graphs, adds maps and photographs and spits them out electronically for states and counties. The automated publication program allows customers to download FIA pamphlets on your cell phone but many still call with special requests.

The Forrest County Administrator down in Hattiesburg, Mississippi emails Knoxville at 9:30 in the morning. He needs some information for a noon-time Rotary speech. Got his email address? Yup. Not a problem. Push a button. Bam! The document is there.

No more closets filled with 50-pound boxes of reports. No more gummed address labels that stick to your fingers. Just a software

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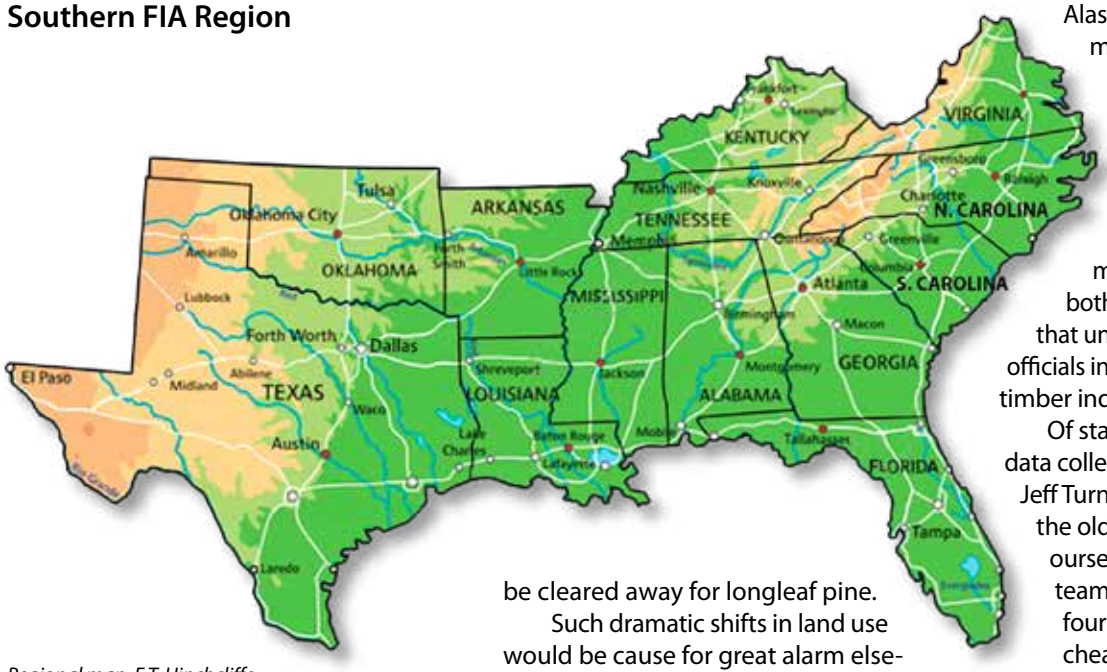
Southern FIA Region



Regional map: E.T. Hinchcliffe

program and a mailing list stored in a computer. Talk about customer service! Talk about efficiency.

Forest economists at the University of Montana and the University of Idaho assemble the same TPO data sets, but public interest isn't nearly as strong as it is in the South, so there are no state-by-state brochures that directly connect forest stakeholders or the news media with FIA's research stations in Portland, Ogden or St. Paul. What is left of the timber industry in the Northeast, Great Lakes region and the Interior West would not move the decimal point in any southern state. Difficult to measure intrinsic forest values associated with outdoor recreation pursuits have usurped the timber industry in the public's consciousness.

But not in the South. To be sure, outdoor recreation is an anthem in the southern states, but folks here see their forest products industry as a part of a larger whole, not as something separate to be viewed with suspicion or disdain. I suspect this uniquely southern trait is tied to the fact that land use changes occur frequently. This year's loblolly pine plantation might be clearcut and planted in soybeans by spring. Or a cotton field might suddenly be cleared away for longleaf pine.

Such dramatic shifts in land use would be cause for great alarm elsewhere in the country, especially the West and Northeast, where urban sprawl is swallowing up hundreds of thousands of acres of forestland. But southerners seem to take it in stride because the land use changes rarely take land out of production. Forestry and farming simply trade acres now and then.

"It is different down here," FIA Knoxville forester, James Bentley, says of the striking cultural differences that distance the South from the rest of the country. "We still participate in all of the same programs that are prevalent at our sister FIA stations in St. Paul, Ogden and Portland, including forest carbon accounting, but there is more of a timber emphasis here, and since FIA is customer driven, we do lots of TPO-related work here."

FIA Knoxville maintains strong working relationships with several southern universities; privately-funded research groups, including Environmental Systems Research Institute [Esri], the world's leading provider of GIS software, industry trade groups and the National Aeronautics and Space Administration (NASA), which is assisting the Forest Service and FIA with its survey work in areas that are not easily reached by road. G-LiHT, a NASA imaging system installed in fixed wing aircraft looks to be the future of survey work in Interior Alaska and possibly elsewhere – mangroves in south Florida.

State crews have been doing most FIA Knoxville's on-the-ground survey work since the 1990s, freeing Knoxville to handle the dizzying array of data requests that come from manufacturers or legislators or both. Such is the tightly woven fabric that unites manufacturers and elected officials in their common quest to keep the timber industry going and growing.

Of state forestry's entry into field data collection in the South, FIA forester, Jeff Turner, says, "It's way different than the old days when we did the work ourselves. We divided ourselves into teams that each worked three or four counties at a time. We lived in cheap motels and ate a lot of fried chicken. Now we train state crews and analyze and verify the field survey data they give us."

Despite its impressive business network, FIA Knoxville struggles with a problem that seems to be more prevalent in the South than anywhere else in the nation. Put simply, southerners – including manufacturers and timberland owners - don't trust the federal government. At FIA, distrust translates into an unwillingness to share forest inventory and production data the Forest Service needs to fulfill its inventory and analysis mission in southern forests.

"It's cultural," James Bentley explains. "We work to build trust between local, state and federal governments, along with both mill and land owners. Here at FIA, we've found it useful to work closely with state and university partners."

The firewalls FIA has erected are impressive to protect landowner identities and sensitive information collected in timber product output surveys. Landowner identities are never revealed and field survey data collected is packaged in ways that make tracking ownerships impossible. The remainder of the data collected by the FIA program is available for downloading by anyone. Sensitive data is not shared with other government agencies, including other branch-

es of the Forest Service or the general public. Your credit card security systems should be this good.

"We are asking landowners and mills some very sensitive questions about their businesses," Bentley says. "Trust is everything. Congress understood this when they exempted FIA from the Freedom of Information Act."

The changing face of ownership in the South has made the trust-building job infinitely more difficult. Time was when Bentley and his colleagues were on a first name basis with most millowners and major landowners. Bentley recalls. "Now it's mostly corporate. The owners and contacts might be in another state or country and are constantly changing."

There are about 1,400 mills in the South, but the top 400 represent about 90 percent of the volume purchased and processed annually, so gaining the trust of those 400 companies is vital – and difficult. Hence, the importance of encouraging the en- dorsements of local and state elected officials who find great value in the work that FIA is doing.

The South is now the timber capital of the world in much the same was that Douglas County Oregon was before the northern spotted owl was listed as a threatened species in 1990. The ensuing collapse of the federal timber sale program crushed western Oregon's sawmilling empire. Hundreds of small mills went out of business. The survivors own forestland or buy logs from other land owners or both, but the South's timber colossus is now what the West once was but will never be again. National forests are no longer the meaningful log sources they were in the years following World War II.

Georgia-Pacific, now owned by Koch Industries, saw the collapse coming from a long way off. They moved their headquarters from Southwest Fifth in downtown Portland, Oregon to Peachtree Street it Atlanta, Georgia in 1982. The company still has nine facilities in Oregon, but there are 17 in Georgia, alone, and 86 throughout the South. Just Georgia-Pacific.

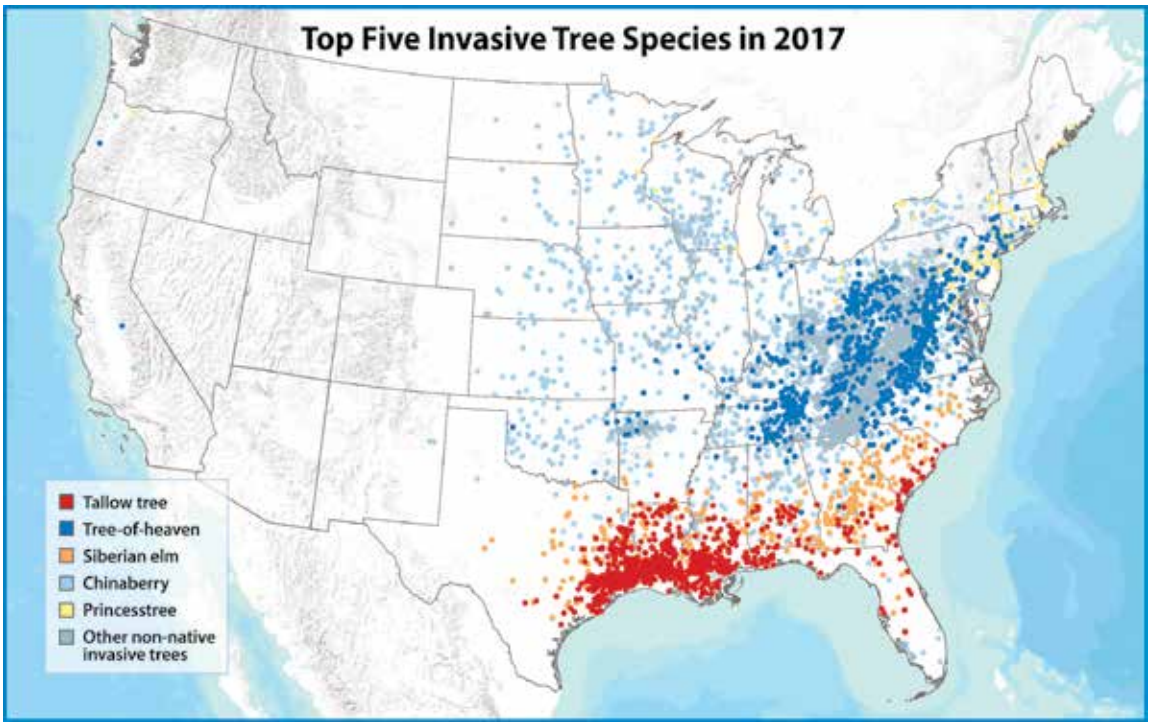
But the South is not invincible. The last recession hit rural sawmilling towns in the South much harder than it hit Detroit. Until the recession wound down, it did not matter that the South is the wood basket of the world or that the southern states are the No. 1 wood producers on earth. There were few customers at any price.

Estimates are that the Knoxville shop handles 60 percent of the information requests fielded annually by FIA's four research stations. Most queries concern the region's timber economy. Forest products manufacturing ranks in the top three economic drivers in most southern states which means that, most days, the Knoxville station is a busy place.

"As FIA scientists, we are basically on call," says Christopher Oswalt, a PhD researcher in Knoxville. "An information request can change your whole day, but it's what we do and the work is really interesting. We pride ourselves on quick responses to customer requests. It's one way to build trust."

Although most of the queries Oswalt and his colleagues' field are related to the region's burgeoning timber economy, there are well-documented concerns for factors that impact forests: insects, diseases, invasive species and damage caused by seasonal hurricanes and tornadoes.

Wildfire isn't the concern here that



Invasive tree species that don't belong where they are growing are a big problem in the Southeast. The Chinese Tallow Tree and the Tree of Heaven are particularly difficult to control because they are prolific re-seeders that will grow in most soil types, including mine waste. Here is a link[26] that will lead you to tons of datasets developed and monitored by FIA's Southern Research Station.

Credit: Christopher M. Oswalt, Sonja N. Oswalt, Brad W. Smith, Patrick D. Miles, and Scott A. Pugh, map produced by Bryan J. Hemmer, USDA Forest Service FIA; Forest Resources of the United States, 2017: a technical document supporting the Forest Service 2020 RPA Assessment. Gen. Tech. Rep. WO-97. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office.

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World's Fair Park – from 1982 - and the University of Tennessee campus as seen from the Tennessean, a fine Knoxville hotel that hosted us while we were visiting FIA's Southern Station. UT houses one of the nation's top forestry, wildlife and fisheries programs, including a doctoral program in natural resources.

it is in the West because about 90 percent of the South's forests are privately owned and well managed. Timber harvesting and prescribed fire go hand in hand, so the woody debris buildups so prevalent on federal lands in the West aren't present here. A 500-acre fire anywhere in the South makes big news.

"Relevance" is a word you hear often at FIA's Knoxville shop. Relevance as in how to package FIA's vast data trove in ways that its southern customer base will find meaningful and useful. Southern Program Manager, Bill Burkman, explains that FIA's national program has gone from six independent data bases in the early 1990s to one data base today.

"Our system is seamless now," Burkman explains. "It links the four research stations – Portland, Ogden, St. Paul and Knoxville – to four national programs for which we share research responsibilities: the FIA database, which includes timber product output data; the National Information Management System, the National Woodland Owners Survey, and the National Assessment and Resource Planning Act database."

Although the system is indeed seamless, its uniqueness rests in a customization that accommodates regional differences, not just in forest and rangeland types but also as a reflection of varying customer needs and public interests and values.

Reaching this goal has required all four stations to transfer years of data from filing cabinets to websites, where it must first be recast in easily navigated formats that rely on a variety of user-friendly graphics programs.

"All four stations are moving in the direction of story maps that help our users understand what's happening in forests," explains Andy Hartsell, yet another PhD research forester stationed at Knoxville. "Basically, we take county-level data sets reflecting different forest values or conditions – timber, water, wildlife, carbon, insects, fire risk, diseases, you name it - and turn those values into colorful interactive story maps. It's cool stuff."

If it sounds easy, it isn't. Maintaining data integrity across multiple data sets that were years in the making is complex and tedious. There is so much information to be evaluated and that most FIA researchers have two and sometimes three large screen monitors on their desks. Their computers are linked to networks powered by servers with enormous data storage capacity. Cloud computing at its finest.

"We can assemble this data just about any way you want it," Hartsell explains. "Want to site a mill in the South that requires a particular kind of wood and you aren't sure where you can find enough of it to run your mill? Looking for an oversupply of underutilized timber? Chances are we can help you find it."

All true, but FIA Knoxville is not a one-stop shop that exists only to serve the pressing needs of its timber industry clients. Far from it. Jeff Turner, Knoxville's Information Technology guru, is tasked with maintaining system integrity, making sure that a field survey protocols are followed to the letter so that a field survey is a field survey is a field survey. Every FIA station has multiple Jeff's and the Jeff's all work together to make sure the entire system follows the same protocols.

Indeed, FIA's project leaders in Knoxville, St. Paul, Ogden and Portland are on a first name basis with one another. They live their work lives surrounded by Star Wars technologies referenced in the language of acronyms: GEDI, G-LiHT, LIDAR and OBI-WAN - light speed tools that link aerial photography, survey plot data, imaging data gathered by pulsed laser light and high-altitude satellite imagery with computers and software programs that merge data files that are so large they can only be processed by banks of computers.

Yet to a person, every research scientist at every station insists that the

FIA system would fail without data collected from anonymous survey plots by field crews: inglorious ground pounders who sleep in tents or cheap motels and eat fried chicken from across the highway or cook pre-packaged meals on tiny propane stoves miles from the nearest highway.

FIA's legendary reputation for data accuracy and integrity periodically invites its misinterpretation and misuse by individuals and organizations with political axes to grind. It frustrates researchers at all four stations, but they seem resolved to the fact that there isn't much they can do about it.

"We aren't the data police," James Bentley says. "The research we do and the data we provide are paid for by taxpayers. We don't own it. They do. It's free to anyone who wants to access it and FIA tries to ensure that customers understand how to use the data"

FIA research foresters in St. Paul, Ogden and Portland voiced similar sentiments and, likewise, the same wish that more Americans knew about FIA and its work. Everyone's heard of the U.S. Census Bureau. They count people. But seemingly no one has heard of the Forest Inventory and Analysis Program. It counts the trees the people love. How hard is it to get the public's attentions, much less hold it?

Very hard it turns out. There are occasional twists and turns in this road that make it difficult for anyone – including FIA and its customers - to peer into the future with as much certainty as we'd like. Computers were supposed to usher in a paperless society, but paper use doubled instead and the rush was on to build more paper mills. Then the Internet was going to drive the newspaper industry out of business, so what to do with all those paper mills, but instead the Internet repackaged our news in algorithms. And it gave us on-line shopping and Amazon which has revolutionized the packaging industry. More trees please. Who knew?

The same unseen forces have completely remade the solid wood industry, transforming it into a technological marvel that can manufacture steel-strong wood products from trees no bigger around than your calf muscle. How will this change the art of growing trees? Will Canadian producers whose homeland forests are dying overtake their American cousins in the South?

No one can answer these questions, just as no one could have guessed that a 36-foot plywood boat built by a brash Louisiana lumberman named Andrew Jackson Higgins would change the face of World War II. Supreme Allied Commander, Dwight Eisenhower – a man not given to brash statements – said Higgin's boats "won the war for us."

Shallow-draft Higgins boats, with their unique drop-down bow, participated in every major amphibious landing in World War: Normandy on D-Day, Sicily, Italy, Guadalcanal, Tarawa, Saipan, Tinian, Okinawa and Iwo Jima.

Hitler called the native Nebraskan "the new Noah." Ike said, "If Higgins hadn't designed and built those boats we never could have landed over an open beach."

Figuratively speaking, FIA's Knoxville crew lands on an open beach every day. Likewise, their colleagues in St. Paul, Ogden and Portland. They have armed you with story maps that appear magically on your cell phone or computer. You push a couple of buttons and this seemingly unending treasure trove of colorful maps, charts and graphs flies down from the cloud at the speed of light. Questions rush into your mind:

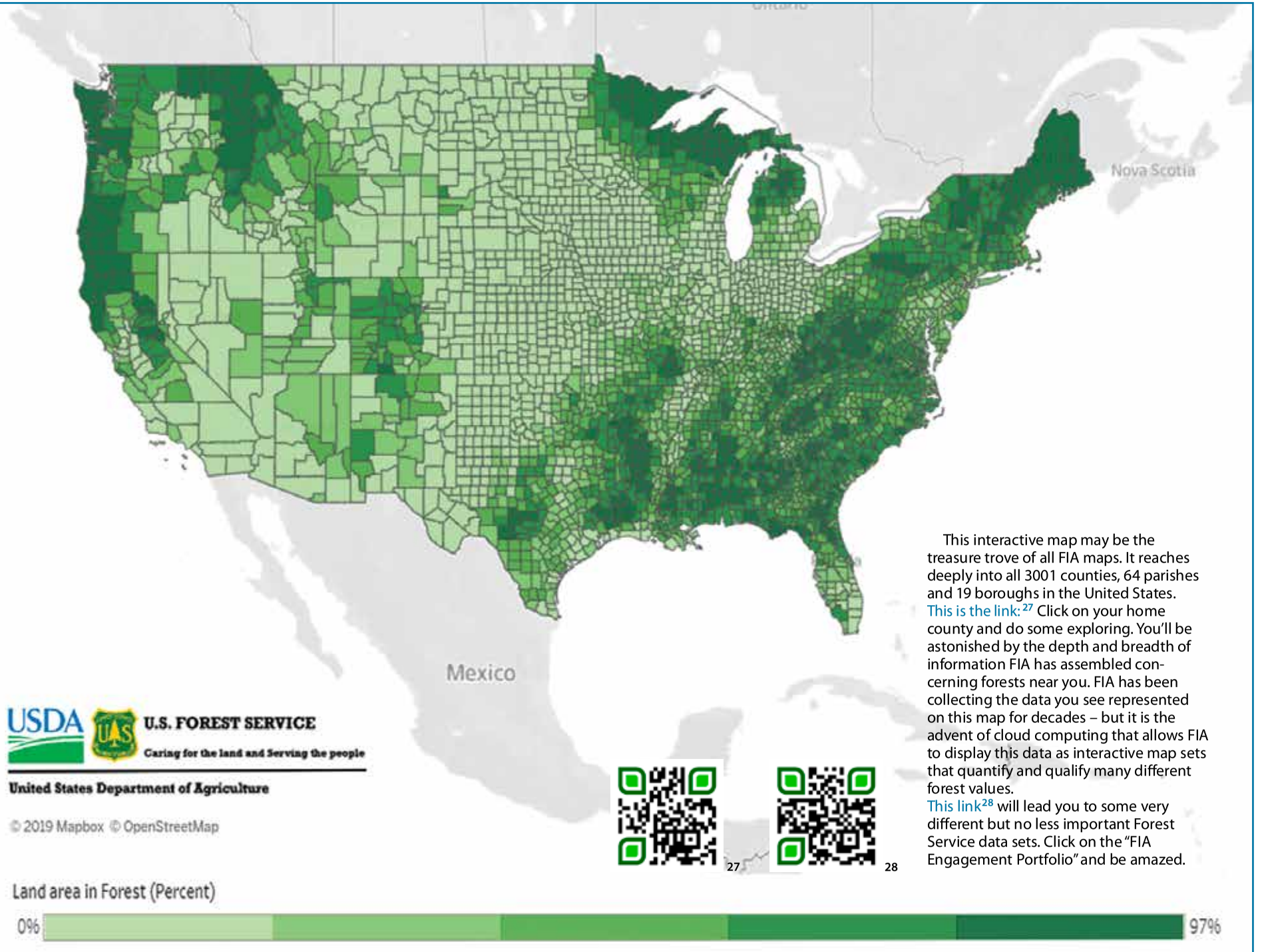
- Are we cutting more trees in the South than we are growing?
- Help. I'm in a meeting and need answers fast!
- What are our most common tree species?
- Where do these trees grow?
- Who owns the forests I see daily?
- Where are our sawmills located?
- Where could a new mill be located based on timber availability?
- Got a term paper to write?
- Need a good map?

You can find answers to these questions and more at SRS website.


Bill Burkman


James Bentley


Chris Oswalt in Tanzania



This interactive map may be the treasure trove of all FIA maps. It reaches deeply into all 3001 counties, 64 parishes and 19 boroughs in the United States. This is the link:[27] Click on your home county and do some exploring. You'll be astonished by the depth and breadth of information FIA has assembled concerning forests near you. FIA has been collecting the data you see represented on this map for decades – but it is the advent of cloud computing that allows FIA to display this data as interactive map sets that quantify and qualify many different forest values.

This link[28] will lead you to some very different but no less important Forest Service data sets. Click on the "FIA Engagement Portfolio" and be amazed.

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