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Making Sense of Big Data: Putting Forest Inventory and Analysis to Work in Forest Planning

AN ACT OF SUSTAINABILITY

For centuries, many Europeans settling North America thought it contained limitless natural resources. As the young nation grew westward, the continent's vast forests supplied the raw material for this settlement and growth, and their harvest cleared away land for farms, homes, and cities.

As limits to the seemingly endless supply of virgin forest became more apparent, calls for more judicious use of this essential natural resource reached the federal government and supported the creation of the National Forest System. After 3 decades of forest preservation and 2 decades of active forest management by the U.S. Forest Service, in 1928 President Calvin Coolidge signed into law the McSweeney-McNary Forest Research Act, which mandated the first U.S. timber and forest products surveys that have become the Forest Inventory and Analysis program. This Act had far-reaching implications for our nation's forests—implications that continue today across the Rocky Mountain region and beyond.

Forest inventory and analyses and shared stewardship have become more important today than ever before.

FIA is a spatially and temporally balanced probabilistic sample. Plots are revisited on a rotation (as seen above) of every 10 years in the RMRS area. Regions rely on FIA data for broad and mid-level analysis and monitoring. Forests use it to evaluate current condition and monitor trends over time (Photo: USDA Forest Service).

SUMMARY

The Rocky Mountain Research Station works with National Forest planning teams to understand and maximize an important resource: forest data collected by the Forest Service's Forest Inventory and Analysis (FIA) program. The program's website, found at https://www.fia.fs.fed.us, provides a variety of tools that allow users to download standard reports and create custom queries that can be used to improve the efficiency of their planning process. By integrating or putting FIA data to work, National Forest planners are able to meet the 2012 Planning Rule's requirements for monitoring and using the best available science. For example, National Forest planning teams can use FIA data to better understand forest characteristics and conditions using readily available data and FIA analysis skills. Additional information on FIA resources for the Interior West region can be found at https://www.fs.usda.gov/rmrs/interior-west-forest-inventory-analysis-fia. Other resources for National Forest plan revision teams include riparian and groundwater-dependent ecosystems assessments and a nationwide toolset of National Forest Climate Change Maps.

With diminishing resources and limited budgets, land managers may struggle to support the 2012 Planning Rule, which requires forests to use the best available science. Rocky Mountain Research Station (RMRS) scientists, Forest Inventory Analysis (FIA), and National Forests (NFS) land managers and planners have been partnering together to improve Forest Planning processes.

NEARLY 90 YEARS OF MONITORING

The McSweeney-McNary Forest Research Act led to the creation of the National Forest Survey, known today as the Forest Inventory and Analysis Program, or FIA. Managed by the Forest Service's Research and Development arm in cooperation with federal, state, and private forestry organizations, the FIA program contains the largest and most comprehensive forest inventory data set for the continental United States.

Forest Inventory and Analysis crew members inspect fir trees that were charred by wind-driven flames 30 feet higher than the base. Collecting data like this provides the opportunity to analyze and interpret trends in the data, (Photo: J. Fried, USDA Forest Service).

In the nearly 90 years since FIA was created, the Forest Service has enhanced the program by changing from a periodic survey that typically occurred every 8–18 years for a given area to an ongoing annual survey that samples a spatially balanced portion of the country each year. (In the Rocky Mountain Research Station area, roughly one-tenth of plots are sampled each year.) FIA has also expanded over the decades from collecting a timber-focused inventory to incorporate multiple forest values and ecosystem services. These include timber but also fuels and fire effects, wildlife habitat, and trends in populations of individual tree species. Today, the FIA program collects not only a wealth of forest monitoring information, but also surveys private forest landowners, where forest products come from, and how forest products are used by industry and the public. These efforts enable FIA to detect and report on changes on an annual basis. The program's website, found at https://www.fia.fs.fed.us/, provides a variety of tools that allow users to download standard reports and create custom queries.

INTEGRATING THE BEST AVAILABLE SCIENCE IN FOREST PLANNING

One critical role that FIA plays is providing much-needed monitoring data to National Forest planning teams. These teams are required under National Forest Management Act regulations to use the best available science and to conduct monitoring in their forest plans. However, many National Forest planning teams are unsure how to get the data they need, especially with limited budgets for data collection and monitoring.

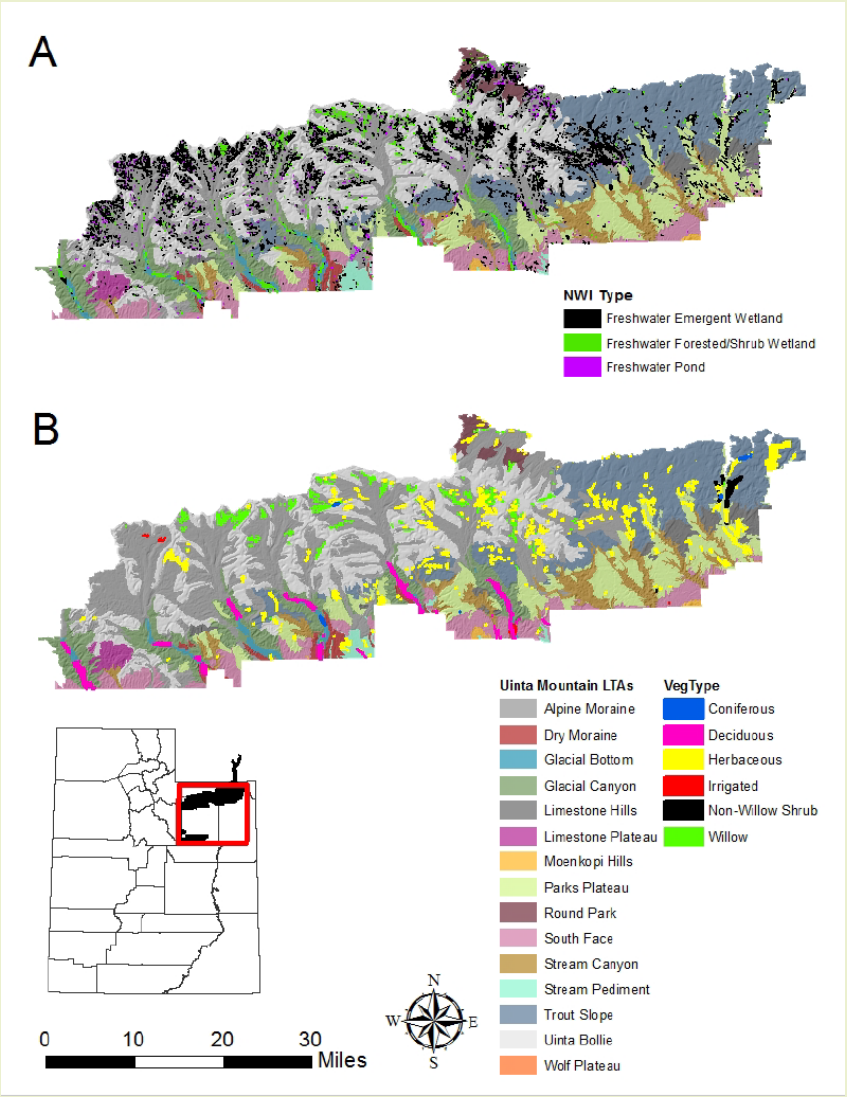
This is where FIA can come in. According to Jamie Barbour, who oversees implementation of the Forest Service's adaptive management process, "As part of the Forest Service's Washington Office Ecosystem Management Coordination Staff, the Adaptive

More Forest Planning Science Resources: Riparian and Groundwater-Dependent Ecosystems Assessments

When forest plan development teams need to evaluate their riparian, wetland, and groundwater-dependent ecosystems, many go to a Rocky Mountain Research Station research team for assistance. One reason this work is important, according to team member Katey Driscoll, a research ecologist based out of Albuquerque, New Mexico, is that groundwater-dependent ecosystems and intermittent streams have often been overlooked in the past. "This often makes them difficult to manage today," Driscoll says, adding, "In some instances, the condition of these systems has been degraded simply due to lack of knowledge of their location. In the future, mapping and monitoring of these resources is important."

Intermountain Region 4 (R4) and the Rocky Mountain Research Station's goal is to have these assessments ready for revision of National Forest management plan under the 2012 Planning Rule. "Our approach is extremely collaborative," Driscoll explains, adding, "We start with at least one site visit with the forest plan revision team and riparian experts, mostly hydrologists and fish biologists, but also recreation and range conservation managers. We find that face-to-face meetings are critical to the effort and that the teams provide more feedback when we have that kind of relationship."

Driscoll and others have completed a series of reports for the Ashley, Manti–La Sal, and Bridger-Teton National Forests, and they are working on assessments for the Dixie, Fishlake, and Humboldt-Toiyabe National Forests.



A Rocky Mountain Research Station team helped to assess and classify wetland ecosystems (A) and riparian vegetation types (B) in the Uinta Mountain management area of the Ashley National Forest in northeastern Utah and Wyoming (Image: USDA Forest Service).

These extensive assessments have all addressed drivers, stressors, structure, function, composition, and connectivity of terrestrial and aquatic ecosystems, although the approach has adapted and is slightly different for each report. "Our work is adaptable to the data and information available," Driscoll says, "and we're able to address unique features or specific interests of managers at each forest, as well as concerns that go beyond the National Forests' borders to private inholdings and resources relevant to surrounding communities, such as municipal watersheds."

More information on this program can be found at https://www.fs.usda.gov/rmrs/projects/riparian-wetland-and-groundwater-dependent-ecosystems-assessments-current-conditions. Information on how to contact Katey Driscoll can be found at https://www.fs.fed.us/rmrs/people/katelyndriscoll.

Management and Resource Information Group continually promotes the use of FIA data for development and monitoring of land management plans."

HELP FROM THE ROCKY MOUNTAIN RESEARCH STATION

Several National Forest teams have turned to data from the FIA program and assistance from analysts working for the Rocky Mountain Research Station FIA.

KEY POINTS

- Forest Inventory and Analysis (FIA) data represent long-term, comprehensive forest data sets for forested areas. These data are updated and published annually.
- FIA data provide scientifically sound estimates of tree, other vegetation, and downed wood conditions across an entire forest that can be used in all phases of the forest planning process: assessment, plan development, and monitoring.
- FIA data can be used with other data sources to improve understanding of resource conditions at multiple scales and to check assumptions.
- Custom analysis of FIA data driven by forest and regional needs and helped by Rocky Mountain Research Station experts can greatly improve the data's usefulness to plan revision, monitoring, and more.
- Additional information can be found at https://www.fs.fed.us/rmrs/research-topics/inventory-monitoring-analysis.

According to Chris Witt, a Rocky Mountain Research Station FIA specialist based in Boise, Idaho, "FIA is a wall-to-wall data set collected across the country that's available free of charge to users." Witt notes that the 2012 Planning Rule mandated the incorporation of broad-scale monitoring, which often means monitoring across multiple National Forests and other designated land areas, as well as across political boundaries such as state lines. "Wildlife don't care about political boundaries," Witt says, adding, "FIA data can help managers assess and track a focal species' forest habitat across areas much larger than their own administrative boundaries. Managers gain an idea what proportion of the realized or potential habitat they have some influence on." This helps with a shared stewardship approach, in which the Forest Service works with states, partners, tribes, and other groups to manage land across wider landscapes than a National Forest administrative area.

In addition, as data analysis has become more sophisticated, FIA data can become more useful in planning efforts. According to Witt: "We're ramping up our ability to make projections on future habitat conditions using simulations based on different habitats and possible management actions. This can help land managers determine the best approaches to monitoring."

"FIA data can help managers assess and track a focal species' forest habitat across areas much larger than their own administrative boundaries."

– Chris Witt

A WIDE RANGE OF USES

Kristen Pelz, a Rocky Mountain Research Station FIA analyst based in Santa Fe, New Mexico, provided additional insights into the program. According to Pelz: "Many people have seen the potential for FIA's unique dataset to inform National Forest System land management planning and monitoring and have worked to realize this potential. This ranges from analysis done on a case-by-case basis by FIA staff or by forest and regional office staff to analyze FIA data themselves, and even develop whole processes for FIA data use. The key issue they have all worked to address is: How can we use FIA data to meet NFS information needs?"

Using FIA data results in using the best available science for planning and monitoring requirements associated with ecological integrity, at-risk species, ecological drivers and stressors, carbon stocks, and sustainable timber production.

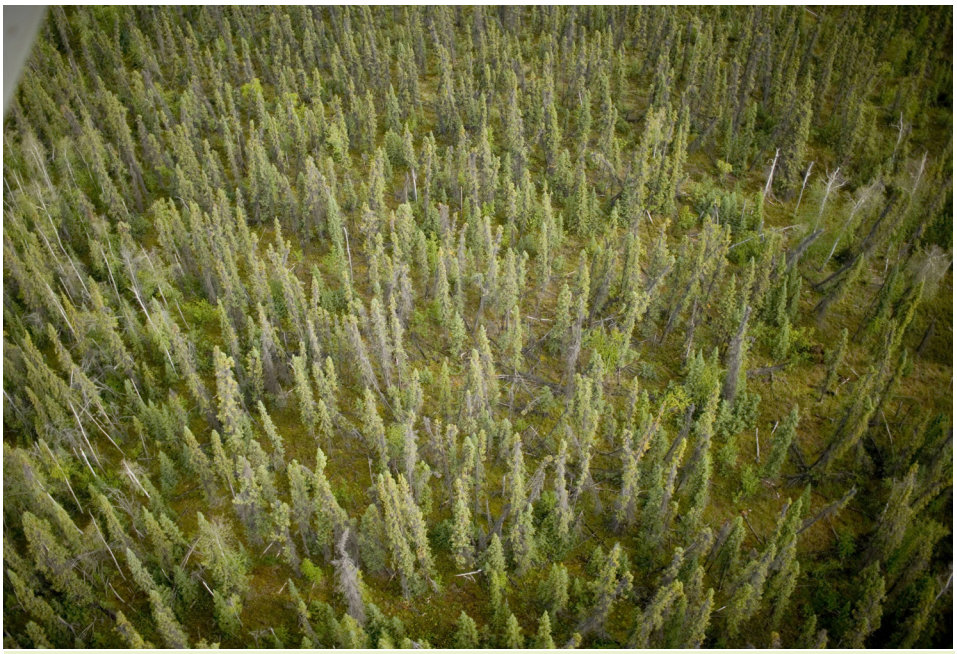
FIA data provide several benefits to National Forests, according to David Anderson, a regional analyst in Albuquerque, New Mexico. "It's consistent, unbiased data on a plethora of variables, collected in a statistically valid fashion across all units," he says, adding, "Because it's re-measured on a recurring timeline, it allows for trend analysis, change detection, and other analyses." For example, the Southwestern Region uses FIA plot data to create models that create a map of vegetation across National Forests in Arizona and New Mexico.

FIA DATA AT WORK IN THE NORTHERN ROCKIES

The National Forest System's Northern Region (R1) is leading out in the use of FIA data, Pelz says, adding, "They have the most integrated use of FIA in planning and management among all the regions in our footprint."

According to Renate Bush, the Northern Region's inventory specialist in Missoula, Montana: "In the Northern Region, every National Forest uses FIA data for land management plan assessments and revision and subsequent monitoring. Because it's a statistically valid sample that is remeasured on a 10-year cycle, our region relies on FIA data for broad and mid-level analysis and monitoring. We use it to evaluate current condition and monitor trends over time. This is more important than ever when you consider how conditions change over time due to disturbances, such as fire and insects."

As an example, Flathead National Forest planners have used FIA data to understand existing conditions and compare those to desired conditions. "They determined that the abundance of the spruce-subalpine fir type were more prevalent than their desired conditions, and that ponderosa pine and western larch needed to be increased to meet desired conditions," Bush says, adding, "Having that information helps us to target vegetation types to be prioritized for harvest and prescribed fire activities. It also informs which species should be planted in different areas."



FIA data have helped several National Forest planning teams to characterize land areas in terms of snags. In the Northern Region, every National Forest uses FIA data for land management plan assessments and revision and subsequent monitoring. Because it's a statistically valid sample that is remeasured on a 10-year cycle, the Northern Region relies on FIA data for broad and mid-level analysis and monitoring (Photo: S. Hillebrand, USFWS).

HELPING DEFINE WILDLIFE HABITAT

Forest Service staff in eastern Idaho have also used FIA data and Rocky Mountain Research Station analyses to help define the needs for change in forest assessments. According to Mary Friberg, an Idaho-based wildlife biologist for the Forest Service: "We have connectivity concerns related to mammals such as fishers, pine marten, and lynx. FIA data give us a better idea of their possible and likely habitat, which gives us the opportunity to collaborate with the BLM and other National Forests on our boundaries."

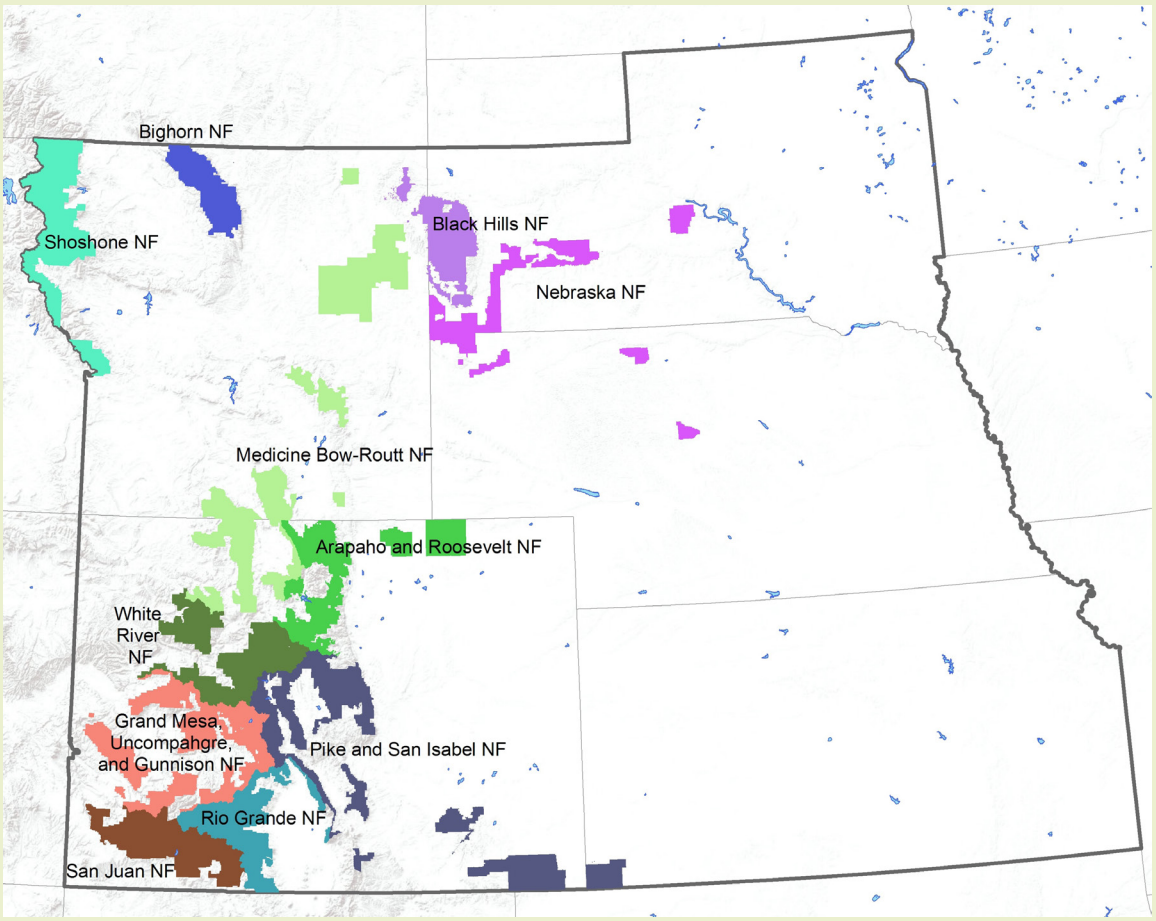
FIA data have also helped the team with planning related to snags and woodpeckers. Friberg explains: "We have a lot of snags

National Forest Climate Change Maps: A Guide for the Future

Another Rocky Mountain Research Station-developed tool called National Forest Climate Change Maps has been developed to help forest planners with their work, especially with vulnerability assessments and scenario planning. These maps, which can be found at https://www.fs.usda.gov/rmrs/projects/national-forest-climate-change-maps-your-guide-future, were developed to provide information on projected climate changes at a scale relevant to decision making processes, including Forest Plans. The maps use state-of-the-art science and are available for every National Forest in the contiguous United States with relevant data coverage.

An underlying concern is usually related to water, along with complying with the 2012 Planning Rule requirement to use the best available scientific information and address measurable changes related to climate change and other stressors. According to developer Charlie Luce, a research hydrologist for the Rocky Mountain Research Station in Boise, Idaho: "Water's pretty fundamental to the land management planning effort. It affects trees, water, lakes, fish and people."

Using data developed by Forest Service research scientists and scientists from other stations and agencies, such as the National Oceanic and Atmospheric Administration, several National Forest teams have used these maps, but the first was the team at the Manti–La Sal National Forest, a 1.2-million-acre National Forest in Utah and western Colorado. According to Luce: "The Manti–La Sal forest plan team wanted to incorporate climate information into their forest assessment and planning process. As an example, they wanted to know about how snowfall timing would affect deer browsing and its impact on livestock grazing. I created some maps about how snowfall would change under projected climate conditions and the presentation just stopped. There were lots of questions and they asked for the data and we realized that these maps would offer value for other forest planning projects around the country."



National Forest Climate Change Maps visually represent projected climate changes to help with forest plan decision making in the Rocky Mountain region and other areas (Image: USDA Forest Service.)

FIA data have helped National Forest planners to work with neighboring areas to manage pine marten and other species of concern (Photo: T. Gage, https://creativecommons.org/licenses/by-sa/2.0/deed.en).

and downed wood due to beetle kill and some extensive fires. We know that we need snags and downed wood across all the stages of succession and that a lot of that material in the large stands that have had big disturbance events. We can tie that into the varied needs of wildlife such as black-backed woodpeckers or pileated woodpeckers. FIA is helping us understand our distribution of snags and how we can manage them for wildlife." In other words, by using FIA data to identify where snags are located, forest planners can localize management efforts to help support specific wildlife species.

FIA DATA AND FOREST PLAN ASSESSMENT

The forest planning team at Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests recently collaborated with the Rocky Mountain Research Station to analyze FIA data. According to GMUG forest ecologist Carlyn Perovich: "We've used FIA in a few different areas for assessment and ecosystem characteristics, along with FIA plots for snags and downed wood. Our use of FIA data is broad, with applications in fire management, fuels loading, and wildlife habitat. Overall, FIA data help us to define our range of desired conditions."

"We've used FIA in a few different areas for assessment and ecosystem characteristics, along with FIA plots for snags and downed wood. Overall, FIA data help us to define our range of desired conditions."

–Carlyn Perovich

Looking forward, Perovich says: "FIA data will also be used to help define our Forest monitoring plan and our timber harvesting plans. For example, we're using FIA plots for temperature monitoring to determine spatial impacts on spruce regeneration. That's an ongoing data collection effort with results expected in a few years."

For the Grand Mesa, Uncompahgre, and Gunnison National Forests, the Rocky Mountain Research Station was a key partner in analyzing the data, Perovich says. "Learning where the data is and how to use it … it was a little complicated," she recalls. "With their help, we were able to use the data to identify normal and healthy ecosystems and to get comfortable with the numbers we used in our planning documentation."

For new FIA users, choosing a variable of interest from the many available options can be a

Forest planners at the Grand Mesa, Uncompahgre, and Gunnison National Forests are using FIA plots for temperature monitoring to determine spatial impacts on spruce regeneration (USDA Forest Service photo).

challenge. Information is available on a variety of parameters describing forests and forest use, including:

- forest area by forest type, forest composition in terms of species, sizes, and volume,
- tree growth, mortality, and removal rates, and
- forest land ownership patterns

Although it may be relatively easy to extract data from the FIA database by using one or more of the tools available on the FIA website, it's important to understand the data's limitations. For example, FIA forest monitoring survey data are generally based on one field sample site roughly every 3 miles, but some states and National Forest System regions fund more intense sampling, which yields more comprehensive and finer-scale data.

FUTURE LAND MANAGEMENT PLANS AND ENVIRONMENTAL IMPACT STATEMENTS (EIS)

Inventory analysis is a key tool to any land management plan or environmental impact statement. FIA is currently equipped and ready with the data to help comply with multiple planning rule requirements. Rocky Mountain Research Station can be the liaison between the National Forest and FIA. There is no cost to download the data and there is a possibility of saving more in the future as assessment, planning, and monitoring needs may decrease.

MANAGEMENT IMPLICATIONS

- Forest Inventory and Analysis (FIA) data can inform forest planning for a wide variety of traditionally separate resource areas, including forest products, fire and fuels, range management, and terrestrial ecology.
- Using the same data set across resource silos can improve collaboration between different land management agencies and partnerships.
- FIA conducts quality control to make sure the dataset contains high quality data, so users can be confident in the data they are using.
- Courts have upheld the validity of FIA data to assess forest conditions.
- If FIA data used for plan revision are integrated into a multi-scale inventory, mapping, and classification system, this can facilitate better connections between the forest planning and project scales.
- Other resources for National Forest planners include a Rocky Mountain Research Station program for assessing riparian and groundwater-dependent ecosystems and a nationwide toolset of National Forest climate change maps.

FIA supports forest planning

The need for nationwide Forest Plan Revisions and the utilization of FIA data to accomplish this is more apparent today than ever. To accomplish National Forest System Planning with FIA Data, systematic investment in capacity-building tools that can enable FIA use for forest planning across NFS is needed. The article Supporting National Forest System Planning with Forest Inventory and Analysis Data has recently been published by researchers from the Rocky Mountain Research Station. The goal of this article is not to enumerate all the possibilities, but to provide examples that can help forest managers understand potential applications of FIA for forest planning and opportunities for pursuing additional and innovative applications of this dataset.

The 2012 Planning Rule called for the importance of scientifically credible assessment and monitoring strategies for adaptive forest planning and the maintenance or restoration of ecological integrity. This recent publication has made it clear how accessible this data can be and the importance behind it. It is a wealth of knowledge and resources for the land managers with boots on the ground to the NEPA specialists and resource specialists in Regional offices.

Management and policy implications

- FIA data and products can be used to comply with regulatory requirements.
- FIA fulfills Planning Rule criteria for the best available scientific information (BASI).
- Data can be used to address assessment, planning and monitoring requirements associated with ecological integrity, at-risk species, ecological drivers and stressors, carbon stocks, and sustainable timber production.
- FIA can support modeling and decision-support tools and providing technical support to forest staff.

Key Points

- These tools have allowed planners on forests such as the Kaibab to assess the “departure” of forest conditions (both current and future) from what are believed to be historic conditions (Weisz et al 2009) and analyze different forest-plan alternatives as required under NEPA.
- Assessment of carbon storage in timber and ecosystems has used FIA timber output data and the FIA-based Carbon Calculation Tool, which is used for international reporting.
- Given the robust “all lands” sampling design and estimation methodologies, FIA data represent the BASI and a defensible source of information that can be used to comply with regulatory requirements and fulfill the adaptive intent of the 2012 Planning Rule.

A central advantage of FIA data is that it can be acquired at little cost to the NFS. However, there are some important considerations for effectively and efficiently leveraging FIA for forest-planning processes.

A Forest Inventory and Analysis crew member inspects a tree core to determine its age (USDA Forest Service photo by Scott Dickson).

SCIENTIST PROFILES

The following scientists and FIA team members were instrumental in the creation of this Bulletin:

KRISTEN PELZ is a forester with the Rocky Mountain Research Station in Santa Fe, New Mexico. She holds a bachelor's degree in geography from Middlebury College and two degrees from Colorado State University: a master's degree in forest science and a Ph.D. in ecology. Her work focuses on using forest inventory information to increase ecosystem resilience to natural and human-caused stressors. She has pursued research on how natural disturbances and management practices affect forest structure. Connect with Kristen at https://www.fs.usda.gov/rmrs/people/kpelz.

CHRIS WITT is an ecologist with the Rocky Mountain Research Station in Boise, Idaho. He has a bachelor's degree in ecology and a master's degree in population ecology, both from Idaho State University. His research focuses on developing tools that quantify habitat for forest vertebrates listed as threatened, endangered, or of special concern by state and/or federal management agencies. He is also working on trend models that can show resource managers which structural characteristics a species' habitat is limiting or is changing in abundance over time. Connect with Chris at https://www.fs.usda.gov/rmrs/people/chriswitt.

KATELYN DRISCOLL is a research ecologist with the Rocky Mountain Research Station in Albuquerque, New Mexico. She holds a bachelor's degree in biology from Gonzaga University and a master's degree in systems ecology from the University of Montana. She is currently a Ph.D. student in biology at the University of New Mexico. Her research interests include ecosystems and the complex interactions that drive large-scale patterns across landscapes, particularly how the structure and function of aquatic and riparian systems are affected by natural and anthropogenic stressors and how disturbance regimes alter ecosystem complexity. Connect with Katey at https://www.fs.usda.gov/rmrs/people/katelyndriscoll.

CHARLIE LUCE is a research hydrologist for the Rocky Mountain Research Station's Air, Water, and Aquatic Environments Program in Boise, Idaho. He holds a bachelor's degree in forest management and a master's degree in forest hydrology from the University of Washington, and a Ph.D. in civil engineering from Utah State University. His research interests include climate change effects on stream and forest ecosystems, ecohydrology of climate extremes, snow hydrology, and forest road effects on hydrology, slope stability, and erosion. Connect with Charlie at https://www.fs.usda.gov/rmrs/people/cluce.

DAVID ANDERSON is the Southwestern Region's regional analyst. His work in the academic, private, and public sectors has focused on analyzing forest inventory data to use as inputs and parameters for forest planning models. David currently develops landscape-scale planning models that utilize regional scale data. He holds a bachelor's degree in forestry from Texas A&M University and a master's degree in quantitative resource management from the University of Washington.

JAMIE BARBOUR is the assistant director for adaptive management in the Forest Service's Ecosystem Management and Coordination Staff, where he is responsible for assisting the agency to adopt adaptive management concepts in the planning process. He spent much of his career with the Pacific Northwest Research Station, where he managed the Social Science, Economics, Ecosystem Services, and Science Delivery research program and served as assistant director for research. He later moved to the Forest Service's Washington Office, where he served as senior policy advisor to the deputy chief for National Forest Systems, advising on inventory, monitoring, and assessment strategy. Jamie has degrees in wood and fiber science and botany.

RENATE BUSH is a forester with the Northern Region, where she oversees the Region's vegetation inventory program. Her staff is responsible for assisting National Forest teams with acquiring, storing, and analyzing inventory data to meet information needs, from project-level planning to forest plan revision. Renate has spent her entire career working in forest sampling, warehousing of inventory data, and subsequent analysis. She earned bachelor's degrees in resource conservation and statistics and a master's degree in applied analysis from the University of Montana.

SCIENTIST PROFILES (continued)

The following scientists and FIA team members were instrumental in the creation of this Bulletin:

MARY FRIBERG is a wildlife biologist for the Salmon-Challis National Forest in Salmon, Idaho. She has worked in the Alaska, Northern, and Intermountain Regions. Mary's work focuses on forest planning, including forest plan amendments and revision and inventory and monitoring. She received a bachelor's degree in biology and a master's degree in conservation biology from the University of Minnesota–Saint Paul.

CARLYN PEROVICH is a forest ecologist with the Grand Mesa, Uncompahgre, and Gunnison National Forests. She holds a bachelor's degree in environmental science from Tulane University and a master's degree in ecology from Colorado State University.

WRITER'S PROFILE

BRIAN COOKE is a science writer for the Rocky Mountain Research Station in Fort Collins, Colorado. In addition to his work for RMRS, Brian has completed writing assignments for the Northern Research Station, the National Park Service, various environmental services companies, and proposal writing and editing for several Bureau of Land Management projects. Brian's science and environmental writing is frequently colored by his National Park Service interpretive training and his experience as a volunteer docent for Alcatraz Island National Historic Landmark and San Francisco Maritime National Historical Park. He received a bachelor's degree in journalism-science writing from Lehigh University.

FURTHER READING

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SCIENCE YOU CAN USE BULLETIN

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POSTAGE

The purpose of the Science You Can Use Bulletin: To provide scientific information to people who make and influence decisions about managing land.

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Rocky Mountain Research Station researchers work at the forefront of science to improve the health and use of our Nation's forests and grasslands.

RMRS is one of 7 Forest Service Research & Development Stations located throughout the U.S. Within the 12 state RMRS footprint, we maintain 12 research locations, conduct long-term ecological research on 14 experimental forests, ranges and watersheds and work in hundreds of research natural areas.

You may also be interested in regular science delivery bulletins similar to Science You Can Use, produced by the Pacific Northwest and Southern Research Stations: PNW Science Findings and SRS CompassLive.

More information about the Rocky Mountain Research Station can be found here www.fs.fed.us/rmrs and you can learn more about Forest Service Research at www.fs.fed.us/research.

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