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FORUM

Modernizing America's National Forest Inventory through a Third Blue Ribbon Panel

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Abstract
The USDA Forest Service's Forest Inventory and Analysis (FIA) program, the United States' national forest inventory operating since 1928, has undergone two independent Blue Ribbon Panel (BRP) reviews (1991–92, 1997–98) that drove major improvements, including the transition toward a nationally consistent annualized inventory system and integration of forest health monitoring. Today, FIA faces unprecedented demands from data-driven markets, intensifying disturbances, supply chain volatility, and sustainability frameworks requiring verified, frequently updated data at sub-county scales through accessible, open-standards platforms that clearly distinguish between design-based and model-based population estimates. Technological advances in remote sensing, artificial intelligence (AI), machine learning (ML), small-area estimation (SAE), and geospatial analysis offer enhanced monitoring opportunities but pose complex challenges in data fusion, analytics, and governance. Non-US entities are accelerating investment in operational forest monitoring infrastructure, integrating satellite Earth observation with ground inventory data and AI-assisted supply-chain verification, creating competitive and regulatory pressure on the US forest sector. This evolving landscape demands a third FIA BRP to chart a path toward a world-leading national forest inventory system addressing SAE, data confidentiality, and AI/ML deployment. Without modernization, the US risks ceding leadership in forest monitoring and undermining the sector's competitive standing in global markets. The US forest sector currently lacks a unified strategic vision to navigate these challenges, perpetuating outdated assumptions regarding technology, governance, and partner coordination. A third FIA BRP would build technical consensus among leading experts and deliver actionable recommendations, enabling agency leaders, policymakers, and partners to ensure that FIA applies the best available technology, provides credible, decision-relevant forest information, and supports science-based digital forest intelligence that meets international market expectations.

Keywords Forest Inventory and Analysis (FIA) · Blue Ribbon Panel · National Forest Inventory · Small-area estimation · Digital forest intelligence · Forest monitoring

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FIA Origins, Mandate, and Core Accomplishments

Since its creation in 1928, the USDA Forest Service's FIA program has been the primary source of comprehensive information on the status and trends of forests across all ownerships in the US (Labau et al. 2007). FIA has long served as a foundational element of national resource monitoring, policy guidance, and scientific innovation (Cahoon et al. 2026; Tinkham et al. 2018). Subsequent legislation, including the 1974 Resources Planning Act (RPA) and the 1978 Forest and Rangeland Renewable Resources Research Act, reaffirmed FIA as the authoritative national assessment of forest resources and linked it to recurring national assessments and forest resource projections, thereby creating the Resources Planning Act Assessment program (Wear et al. 2013; Coulston et al. 2023; Wear and Coulston 2025; Oswalt et al. 2026). The FIA program's core responsibilities include maintaining forest inventories, enhancing the inventory through applied research and development, and analyzing trends in commercial use and production. The program currently centers on four components: (1) enhanced National Forest Inventory (NFI; Westfall et al. 2022); (2) National Resource Use Monitoring (NRUM), formerly known as the Timber Products Output monitoring program (TPO; Coulston et al. 2018); (3) the National Woodland Owner Survey (NWOS; Butler and Caputo 2022); and (4) Urban Forest Inventory (UFI; Edgar et al. 2021).

While FIA has achieved significant milestones in national forest inventories in the past 20 years, critical yet interrelated opportunities for refinement remain (Fig. 1). Key recent achievements include implementing a nationally consistent annualized inventory (Bechtold and Patterson 2005; Westfall et al. 2022), integrating forest health monitoring protocols (Woodall et al. 2011), making data publicly available within 12 months of collection that feed national geospatial databases and analytical tools (e.g., Frescino et al. 2023; Stanke et al. 2020; Wei et al. 2025), and advancing biomass/carbon estimation (Westfall et al. 2024). These refinements and strategic investments have established the FIA ground plot network as the gold standard for design-based forest population estimation in the US (Goeking et al. 2024) and a role model for the world.

These successful outcomes were a direct result of two earlier USDA Forest Service FIA Blue Ribbon Panels (BRPs) (convened in 1991–92 and 1997–98), annual program engagement with the FIA User Group (FIA User Group 2025), and prior legislation (e.g., Farm Bill), which provided strategic recommendations to expand ecosystem monitoring, standardize procedures (field and statistical procedures), improve data accessibility, and integrate advanced technologies (Cahoon et al. 2026). Key recommendations from previous BRPs, together with recent program achievements and persistent gaps in technology integration, underpin the need for a third BRP to address emerging organizational, policy, and technical challenges in SAE (Prisley et al. 2021; Wiener et al. 2021), remote sensing (Lister et al. 2020), and evolving user geospatial priorities given existing products like BIGMAP (Wilson and Oswalt 2025), TreeMap (Riley et al. 2021), and associated geospatial data (Chivhenge et al. 2025; Riley et al. 2022, 2023). These recent accomplishments highlight rising demands that the current FIA program structure and funding cannot fully meet, particularly

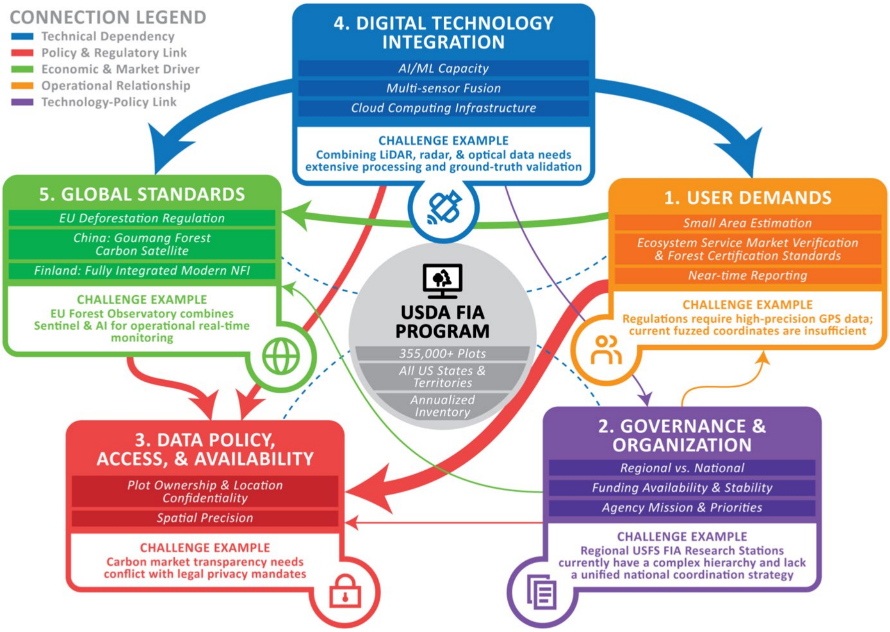

Fig. 1 Network diagram illustrating interconnected challenges facing the USDA Forest Service FIA program that require a comprehensive assessment through a third Blue Ribbon Panel. The five primary challenge domains (colored boxes), (1) user demands and applications; (2) governance and organization; (3) data policy; (4) digital technology integration; and (5) global standards, are linked by connections indicating relationships between challenges. Line colors indicate connection types: technical (blue), policy/regulatory (red), economic/market (green), and operational (orange); line thickness represents connection strength. Specific examples in callout boxes demonstrate challenge interactions. For instance, the European Union Deforestation Regulation (EUDR) simultaneously drives user demands for spatial precision, exposes data constraints, and highlights international competitive pressures. *AI/ML*, artificial intelligence/machine learning; *SAE*, small-area estimation; *LiDAR*, light detection and ranging; *GPS*, global positioning system

in SAE, confidentiality, AI/ML integration, and the deployment of scalable, open-standards digital architectures. In this article, we use the general term *digital forest intelligence* to describe the integrated product of ground inventory measurements, remotely sensed data, and analytical models delivered through open-standards digital systems for decision-making across spatial and temporal scales. This concept frames the modernization challenge that a third BRP must address.

Lessons from Past FIA Blue Ribbon Panels

The first two FIA BRPs (1991–1992, 1997–1998) were independent, external reviews convened by industry associations in response to concerns from forest products companies, state agencies, and conservation groups about FIA's adequacy and visibility (American Forest and Paper Association 1998; American Forest Council

1992). Panelists included industry leaders, state foresters, federal scientists, academics, and representatives of non-governmental organizations (NGOs), and they produced public reports with recommendations for Congress, the US Department of Agriculture (USDA) leadership, and FIA management (Table 1).

Together, the panels called for a clear national vision, standardized methods, shorter inventory cycles, improved statistical design, enhanced technology adoption, better data accessibility, and stronger external partnerships. Many of the recommendations have since been implemented. A 2001 update documented significant progress on design and integration but also noted persistent delays between measurement and analyses (American Forest and Paper Association 2001), issues that remain relevant today.

Major FIA Program Accomplishments

FIA has made considerable progress since these recommendations were issued (Fig. 2). Notable accomplishments include transitioning the CONUS and Coastal Alaska inventories to a nationally consistent annualized design mandated by the 1998 Farm Bill, fully integrating with Forest Health Monitoring, and standardizing data management and field procedures nationwide (Fig. 3). The program has improved technological adoption, including high-precision GPS integration and multi-agency remote sensing partnerships (Cahoon et al. 2026), particularly for core products such as the National Tree Canopy Cover layer (Coulston et al. 2016) and the ongoing Interior Alaska inventory (Khatri-Chhetri et al. 2025).

Public access to FIA data has been enhanced through improved online databases and spatial data services, including open-source platforms such as EVALIDator and FIA Database (FIADB-API[1]), pyFIA (Wei et al. 2025), rFIA (Stanke et al. 2020), and FIESTA R packages (Frescino et al. 2023), all built on open-standards facilitating data access and reproducible analysis across diverse user communities. External partner engagement has increased through user groups (e.g., FIA User Group 2025), annual business reports, strategic plans, and online dashboards. The National Council for Air and Stream Improvement (NCASI) Biometrics Working Group,[2] an independent technical consortium including representatives from the forest industry, state forestry agencies, academic institutions, and federal research programs, several of whom are coauthors of this article, has provided ongoing input to FIA on sampling design, estimation methods, and analytical approaches. The group's membership and activities are coordinated through NCASI.

The FIA program has delivered advances in national biomass estimation, carbon monitoring for greenhouse gas emissions, urban forestry inventories, wood product tracking (Coulston et al. 2018; Wear and Coulston 2025), private forest ownership surveys (Butler and Caputo 2022; Caputo and Butler 2025), and spatial data products for policy planning (Domke et al. 2024; Riley et al. 2021). The annualized inventory currently operates across the 48 contiguous states and the Coastal Alaska inventory unit, while Interior Alaska, Hawaii, Puerto Rico, the US Virgin Islands, and other US

[1] https://apps.fs.usda.gov/fiadb-api/evalidator
[2] https://www.ncasi.org/resource/biometrics-working-group/

Table 1 Evolution of FIA Blue Ribbon Panels, showing panel composition, key issues, recommendations, and remaining gaps motivating a third panel

Panel (Year)	Composition	Identified (Anticipated) Issues	Primary (Anticipated) Recommendations
First Blue Ribbon Panel (1991–1992)	Industry leaders; state foresters; federal agencies; academics; NGOs	• Infrequent, periodic inventories • Inconsistent regional methods • Limited ecological/non-commodity data • Slow data delivery and low visibility	• Define the national FIA vision • Standardize field and analytical procedures • Shorten inventory cycle • Expand ecosystem and non-commodity metrics • Improve customer service and interagency coordination
Second Blue Ribbon Panel (1997–1998)	Industry associations; state foresters; USFS leadership; academic experts	• Need for annualized inventories • Outdated data management systems • Weak integration of forest health monitoring • Lag between measurement and analysis	• Implement annualized design and control panel creep • Modernize data management systems • Integrate Forest Health Monitoring • Strengthen collaboration and secure stable funding
Status Update to Second Panel (2001)	Many of the original panel members, including industry associations, state foresters, and federal partners	• Data management bottlenecks • Declining share of resources for analysis • "Panel creep" in the annual system • Limited performance metrics and accountability	• Accelerate Forest Health Monitoring integration; • Expand remote sensing and advanced analytics partnerships • Formalize performance tracking and progress reporting

Table 1 (continued)

Panel (Year)	Composition	Identified (Anticipated) Issues	Primary (Anticipated) Recommendations
Proposed Future Blue Ribbon Panel	10–15 members, 1–2 survey statisticians, 2–3 biometricians, 2–3 remote sensing specialists, 2–3 industry leaders, 2–3 Federal scientists, 1–2 State foresters, 1–2 NGO representatives, 1–2 fiber market experts, 1–2 policy analysts; Supported by 3–5 external subject matter experts and independent reviewers	• User demands for timely, decision-relevant information with available digital tools, including AI/ML; FIA lacks statistical expertise commensurate with its role as a national statistical program • Ensure the ground-based plot network remains intact and enhanced with new technological innovations • Meet the rising demand for quantified, small-area, decision-ready estimates • Address unresolved issues related to plot confidentiality, data governance, and fragmented regional roles • Respond to pressures from carbon markets, disturbance regimes, and rising expectations from global reporting and certification standards • Integrate FIA with remote sensing and other auxiliary data	• Articulate a future vision for a unified national FIA; include international NFI perspectives • Set standards for small-area estimation and sensor fusion • Recommend governance and confidentiality frameworks • Prioritize investments in analysis and data infrastructure • Expand strategic partnerships across sectors • Align FIA products with environmental, carbon, and sustainability policies

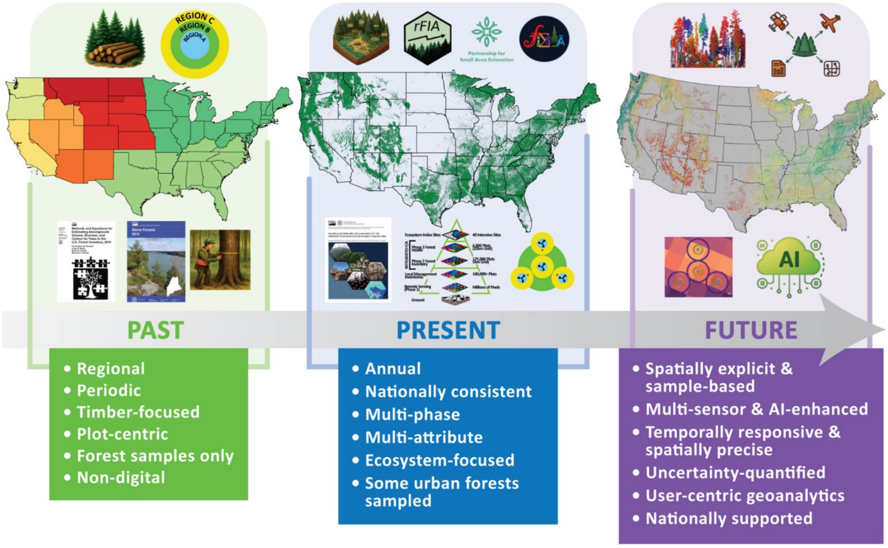

Fig. 2 Evolution and future opportunities for the USDA Forest Service's Forest Inventory and Analysis program. Sample-based measurement with plot network intensification remains foundational as 'census' refers to wall-to-wall mapping derived from sample-based models, not the elimination of ground-based sampling

territories maintain periodic inventories. Historically, the Interior Alaska inventory operated on a periodic basis with a 20- to 25-year remeasurement cycle; it has been redesigned to adopt an annualized sampling strategy beginning in 2026, representing a major ongoing expansion of the program's annualized national coverage. The National Scale Volume and Biomass Estimation (NSVB) project has produced refined estimates of tree-level biomass and carbon (Westfall et al. 2024). Simultaneously, growing interest in forests and innovative wood products has dramatically increased demand for FIA data.

Critical to FIA's success are financial partnerships with state forestry agencies that co-fund inventory sampling and other program data collection. Several states contribute resources and field capacity, enabling data intensification, sub-state estimates, and demonstrating sustained co-investment. Federal agency partners, including units of the National Forest System, the National Park Service, the Bureau of Land Management, and NASA, also contribute resources, data, and field capacity in specific geographic areas and for particular program components. Maintaining these partnerships requires organizational arrangements that recognize states as co-investors rather than merely data recipients. However, recent workforce reductions and delayed federal appropriations have disrupted collaborative field operations (FIA User Group 2025), creating a bottleneck that threatens the efficiency and efficacy of these partnerships. FIA now faces interconnected challenges requiring a comprehensive external assessment by a third BRP. The following topics illustrate key questions a BRP needs to examine; they are not intended to predetermine the discussion or its outcomes, as the panel should remain free to identify additional issues and solutions.

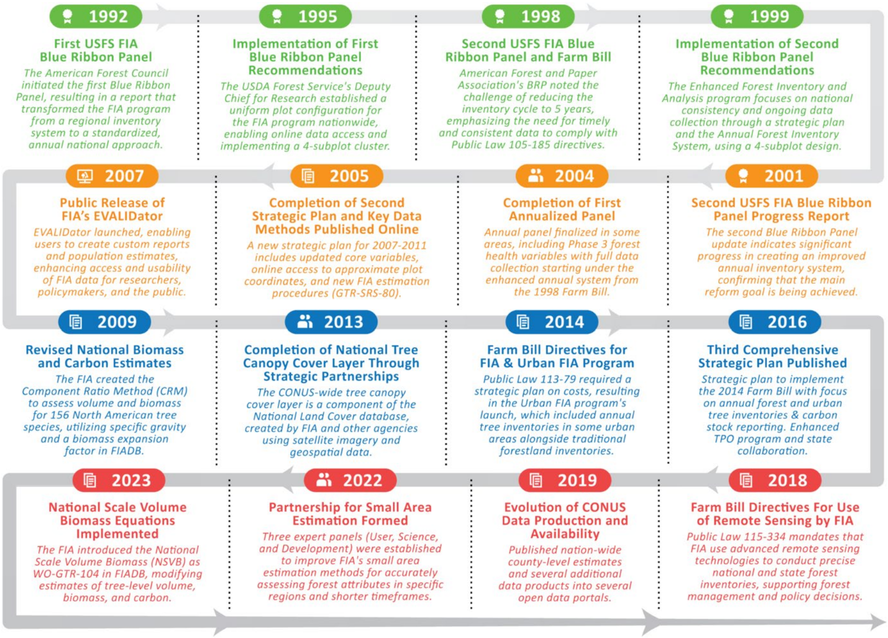

Fig. 3 Overview and timeline of the USDA Forest Service Forest Inventory and Analysis (FIA) program following the first Blue Ribbon Panel in 1992, which extends through 2023

Emerging Digital Context

The European Union has established forest information systems under the EU Deforestation Regulation (EUDR), which will become applicable in phases during 2026–2027 (December 30, 2026, for large/medium operators and June 30, 2027, for micro or small operators) and is driving demand for satellite-based, AI-assisted supply-chain verification (Johnston et al. 2025; Renwick et al. 2025). Notably, an emerging ecosystem of satellite-AI compliance tools for EUDR (e.g., LiveEO, Planet Labs, osapiens, ResourceWise, IntegrityNext) has already arisen despite ongoing implementation delays. In addition, the Copernicus Land Monitoring Service provides wall-to-wall forest disturbance tracking updated annually across EU member states, potentially underpinning regulatory compliance (e.g., European Commission 2023; European Parliament 2023) and sustainability certification workflows that increasingly affect US forest product exports. China has substantially expanded its Earth observation infrastructure for national-scale terrestrial ecosystem carbon monitoring with a focus on forests, including the Goumang (TECIS) satellite (launched August 4, 2022), which combines LiDAR with multispectral and hyperspectral sensors for forest carbon monitoring, reflecting a broader international trend toward operationalizing remote sensing as a core component of national forest inventory programs (NFIs; Pérez 2025). Notably, Finland's NFI exemplifies a highly modern, fully integrated inventory, combining universal LiDAR coverage, ongoing ground-based field sampling, and satellite-based change detection (Mäkisara et al. 2022). These developments demonstrate that multiple peer nations are transitioning from research pilots to operational, AI-integrated forest monitoring at the national scale, creating expectations in international markets and regulatory frameworks that US forest data systems will need to match and likely exceed.

Importantly, the US is not lacking in domestic technology investment. Federal programs, including NASA's Global Ecosystem Dynamics Investigation (GEDI; Dubayah et al. 2022) or Ice, Cloud, and land Elevation Satellite-2 (ICESat-2; Magruder et al. 2025) missions and the USDA/NASA Western Ecosystems Research using Ketzal (WERK) partnership,[3] have generated nationally relevant forest structure and biomass data streams. Multiple states have invested in statewide LiDAR acquisitions and high-resolution imagery products like 3D National Agriculture Imagery Program (NAIP[4]). Private-sector platforms such as CTrees, Planet Labs, and Vibrant Planet are producing forest structure, dynamics, and canopy-monitoring products at a continental scale. Yet these substantial investments remain largely disconnected from FIA's estimation pipeline, as no systematic operational framework exists to integrate externally generated remote sensing products with FIA's ground plot data to produce calibrated, uncertainty-quantified forest estimates. The result is a fragmented landscape in which parallel investments by federal agencies, states, and the private sector cannot be combined into the coherent national forest intelligence system that markets and policymakers increasingly expect. The current challenge is not only to advocate and prioritize new technology investments per se, but also to design the institutional and analytical architecture that connects existing assets into an integrated, operational whole.

This forum article argues that a third FIA Blue Ribbon Panel (BRP) on forest inventory and analysis is essential to move from technology testing to national-scale implementation of modern analytical and governance frameworks in the US, including AI/ML, SAE, remote sensing with geospatial data fusion, and data-access and confidentiality governance, so that the national inventory can meet emerging market and policy expectations. Previous BRPs operated in an era of largely siloed systems, where field measurements, remote sensing programs, and data products were developed and maintained independently. In 2026, the competitive landscape is changing rapidly and continually evolving, so a key technical challenge for a third BRP is to design an FIA program that accelerates, rather than impedes, the flow of data and analytics through a modern digital intelligence pipeline, one in which transparency, interconnectedness, and near-real-time delivery are baseline expectations for markets, managers, and the public.

Despite its historical NFI leadership, the US risks falling behind competing nations and economies if it does not make strategic investments integrating its FIA ground plot network with modern computing and analytical systems to dynamically deliver forest intelligence across spatiotemporal scales. Since 1998, the FIA program has assumed responsibility for carbon accounting, urban inventories, disturbance monitoring, and trade compliance. These additional mandates have not been matched by commensurate increases in personnel, computing, or

[3] https://www.nasa.gov/werk/

[4] https://naip-usdaonline.hub.arcgis.com/

analytical capacity, creating a widening gap between mission and means that has been further compounded by cumulative workforce constraints, including hiring limitations that predate recent federal reductions in force, that have left some regions unable to fill FIA funded positions for multiple field seasons (E&E News 2026). Emerging technologies can address this gap by improving efficiency while reserving field crews for measurements that require human expertise.

The US forest products sector generates $427.3 billion in GDP annually and supports 3.4 million jobs (Pelkki 2024), making forest intelligence infrastructure economically critical. Forest products industry decision-makers routinely use FIA data to make strategic decisions regarding manufacturing assets, timberland investments, and regional timber supply dynamics (e.g., Lang 2024; see also Wear and Coulston 2025). FIA data also support assessments of the impacts of natural disasters on forest resources, including wildfire effects on timber supply in the Pacific Northwest (e.g., Lang 2021) and post-hurricane rapid damage assessments and long-term inventory updates in the Southeast (Glass and Oswalt 2007). Yet FIA's data and analytics architecture are increasingly misaligned with the data needs of key user groups: (1) carbon market developers and verifiers who require project-level biomass and carbon estimates with quantified uncertainty at parcel or stand scales to support credible digital MRV architectures (Woodall 2025); (2) state forestry agencies and wildfire managers needing county-scale, frequently updated forest condition, fuel loading, and three-dimensional fuel structure information for risk assessment, fire behavior prediction, resource allocation, and state climate action planning where natural and working lands carbon inventories depend on FIA plot data for calibration and validation (e.g., CARB 2026); (3) forest products companies making timberland acquisition and manufacturing investment decisions at the landscape scale; (4) regulatory compliance practitioners working under frameworks such as the EUDR (European Parliament 2023) that require spatially explicit, frequently updated deforestation verification (Renwick et al. 2025) tied to specific supply chain transactions; and (5) Tribal entities and conservation organizations requiring culturally and ecologically appropriate inventory data for sovereignty-based or other resource decisions.

Compounding these unmet demands, state agencies that have invested substantially in complementary remote sensing infrastructure, including statewide LiDAR acquisitions and satellite-derived products, report persistent difficulty accessing the FIA plot data needed to calibrate and validate these investments, even when offering to provide their own data science capacity to address confidentiality constraints. These pressures underscore the need for a third FIA BRP to chart a modernized path forward, ensuring that the FIA program applies the best available science efficiently while meeting market, regulatory, policy, and land-management needs. Participants in the FIA National User Group and the NCASI Biometrics Working Group, groups represented among the authors of this forum article, have documented growing concern that, without a clear modernization strategy, inventory delays and capacity constraints will increasingly undermine wildfire risk assessment and management planning, forest-product investment, and community-resilience efforts that depend heavily on FIA data (e.g., FIA User Group 2025). Given the sector's economic scale, strategic investment in FIA modernization represents a high-return, low-risk opportunity. A third BRP could directly examine how targeted investments in analytical capacity, technology integration, and governance could sustain data quality and timeliness for a key US sector that annually generates more than 3,000 times the current annual FIA appropriation.

What a Third FIA Blue Ribbon Panel Should Deliver

Central to any modernization discussion is a clear distinction between the two primary estimation frameworks that FIA employs and that a third BRP would need to evaluate jointly. Design-based estimation, which relies on the probability sampling structure of FIA's permanent ground plot network, has been the program's statistical foundation for more than 60 years and produces unbiased estimates of forest population parameters at state and national scales. Model-based estimation, including small-area estimation (SAE), AI/ML-assisted prediction, and imputation methods, uses ancillary variables and modeling assumptions to produce estimates for small spatial domains or frequent time intervals that direct sampling alone cannot support; however, these estimates are model-dependent and can introduce bias or understate uncertainty when ancillary data, domain structure, or modeling assumptions are misspecified.

The design-based inventory is the gold standard (Goeking et al. 2024) for estimating forest population parameters, such as total volume, biomass, carbon stocks, and area by forest type, at state and national scales over multi-year reporting periods. It is not designed, however, to provide rapid post-event assessments following hurricanes or wildfires, nor county-scale or finer estimates that users increasingly require. Standard FIA sampling intensity and the rotating panel design do not support finer spatial and temporal scales, such as point-in-time estimates for a 100,000-acre area of interest or county-level projections needed for mill procurement and strategic planning decisions.

The two approaches are not mutually exclusive. The US Census Bureau provides a useful analogy, as it maintains the decennial census as its benchmark enumeration while producing postcensal and intercensal population estimates as clearly labeled complements between census years. FIA is well-positioned to operate on the same dual-track basis, with design-based estimates anchoring national and state reporting and model-based products providing more frequent or spatially granular intelligence for specific applications. The permanent ground plot network and the nearly unbiased estimation it enables are irreplaceable; a third BRP would seek to augment these strengths with modern tools rather than supplant them.

A third BRP must address whether FIA's current design and business model can deliver timely estimates using a combination of design-based methods, which remain the primary, nearly unbiased foundation of the program, and model-based techniques (SAE, AI/ML) that complement design-based products for sub-county or project-scale estimates, recognizing that the feasibility and appropriate role of FIA in delivering such granular information is itself a question the BRP should address along with the need for near-real-time applications. Simultaneously, the panel must resolve fundamental challenges in governance, partnership integration, funding, technology integration, and confidentiality (Fig. 1), each requiring independent expert assessment. While existing user groups provide valuable incremental feedback, they cannot credibly recommend national governance reforms or balance competing priorities among diverse partners. The Biometrics Working Group (described above) currently provides technical guidance on sampling and estimation but lacks the independence and scope to address system-level questions of governance, confidentiality policy, or strategic investment priorities. Consequently, a third BRP would provide the platform to evaluate FIA's core products and precision standards, assess technology and governance frameworks, and prioritize investments for at least the next two decades (Table 2).

Advances in aerial and terrestrial LiDAR, satellite imagery, and digital mapping offer opportunities for monitoring, but still depend on FIA's permanent ground plots for calibration, validation, and bias correction, functions that underscore their irreplaceable role. Remote sensing alone cannot provide species-level composition, diameter distributions, or reliable attribution of change, so sampling remains essential. A key task for a third BRP will be to assess which attributes are most accurately and cost-effectively obtained from ground-based plots versus remote sensing, and to recommend principles for an optimal hybrid design that leverages SAE methods to combine these strengths. In addition, the BRP is needed to reinforce that detailed measurements from ground-based plots remain the most cost-effective and accurate foundation for calibrating model-based estimates, ensuring that modernization augments rather than displaces this irreplaceable infrastructure.

The BRP should also evaluate how data fusion, the statistical and computational integration of ground plot measurements with remotely sensed data streams such as LiDAR, optical imagery, and synthetic aperture radar, and quality assurance practices can be standardized across FIA activities. This should include a structured evaluation of how operationally mature a given technology is for national-scale deployment, from research proof-of-concept through to reliable operational use, enabling a tiered deployment strategy that distinguishes mature technologies ready for immediate integration from those requiring further validation. In short, the panel's role is to chart a strategic direction, not to prescribe operational details, which remain the responsibility of FIA leadership and implementing agencies.

Plot location confidentiality serves two distinct purposes that any program modernization must protect: landowner privacy under applicable federal statutes, and the statistical integrity of the probability sample itself, since disclosure of exact locations could allow selective exclusion or preferential treatment of specific plots in ways that introduce bias into the design-based estimates that are FIA's core product. The Census Bureau offers a relevant model as it conducts most of its sensitive data work in-house rather than releasing raw microdata and invests in internal analytical capacity as an alternative to broad data disclosure.

Plot location confidentiality is likely the most contentious FIA policy issue (e.g., Goeking et al. 2024), with the issue actively debated globally (Schadauer et al. 2024). Current fuzzing or swapping protocols were designed under privacy laws from the 1980s (Smith 2002) when remote sensing capabilities were emerging. Today, commercial constellations can reveal stand-level or finer detail (Duncanson et al. 2025). A vital role for the BRP will be to evaluate alternatives that balance privacy with precision requirements, such as differentiated protocols by ownership, voluntary higher-resolution

Table 2 Potential priority domains for FIA modernization and specific roles for a proposed third Blue Ribbon Panel in addressing each. These priority domains and potential panel roles are illustrative examples intended to inform panel scope. The Blue Ribbon Panel would have the independence to identify additional issues, refine priorities, and develop alternative solutions as evidence and expert deliberation warrant

Domain	Current Gap	Priority role for Third FIA Blue Ribbon Panel
Remote sensing & AI/ML integration	Multiple pilots with inconsistent use of LiDAR, satellite, and other auxiliary data; limited standards for data fusion and QA/QC across regions	Define integration and QA/QC standards for combining plots and remote sensing; classify technologies by maturity and recommend a tiered deployment strategy for mature, developing, and experimental methods
Confidentiality & data access	Legacy plot fuzzing was designed for a pre-high-resolution satellite era; tension between privacy expectations and demand for sub-county estimates	Assess alternative modern confidentiality frameworks (e.g., ownership-specific rules, voluntary higher-precision options, anonymization methods) that balance privacy protection with spatial precision needs
Governance & organizational structure	FIA is housed in USFS R&D and administered via regional stations while carrying an increasingly operational mandate; potential relocation to NFS raises all-lands concerns	Evaluate potential governance options and recommend structures that maintain national consistency, support state co-investments, and protect FIA's all-lands mission across private and public ownerships
Precision standards & small-area estimation	No formal, application-specific precision targets; no framework for distinguishing precision requirements of design-based vs. model-based products; growing demand for project- and county-scale estimates using SAE and auxiliary data	Recommend potential precision targets for key applications (e.g., carbon projects, fiber supply, disturbance monitoring, trade compliance) and recommend sampling intensities, SAE methods, and validation protocols to achieve them
Markets, trade, & economic relevance	A forest sector contributing \$427.3B in GDP and supporting 3.4 million jobs faces new regulations (e.g., EUDR); FIA is not yet fully positioned as the trusted source for digital verification	Clarify FIA's role in supporting emerging ecosystem markets, certification, and trade compliance, and prioritize investments that secure US competitiveness in data-driven forest and global markets
Digital architecture & open-standards	Legacy data systems not optimized for AI, cloud, or open-standards workflows; uneven interoperability across federal, state, and private systems	Assess the current FIA digital infrastructure, including technical debt, reliability, and interoperability, and recommend any strategic changes needed so systems can deliver timely, reliable, and accessible data that support end-user goals and a range of analytical techniques, including SAE and AI/ML where appropriate

participation, or anonymization approaches that protect individual landowners' identities while preserving the spatial precision needed for modern monitoring applications. Beyond confidentiality, the BRP should also evaluate FIA's role in site quality assessment. Productivity and site quality drive investment decisions in the forest sector and economic returns. Thus, the BRP will need to assess whether FIA should be expanded to include enhanced site-quality information by combining plot measurements with digital soils and high-resolution environmental variables through SAE.

External partners have highlighted the need for a clear vision: systems that support decision-making across scales, advance sustainability, adapt to emerging technologies, and apply the best available science to meet market expectations. The current FIA administrative structure poses challenges to implementing a nationally consistent inventory. FIA is housed within the Forest Service Research and Development, with a cadre of national leadership (Director, National Leader, and National Program Manager) reporting up through the Deputy Chief for R&D, but with the program administered through regional research stations, each with distinct priorities and each with a regional FIA Program Manager reporting to a Research Station Director. However, FIA's mandate has evolved into a substantial operational undertaking requiring national coordination. A critical organizational concern is FIA's potential placement within structures focused primarily on National Forest System lands, which could marginalize the program's all-lands mandate, considering that privately owned forests account for 58% of the nation's forest resources (Butler and Caputo 2022) and 88% of timber production (Oswalt et al. 2026). Furthermore, recent federal workforce reductions have particularly affected analytical capacity (E&E News 2026), underscoring the need for organizational arrangements to maintain emphasis across ownerships while supporting coordinated field operations and state partnerships.

FIA could evolve toward enhanced national coordination while maintaining regional field operations, with state partnerships integral; the BRP should evaluate the optimal balance between national consistency and regional flexibility. A purely nationally consistent approach is not universally feasible: the Interior Alaska inventory operates under ecological and logistical conditions that require distinct protocols; tropical island territories have forest types and access constraints that differ substantially from contiguous US forests; and plot visit costs vary dramatically across regions such that a uniform five-year cycle is not operationally achievable everywhere without substantial additional resources. The BRP should also consider the long-standing need to be responsive to the data needs of state forestry agencies and National Forest System partners, which may require regional differentiation in sampling intensity or measurement protocols. Recent workforce reductions and funding constraints have necessitated extensions of measurement cycle intervals in some states (FIA User Group 2025), yet regional variation in forest dynamics, disturbance rates, and information needs requires differentiated approaches that balance timeliness with cost-effectiveness. Hiring constraints, staff losses, and appropriations delays have already slowed field campaigns in some states and raised the prospect of longer remeasurement cycles, directly undermining FIA's long-standing aim of keeping state-level inventory data no more than a few years out of date. Terrestrial LiDAR, in particular, may have a growing role in plot-level structural measurements and in quality assurance for field data, while aerial LiDAR and other sensors (e.g., radar and hyperspectral) support wall-to-wall mapping and SAE, all of which can help inform appropriate cycle lengths for different regions and information needs. Intensifying disturbance or harvest regimes in some regions may further necessitate more frequent inventory updates to support timely assessments and management responses. For example, some western states experiencing unprecedented wildfire activity are pursuing accelerated remeasurement cycles (e.g., 5-year cycles) to replace the current 7- to 10-year effective intervals, with targeted post-disturbance updates on shorter timeframes to support timely resource assessments.

FIA has historical precedent for responsive, disturbance-driven inventory updates, including targeted plot remeasurement following major hurricane events in the Gulf Coast states, demonstrating that the program can mobilize rapid field responses when resources permit. However, it is important to distinguish between design-based updates and current gold standard (Goeking et al. 2024; systematic remeasurement of a probability sample of plots, producing updated estimates with known statistical properties) and model-based interim products (which incorporate remotely sensed disturbance indicators and growth model projections to generate estimates between measurement cycles, analogous to interim estimates produced by the Census Bureau between decennial enumerations). Both types of update products have value, but they must be clearly labeled and distinguished in all FIA communications to prevent conflation of measured and modeled values.

A critical gap is the lack of precision standards matched to decision requirements. Current FIA accuracy standards address only commercial and noncommercial forest areas, volume, growth, and timber cut (USDA Forest Service 2008), not contemporary information needs. The BRP should evaluate the precision standards required by different applications and recommend sampling intensities, SAE methods, and validation protocols to achieve them. Further, the BRP should assess user needs for forecasts across relevant time-scales and FIA's use of forecasting applications, including growth and yield models (e.g., FVS, Munro et al. 2025), economic models (e.g., SRTS, Abt et al. 2000; MIFSM, Daigneault et al. 2024), and projection modeling systems (e.g., RPA Forest Dynamics Model, Coulston et al. 2023). These forecasting capabilities would complement the RPA Assessment's regional analyses and enable plot-level projections to be stored in the FIA Database (FIADB) as clearly labeled, model-derived data products, separate and distinguishable from the design-based measured plot data, to generate more dynamic site productivity and forest condition metrics for specific applications. Maintaining a rigorous distinction between measured and modeled values in all FIA products is essential to preserve user trust and the program's statistical credibility.

Public–private partnerships, such as the Partnership for Small Area Estimation and the National Scale Volume & Biomass Estimators, demonstrate the potential for collaboration. However, such sustained partnership engagement is strained by federal workforce losses and delayed appropriations that have disrupted field operations and eroded data timeliness (E&E News 2026; FIA User Group 2025). Without external assessment and strategic investment, the US risks a highly fragmented framework with incompatible datasets, weakened disturbance monitoring, and diminished competitiveness in markets that require verified data. While legislative action, including through the Farm Bill, presents policy opportunities such as those proposed in the Forest Data Modernization Act, BRP recommendations would provide a revitalized strategic vision with phased milestones. Urgency is warranted given the costs of inaction and Congressional interest (King 2023).

Forum Call to Action

The authorship team includes participants from the BWG and the FIA National User Group, an annual external partner forum that brings together representatives from industry, state agencies, academia, NGOs, and federal partners to provide input on FIA program priorities and data needs. This forum article emerged from discussions at the December 2025 FIA National User Group meeting, where participants identified an urgent need for a comprehensive strategic reassessment amid rapid changes at the agency and current geopolitical challenges. The diverse authorship reflects the broad spectrum of the forest community in FIA modernization and a shared recognition that incremental improvements alone are insufficient.

In short, we recommend convening a third FIA Blue Ribbon Panel, supported by USDA leadership and Congress, that is informed by key partners and composed of 10–15 independent experts in survey statistics and design-based inference, biometrics, SAE, digital systems, remote sensing, forest products markets, and forest policy. Given FIA's formal status as a national statistical program, inclusion of statisticians with specific expertise in probability sampling theory and survey design is essential, an area where the program would benefit from strengthened capacity. Panel members should demonstrate technical knowledge and an understanding of operational NFI programs, including forest measurements, data management, quality assurance, and the sustained annual measurement across diverse ownerships. The panel should also consider including one or two subject-matter experts or external reviewers from other international NFI programs operating in temperate and boreal forests in advanced economies, where comparable institutional capacity and regulatory environments make operational experience directly transferable, such as the Scandinavian national inventories or the European Forest Institute. Consequently, the panel's charge should include: (1) evaluating FIA's strategic progress and priorities; (2) recommending precision standards and sampling methods; and (3) recommending governance, modernization priorities, and open-standards digital architectures ensuring FIA's continued leadership (Fig. 4).

BRP recommendations on technology adoption must account for the federal policy environment in which FIA operates currently or in the future. Congressionally mandated cybersecurity regulations, agency-level restrictions on AI use, and procurement constraints have already limited FIA's ability to develop and deploy modern public-facing tools, including data access platforms. Navigating these constraints is itself a governance challenge that the BRP should address explicitly, recommending not only which technologies FIA should adopt but also which policy-level actions (at the USDA, Office of Management and Budget (OMB), and Congressional levels) are needed to enable their adoption. Without attention to this implementation environment, even well-designed recommendations risk remaining aspirational.

Fig. 4 Three key pillars of modernization for the FIA program, along with specific charges for the proposed third FIA Blue Ribbon Panel

Given FIA's status as a national program with substantial state co-investment and broader reliance across the forest sector, convening a third BRP logically requires USDA participation, in consultation with Congress and key partners. A panel commissioned in this way would have an institutional connection enabling credible, nonpartisan recommendations while building cross-sector consensus. The panel should evaluate strategic frameworks for investment priorities spanning operational continuity, SAE, and remote sensing integration, as well as research on emerging ML approaches. These investments require scalable, open-standards software ensuring FIA data interoperability. A modernized FIA program requires analytics-ready, AI/ML-enabled back-end systems built on open standards that support science-based decision-making and credible digital MRV in markets that require verified sustainability data (Woodall 2025). The BRP should coordinate with existing and independent technical bodies, such as the Biometrics Working Group, FIA User Group, Center for Advanced Forestry Systems, and the Partnership for Small Area Estimation.

The value of a third BRP depends entirely on the commitment to implement its recommendations. BRP recommendations will only translate into meaningful improvements if USDA leadership and Congress provide commensurate funding, staffing capacity, and IT infrastructure. Limited appropriations for federal staff, hiring restrictions, and reduced IT budgets have already constrained what FIA can accomplish beyond its current operational workloads. The BRP itself should therefore be charged with specifying the resource requirements in personnel, computing infrastructure, and external partnership support needed to implement each category of recommendation, grounding its output in operational reality rather than producing an aspirational document that exceeds the program's capacity to act.

FIA has served the nation well for nearly a century. However, high operational uncertainty, a declining workforce, and growing funding constraints have created urgent capacity constraints, even as user demand continues to increase. Recommendations on key investments, governance structures, and performance metrics, emerging from a third BRP, will ensure that FIA applies the best available science and positions the US forestry sector for future success. USDA leadership, Congress, and partners all have a critical role to play in convening the BRP and implementing its recommendations, thereby providing strategic direction for credible, science-based forest intelligence that secures US leadership in forest digital MRV. Without a comprehensive assessment and a reformulated vision, FIA risks continued erosion of data timeliness, analytical capacity, and competitive standing in global markets that increasingly demand verified sustainability data and robust MRV frameworks.

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Declarations

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References

Abt, R., F. Cubbage, and G. Pacheco. 2000. Southern forest resource assessment using the subregional timber supply (SRTS) model. *Forest Products Journal*, 50 (4, 50): 25–33. https://research.fs.usda.gov/treesearch/2289. Accessed 10 Apr 2026.

American Forest and Paper Association. 2001. *Status update to the Second Blue Ribbon Panel on Forest Inventory and Analysis*. Washington, DC: American Forest and Paper Association.

American Forest Council. 1992. *Report of the Blue Ribbon Panel on Forest Inventory and Analysis*. https://nefismembers.org/documents/report-of-the-blue-ribbon-panel-on-forest-inventory-and-analysis/. Accessed 10 Apr 2026.

American Forest and Paper Association. 1998. *Report of the Second Blue Ribbon Panel on Forest Inventory and Analysis*. https://nefismembers.org/documents/report-of-the-second-blue-ribbon-panel-on-fia/. Accessed 10 Apr 2026.

Bechtold, W. A., and P. L. Patterson. 2005. *The enhanced forest inventory and analysis program: national sampling design and estimation procedures* (No. Gen. Tech. Rep. SRS-80). USDA Forest Service, Southern Research Station. https://doi.org/10.2737/SRS-GTR-80.

Butler, B. J., and J. Caputo. 2022. *National woodland owner survey*. In ed., J. A. Westfall, J. W. Coulston, G. G. Moisen, and H.-E. Andersen. https://research.fs.usda.gov/treesearch/download/65551.pdf#page=39. Accessed 10 Apr 2026.

Cahoon, S.M.P., K. Randolph, G.C. Gaines III., S. Crocker, V. Thomas, and H. Munro. 2026. Advancing forest inventory science for enhanced insights into tomorrow's forests. *Forest Ecology and Management* 602. https://doi.org/10.1016/j.foreco.2025.123405.

California Air Resources Board (CARB). 2026. An inventory of ecosystem carbon in California's natural & working lands, 2025 Edn. Sacramento, CA. https://ww2.arb.ca.gov/nwl-inventory. Accessed 10 Apr 2026.

Caputo, J., and B. Butler. 2025. *National Woodland Owner Survey Dashboard (NWOS-DASH) version 1.0*. https://research.fs.usda.gov/products/dataandtools/national-woodland-owners-survey-dashboard. Accessed 10 Apr 2026.

Chivhenge, E., A.R. Weiskittel, C.W. Woodall, A.W. D'Amato, and A. Daigneault. 2025. Geospatial estimation of forest relative density for carbon stewardship decision support across the continental US. *Scientific Data* 12 (1). https://doi.org/10.1038/s41597-025-06012-6.

Coulston, J.W., C.W. Woodall, G.M. Domke, and B.F. Walters. 2016. Refined forest land use classification with implications for United States national carbon accounting. *Land Use Policy* 59: 536–542. https://doi.org/10.1016/j.landusepol.2016.10.003.

Coulston, J.W., J.A. Westfall, D.N. Wear, C.B. Edgar, S.P. Prisley, T.B. Treiman, R.C. Abt, and W.B. Smith. 2018. Annual monitoring of US timber production: Rationale and design. *Forest Science* 64 (5): 533–543. https://doi.org/10.1093/forsci/fxy010.

Coulston, J.W., G.M. Domke, D.M. Walker, E.B. Brooks, and C.B. O'Dea. 2023. Near-term investments in forest management support long-term carbon sequestration capacity in forests of the United States. *PNAS Nexus* 2 (11). https://doi.org/10.1093/pnasnexus/pgad345.

Daigneault, A., E. Simons-Legaard, and A. Weiskittel. 2024. Tradeoffs and synergies of optimized management for maximizing carbon sequestration across complex landscapes and diverse ecosystem services. *Forest Policy and Economics* 161. https://doi.org/10.1016/j.forpol.2024.103178.

Domke, G. M., B. F. Walters, J. E. Smith, E. J. Greenfield, C. L. Giebink, S. M. Ogle, J. Steller, K. Rewcastle, J. A. Knott, J. W. Coulston, K. A. Heilman, and A. K. Lang. 2024. *Greenhouse gas emissions and removals from forest land, woodlands, urban trees, and harvested wood products in the United States, 1990–2022*, Vol. 102. USDA Forest Service. https://doi.org/10.2737/wo-rb-102.

Dubayah, R., J. Armston, S.P. Healey, J.M. Bruening, P.L. Patterson, J.R. Kellner, L. Duncanson, S. Saarela, G. Ståhl, Z. Yang, and H. Tang. 2022. GEDI launches a new era of biomass inference from space. *Environmental Research Letters* 17 (9).

Duncanson, L., N. Hunka, T. Jucker, J. Armston, N. Harris, L. Fatoyinbo, C.A. Williams, J.W. Atkins, B. Raczka, S. Serbin, M. Keller, R. Dubayah, C. Babcock, M.A. Cochrane, A. Hudak, G.C. Hurtt, P.M. Montesano, L.M. Moskal, T. Park, S. Saatchi, C.A. Silva, H. Tang, R. Vargas, A. Weiskittel, K. Wessels, and S.J. Goetz. 2025. Spatial resolution for forest carbon maps. *Science* 387 (6732): 370–371. https://doi.org/10.1126/science.adt6811.

E&E News. 2026. *Key research program stumbles at USDA Forest Service*. https://www.eenews.net/articles/key-research-program-stumbles-at-forest-service/. Accessed 10 Apr 2026.

Edgar, C.B., D.J. Nowak, M.A. Majewsky, T.W. Lister, J.A. Westfall, and N.F. Sonti. 2021. Strategic national urban forest inventory for the United States. *Journal of Forestry* 119 (1): 86–95. https://doi.org/10.1093/jofore/fvaa047.

European Commission. 2023. Proposal for a Regulation on a monitoring framework for resilient European forests. https://environment.ec.europa.eu/publications/proposal-regulation-forest-monitoring-framework_en. Accessed 10 Apr 2026.

European Parliament. 2023. Regulation (EU) 2023/1115 of the European Parliament and of the Council of 31 May 2023 on the making available on the Union market and the export from the Union of certain commodities and products associated with deforestation and forest degradation and repealing Regulation (EU) No 995/2010. Official Journal of the European Union, L 150, 206–247. https://eur-lex.europa.eu/eli/reg/2023/1115/oj. Accessed 10 Apr 2026.

FIA User Group. 2025. *FIA National User Group Meeting*. https://eforester.org/Main/Issues_and_Advocacy/FIA-National-User-Group.aspx. Accessed 10 Apr 2026.

Frescino, T.S., G.G. Moisen, P.L. Patterson, C. Toney, and G.W. White. 2023. "Fiesta": A forest inventory estimation and analysis R package. *Ecography*. https://doi.org/10.1111/ecog.06428.

Glass, P. A., and S. N. Oswalt. 2007. Initial estimates of hurricane Katrina impacts of Mississippi Gulf Coast forest resources. *Mississippi Institute For Forest Inventory* 1–4. https://research.fs.usda.gov/treesearch/29516. Accessed 10 Apr 2026.

Goeking, S.A., C.W. Woodall, R. Bush, and L.S. Heath. 2024. Collaboration can preserve the integrity of gold standard carbon data from forest inventories. *Proceedings of the National Academy of Sciences* 121 (38): e2409263121. https://doi.org/10.1073/pnas.2409263121.

Johnston, C., J. Guo, and J.P. Prestemon. 2025. The European Union Deforestation Regulation: Implications for the global forest sector. *Forest Policy and Economics* 173. https://doi.org/10.1016/j.forpol.2025.103462.

Khatri-Chhetri, P., H.-E. Andersen, B. Cook, S.M. Hendryx, L. van Wagtendonk, and V.R. Kane. 2025. Synthesizing field plot and airborne remote sensing data to enhance national forest inventory mapping in the boreal forest of Interior Alaska. *Science of Remote Sensing* 11. https://doi.org/10.1016/j.srs.2024.100192.

King, A. S. 2023. *A bill to require the Secretary of Agriculture to convene a blue ribbon panel to review the forest inventory and analysis program of the Forest Service, and for other purposes*. https://www.congress.gov/bill/118th-congress/senate-bill/433/text. Accessed 10 Apr 2026.

Labau, V. J., J. T. Bones, N. P. Kingsley, H. Gyde Lund, and W. B. Smith. 2007. *A history of the forest survey in the United States* (No. FS-877). USDA Forest Service. https://foresthistory.org/wp-content/uploads/2017/01/HistoryofForestSurvey1830-2004.pdf. Accessed 10 Apr 2026.

Lang, A. 2021. *Smoke and timber: Forest inventories and wildfires in the Pacific Northwest*. Forisk Blog. https://forisk.com/smoke-and-timber-forest-inventories-and-wildfires-in-the-pacific-northwest/

Lang, A. 2024. *Local timber supply and growth-to-drain in the U.S. South*. Forisk Blog. https://forisk.com/local-timber-supply-and-growth-to-drain-in-the-u-s-south/. Accessed 10 Apr 2026.

Lister, A.J., H. Andersen, T. Frescino, D. Gatziolis, S. Healey, L.S. Heath, G.C. Liknes, R. McRoberts, G.G. Moisen, M. Nelson, R. Riemann, K. Schleeweis, T.A. Schroeder, J. Westfall, and B.T. Wilson. 2020. Use of remote sensing data to improve the efficiency of national forest inventories: A case study from the United States National Forest Inventory. *Forests* 11 (12). https://doi.org/10.3390/f11121364.

Magruder, L.A., T. Neumann, N. Kurtz, T.C. Sutterley, D. Hancock, P. Vornberger, J. Robbins, and B. Smith. 2025. Assessment of the Ice, Cloud, and land Elevation Satellite-2 performance against prime mission science requirements. *Earth and Space Science* 12 (4): e2025EA004221.

Mäkisara, K., M. Katila, and J. Peräsaari. 2022. The multi-source national forest inventory of Finland — methods and results 2017 and 2019. *Natural resources and bioeconomy studies*. Report 90/2022. Natural Resources Institute Finland, Helsinki, 73. https://urn.fi/URN:ISBN:978-952-380-538-5. Accessed 10 Apr 2026.

Munro, H.L., C.W. Woodall, W.R.L. Anderegg, J.W. Atkins, C.M. Beier, B.P. Bullock, K. DeLyser, D.D. Diaz, B.N.I. Eskelson, M.E.K. Evans, J.D. Foppert, B.C. Foster, T.R. Fox, J.M. Frank, R.E. Froese, G.C. Gaines III., P. Gould, T. Hailemariam, E.S. Hall, K.A. Heckman, E.H. Helmer, J.A. Hogan, C.M. Hoover, S.M. Kinane, D.W. MacFarlane, L.T. Murray, G. Paradis, K.P. Poudel, S.P. Prisley, J.L. Rakestraw, H. Restrepo, A. Sharma, J.D. Shaw, E. Smith-Mateja, C.L. VanderSchaaf, C. Vatandaslar, A.R. Weiskittel, and S.-I. Yang. 2025. Challenges and strategic recommendations for enhancing quantification and projection of forest carbon dynamics. *Journal of Forestry*. https://doi.org/10.1007/s44392-025-00048-7.

Oswalt, S. N., R. Bush, L. T. Murray, and D. Walker. 2026. *Forest resources of the United States, 2022: A technical document supporting the Forest Service 2020 RPA Assessment*. Gen. Tech. Rep. WO-107. Washington, DC: USDA Forest Service, Washington Office, 230. https://doi.org/10.2737/WO-GTR-107.

Pelkki, M. 2024. *2023 US Forestry Economic Contribution by State*. Arkansas Center for Forest Business. https://www.uamont.edu/academics/CFANR/forestbusiness/USForestryEconomicContributionbyState20240221.pdf. Accessed 10 Apr 2026.

Pérez, J. G. 2025. *National forest inventories: Where are we headed?* UN FAO. https://openknowledge.fao.org/items/e6afd469-d554-4934-9bf7-b80de771662e. Accessed 10 Apr 2026.

Prisley, S., J. Bradley, M. Clutter, S. Friedman, D. Kempka, J. Rakestraw, and E. Sonne Hall. 2021. Needs for small area estimation: Perspectives from the US private forest sector. *Frontiers in Forests and Global Change*, 4. https://doi.org/10.3389/ffgc.2021.746439

Renwick, K.M., C.W. Woodall, C. Mihiar, L.T. Murray, R. Lewis, P.C. Beeson, and J. Coulston. 2025. Evaluating the current status of agriculture-driven deforestation across jurisdictional scales in the United States using foundational, federal datasets. *Environmental Research Letters* 20 (7). https://doi.org/10.1088/1748-9326/addc83.

Riley, K.L., I.C. Grenfell, M.A. Finney, and J.M. Wiener. 2021. TreeMap, a tree-level model of conterminous US forests circa 2014 produced by imputation of FIA plot data. *Scientific Data* 8 (1). https://doi.org/10.1038/s41597-020-00782-x.

Riley, K.L., C.D. O'Connor, C.J. Dunn, J.R. Haas, R.D. Stratton, and B. Gannon. 2022. A national map of snag hazard to reduce risk to wildland fire responders. *Forests* 13 (8). https://doi.org/10.3390/f13081160.

Riley, K. L., I. C. Grenfell, and J. D. Shaw. 2023. *FuelMap 2014: imputed map of carbon stored in litter, duff, fine woody debris, and coarse woody debris for CONUS forests circa 2014*. https://www.fs.usda.gov/rds/archive/catalog/RDS-2023-0042. Accessed 10 Apr 2026.

Schadauer, K., R. Astrup, J. Breidenbach, J. Fridman, S. Gräber, M. Köhl, K.T. Korhonen, V.K. Johannsen, F. Morneau, R. Päivinen, and T. Riedel. 2024. Access to exact National Forest Inventory plot locations must be carefully evaluated. *The New Phytologist* 242 (2): 347–350. https://doi.org/10.1111/nph.19564.

Smith, W.B. 2002. Forest inventory and analysis: A national inventory and monitoring program. *Environmental Pollution* 116: S233–S242. https://doi.org/10.1016/S0269-7491(01)00255-X.

Stanke, H., A.O. Finley, A.S. Weed, B.F. Walters, and G.M. Domke. 2020. rFIA: An R package for estimation of forest attributes with the US Forest Inventory and Analysis database. *Environmental Modelling & Software* 127. https://doi.org/10.1016/j.envsoft.2020.104664.

Tinkham, W.T., P.R. Mahoney, A.T. Hudak, G.M. Domke, M.J. Falkowski, C.W. Woodall, and A.M.S. Smith. 2018. Applications of the United States Forest Inventory and Analysis dataset: A review and future directions. *Canadian Journal of Forest Research* 48 (11): 1251–1268. https://doi.org/10.1139/cjfr-2018-0196.

USDA Forest Service. 2008. *Forest Service Handbook (fsh) 4809.11: Chapter 10 Operational Procedures* (No. Forest Service Handbook 4809.11). https://nefismembers.org/wp-content/uploads/2026/01/4809.11_10.pdf. Accessed 10 Apr 2026.

Wear, D.N., and J.W. Coulston. 2025. A comparative analysis of timber harvesting, timber supply, and tree planting across ownerships and regions of the United States. *Forest Policy and Economics* 178. https://doi.org/10.1016/j.forpol.2025.103542.

Wear, D.N., R. Huggett, R. Li, B. Perryman, and S. Liu. 2013. *Forecasts of forest conditions in regions of the United States under future scenarios: A technical document supporting the Forest Service 2012 RPA Assessment (Gen. Tech. Rep. SRS-GTR-170)*, 101. Asheville, NC: USDA Forest Service Southern Research Station.

Wei, X., D. Hayes, G. McHale, J. Zhao, A. Weiskittel, and A. Daigneault. 2025. PyFIA: Analyzing and visualizing forest attributes using the United States Forest Inventory and Analysis database. *Carbon Balance and Management*. https://doi.org/10.1186/s13021-025-00364-7.

Westfall, J. A., J. W. Coulston, G. G. Moisen, and H.-E. Andersen (Eds.). 2022. *Sampling and estimation documentation for the enhanced forest inventory and analysis program*, Vol. 207, 1–129. USDA Forest Service Northern Research Station. https://doi.org/10.2737/nrs-gtr-207.

Westfall, J. A., J. W. Coulston, A. N. Gray, J. D. Shaw, P. J. Radtke, D. M. Walker, A. R. Weiskittel, D. W. MacFarlane, D. L. R. Affleck, D. Zhao, H. Temesgen, K. P. Poudel, J. M. Frank, S. P. Prisley, Y. Wang, A. J. Sánchez Meador, D, Auty, and G. M. Domke. 2024. *A national-scale tree volume, biomass, and carbon modeling system for the United States* (Vol. 104). USDA Forest Service. https://doi.org/10.2737/wo-gtr-104.

Wiener, S.S., R. Bush, A. Nathanson, K. Pelz, M. Palmer, M.L. Alexander, D. Anderson, E. Treasure, J. Baggs, and R. Sheffield. 2021. USDA Forest Service use of forest inventory data: Examples and needs for small area estimation. *Frontiers in Forests and Global Change*. https://doi.org/10.3389/ffgc.2021.763487.

Wilson, B. T., and C. Oswalt. (2025). *USDA Forest Service FIA BIGMAP Tree Species Aboveground Biomass Layers*. https://data.fs.usda.gov/geodata/rastergateway/bigmap/index.php. Accessed 10 Apr 2026.

Woodall, C.W., M.C. Amacher, W.A. Bechtold, J.W. Coulston, S. Jovan, C.H. Perry, K.C. Randolph, B.K. Schulz, G.C. Smith, B. Tkacz, and S. Will-Wolf. 2011. Status and future of the forest health indicators program of the USA. *Environmental Monitoring and Assessment* 177 (1–4): 419–436. https://doi.org/10.1007/s10661-010-1644-8.

Woodall, C. W. 2025. Beyond Paris and net-zero ledgers: Restoring trust in US forest climate solutions via tree-centric digital MRV architecture. *One Earth*. https://www.cell.com/one-earth/abstract/S2590-3322(25)00347-1. Accessed 10 Apr 2026.

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