Forest Inventory and Analysis

Fiscal Year 2021 Business Report

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Forest Inventory and Analysis

Fiscal Year 2021 Business Report

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Executive Summary

For more than 90 years, the Forest Inventory and Analysis (FIA) Program has played an integral role in providing the information vital to the management and conservation of the Nation's forest resources. In recent years, an increased number of major decisions regarding the Nation's forests have been made with reference to and reliance on FIA findings and forest resource evaluations. Today, FIA data is the authoritative source to inform carbon measuring, monitoring, reporting, and verifying (MMRV), as well as to support the sustainable management and conservation of forests, water resources, biodiversity, forest products and services, biomass availability, economic development, changes in land use and land cover, nonnative invasive species, pests and diseases, and wildfire risk.

In 1999 (Farm Bill, Public Law 105–185) and again in 2014 (Farm Bill, Public Law 113–79), Congress directed the Forest Service, an agency of the U.S. Department of Agriculture (USDA), to reevaluate its statewide inventory mission and to transition to survey each State annually rather than periodically, with the exception of Interior Alaska and U.S.-associated islands of the Caribbean and Pacific Ocean. In collaboration with partners, FIA developed strategic plans to fully transition into an annualized inventory and comply with other requirements. The latest FIA Strategic Plan includes a requirement for an annual business report that outlines the status and progress of the national, annual inventory program. In 2018 (Farm Bill, Public Law 115–334), Congress repealed the direction to revise the strategic plan for FIA, as directed in the 2014 Farm Bill, making the content of the existing strategic plan remain valid.

This annual business report, the program's 24th, presents program results accomplished with the provided financial resources, and plans for the coming year with budgeted financial resources. FIA's continued success is due in part to our commitment to accountability, to transparently deliver the best value, quality, and array of products in partnership with the communities we serve.

In fiscal year (FY) 2021, the program faced the continued impact of difficult circumstances caused by the coronavirus (COVID-19) pandemic and hazardous conditions induced by the wildfire season, as in the prior year. Although the program was allowed to fill some of the many vacancies under a new budget structure, the capacity to hire and available operational funding continued to be limiting factors to deliver the program. These conditions, compounded by the plot backlog from the previous year, directly impacted field

operations and the related cascade effects in subsequent data analysis and delivery. In fact, this year the percent of States with inventory data available online less than 2 years old remained low, 88 percent, as in the prior year. In FY 2021, some key findings included in this report are—

Progress on inventory. FIA conducted inventory activity in all 50 States, including Interior Alaska, and measured about 12 percent of the forest sample locations included in the base FIA grid. Except for Interior Alaska and Hawaii, all States, as well as Coastal Alaska, implement an annualized survey. The total area currently sampled represents about 94 percent of all U.S. forest lands with Interior Alaska outside the Tanana Valley, the Susitna-Copper, and the Southwest units housing the remaining 6 percent of the Nation's forest area. FIA crews prioritized the measurement of the 2020 plot catchup due to the impact of COVID-19 and other natural disasters, except in western remote areas where it was not financially efficient to operate. By the end of 2021, the Northern Research Station (NRS) and Southern Research Station (SRS) FIA units surveyed all 2020 plots except for the U.S. Virgin Islands, Rocky Mountain Research Station (RMRS) FIA measured 60 percent, and Pacific Northwest Research Station (PNW) FIA 90 percent. The percentage of FY 2021 plots that remained unmeasured was 18 percent in SRS and NRS, 43 percent in RMRS, and 55 percent in PNW.

For the second year, inventory efforts continued in the Southwest unit of Interior Alaska where field crews worked exclusively by helicopter in roadless areas that had not been inventoried beyond its rivers before. The Southwest unit represents a total forest area sampled of 27 million acres. About 27 percent of the ground plots in this unit have been measured. Data acquisitions by Goddard's LiDAR, hyperspectral, and thermal imager (G-LiHT) across the Southwest, which supplements field plot information, is planned to resume during the summer of FY 2022, after a 2-year pause caused by the COVID-19 pandemic.

Funding and partners' support. FIA operations were funded through appropriations at $17.6 million and the Senate Committee on Appropriations explanatory statement provided direction for the program to be funded at no less than the enacted level of $77 million, when combining the FIA operations appropriated budget with FIA salaries and expenses (S&E). Under the new budget structure, Congress appropriated $200 million for the newly established S&E budget line item for the Forest and Range Research Deputy Area account, which includes FIA.

In addition to annual program appropriations, FIA received an additional $1.3 million for COVID mitigation from the Coronavirus Aid, Relief, and Economic Security (CARES) Act at the end of FY 2020 and in FY 2021. R&D also provided FIA with $2.25 million for operations and $2.3 million in information technology (IT) dollars. State agencies, universities, other Forest Service programs, other Federal agencies, and nongovernmental organizations (NGOs) contributed 15 percent of the total available funds—$12.1 million, representing a one-third million dollar decrease over the previous year. Almost $4.6 million of the partners' fund was directed at intensifying the plot network or buying down plot measurement and reporting cycles to 5 years or less. The remaining $7.5 million were contributions that added value to the FIA Program. Forty-two State agencies, the largest group of supporters, contributed $3.3 million to the base program and an additional $2.4 million that adds value. About 73 percent of State agency contributions, $4.2 million, were from the Eastern States, reflecting the ownership contrast with western lands, where Federal agencies are responsible for a much larger share of the land stewardship activities.

Grants and agreements. FIA uses grants and agreements G&A) with external partners to expand capacity, expertise, or achieve high-quality results for less money. About $23 million or 29 percent of the available funding was invested in G&As in FY 2021, with 30 percent—$7 million—managed by the SRS FIA. Seventeen State agencies received 47 percent of granted funds, about $11 million. The largest recipients were Alaska, Colorado, Texas, and Maine.

Data availability. Data for all States, Coastal Alaska, and the Tanana Valley of Interior Alaska were accessible online in FY 2021. Data for most States with annual inventories, 88 percent, were less than 2 years old, except for Oklahoma and Louisiana, which were 3 years old, and Kentucky, Tennessee, Florida, and Texas, which were 4 years old. Data collection for the Tanana Valley unit inventory was completed in 2018 and released to the public in 2020 through its own online database. The latest forest inventory data for Hawaii is also available to the public through a stand-alone online database. Published inventories of most of the Caribbean and Pacific islands data were 5 years old or older because, in part, they are sampled under a periodic inventory. FIA data supplied information for 257 spatial data requests and almost 1 million online data requests. The number of consultations to the FIA team reached 696 and required an investment of time equivalent to 4 full-time staff positions.

Reporting and publications. FIA published 248 publications, continuing the upward trend from the previous year, including 97 core publications (reports specific to a complete survey unit, complete State, national forest, or national reports), and 97 journal articles. This year's

published core publications included one 5-year State report—for Missouri—analyzing inventory data collected in previous years. Drafts of State reports for Delaware, Maine, and Minnesota were released electronically.

Quality assurance. To ensure that FIA databases comprise only the highest quality data, FIA field-checked 9 percent of all measured field plots, representing a 4-percentage point drop from the previous year. All plots were checked for consistency when loaded into the FIA databases.

Relevant meetings. The FIA Program held four user-group meetings and six management meetings to ensure that the program is providing the highest quality service and meeting its planned objectives according to the goals stated in the strategic plan and ongoing commitments made to our partners. Six of the meetings were national and four regional.

Personnel. FIA, directly and through cooperators, employed 564 full-time employees, 38 fewer employees than the previous year. The net decrease was due to the fact that R&D S&E funds accounted toward FIA no longer include Federal non-FIA staff, which represented around 10 percent of the total Federal workforce paid with FIA dollars last year. In FY 2021, the number of Federal employees paid with S&E funds accounted toward FIA totaled 332.3 Federal employees. The number of FIA cooperators went up from 223.6 in FY 2020 to 231.8 in FY 2021. Cooperators are integral to the efficient delivery of the FIA Program, comprising 41 percent of the total FIA workforce. Of the total workforce, 66 percent, or 373.5 employees, were employed in data collection and quality assurance; 18 percent in analysis and research; 10 percent in information management; and 5 percent in administration.

Nonplot surveys. Although plot-based field surveys comprise most of the FIA data, additional questionnaires and surveys are conducted to report on timber product output (TPO), logging utilization, and the characteristics and management objectives of the Nation's private woodland owners through the National Woodland Owner Survey (NWOS). Since FY 2000, FIA has collected such data from about 103,446 surveys and questionnaires—49,321 for TPO and 54,145 for NWOS. This information, in concert with FIA plot data, is critical to monitoring the sustainability of the Nation's forest resources.

Information technology. Through FY 2021, the FIA Program continued information technology modernization, to comply with agency implementation of the Federal Information Technology Acquisition Results Act.

For additional details for the above, "see FIA Program Area Updates for FY 2021."

Looking to 2022 and beyond. FIA anticipates challenges driven by the ongoing COVID-19 pandemic, continued trends in natural disasters and climate change, as well as difficult tradeoffs due to ongoing budget constraints. At the same time, we foresee congressional funding relief helping to overcome some of the impacts of the pandemic and natural disasters. Important goals for FY 2022 and beyond include—

- Prioritize data collection and information production to reduce pandemic-caused backlog. Based on available resources:

  ◦ Complete the remaining FYs 2020 and 2021 plot backlog and most of the FY 2022 scheduled plots during the FY 2022 field season.

  ◦ Continue annualized inventory of 50 States, with focused attention on the completion of the periodic field inventory in the Southwest Alaska unit, the 3rd unit of 6 in Interior Alaska. Data collection in the U.S. Virgin Islands for the fourth consecutive remeasure, originally scheduled to start in 2019, remained on pause due to the COVID-19 pandemic. Field operations are planned to resume in 2024, skipping one 5-year cycle.

  ◦ Continue urban data collection in all partner cities by completing the scheduled FY 2022 sample. Publish most of the 19 5-year State reports that are currently in final review and layout.

- Due to the logistics and higher costs of measuring remote roadless units in Interior Alaska, continue discussing possible modifications to the inventory design in this region that is financially and logistically feasible while keeping safety a priority.

- Continue working toward achieving annual TPO survey collection and delivery of data using a sample survey design with a sample size that varies based on the surveyed region. Following the release of 2018 mill data for the South in FY 2021, FIA plans to make 2018 mill data for the North publicly available in the coming year.

- Disseminate research on large corporate forest landowners by publishing the results of the 2018 large corporate pilot survey and the analysis of the ownership transitions from and to corporate ownership between 2007 and 2017. Initiate review process for the next NWOS cycle, including planning the next NWOS meeting with data users and partners scheduled for the beginning of FY 2023.

- Continue our investment in online applications that improve the delivery of FIA information, including the production or release of:

  ◦ EVALIDator 2.0, to replace EVALIDator. The software tool will allow the same functionality to access and query FIA data as its predecessor but will be easier to maintain and functions in a more secure environment that meets the Forest Service Chief Information Office (CIO) security requirements.

  ◦ The One-Click Timber Products Output factsheet, an interactive application to provide annual estimated summaries on industrial and nonindustrial uses of roundwood across the United States. The tool was released in FY 2020 with data available for the South and will be populated with other States and regions as information becomes available in FY 2022.

  ◦ 30-meter raster maps depicting current forest characteristics from the public FIA database using the Big Data Mapping and Analytics Platform (BIGMAP), in addition to the products released through the FIA Geospatial Showcase hub in FY 2021. BIGMAP is a cloud-based computing environment designed to store, process, analyze, and deliver FIA content.

  ◦ A variety of tools that will include FIESTA functionality to generate estimates, maps, and reports for small areas. Some of the planned FIESTA delivery platforms include R packages, a stand-alone desktop application, geospatial tools leveraging Esri's ArcGIS Pro software, and R Shiny dashboards.

  ◦ The Design and Analysis Toolkit for Inventory and Monitoring (DATIM) and User Guide. No new updates are scheduled for next year.

- New updated biomass equations will be finalized and included in the National Information Management System (NIMS) and FIA database. Changes in data estimations through FIA's National DataMart will take effect before the end of FY 2022.

- i-Tree Suite of Tools, developed and maintained through a public-private partnership between the Forest Service and the Davey Tree Expert Company, will expand species information included in i-Tree to aid users in making species selections and explore the connections to human health and environmental regulations related to air temperature, ultraviolet radiation, and stress reduction.

- The national Urban FIA team will increase its training efforts by hosting several UFIA certification sessions to expand the workforce immediately available for Urban FIA field work.

- Develop a new search tool that will query, by topic of choice, all FIA publications in one place.

- Host a meeting on forest carbon related to FIA, in addition to the annual FIA National User Group meeting.

- Continue to respond to the 2018 Farm Bill direction to find efficiencies in the FIA Program through the improved use and integration of advanced remote-sensing technologies, with the approach focused on implementing small area estimation techniques.

- Fill vacant positions with quality recruits at levels required for successful program delivery.

Introduction

The Forest Inventory and Analysis (FIA) Program of the Forest Service, an agency of the U.S. Department of Agriculture (USDA), provides the information needed to assess the status, trends, and sustainability of America's forests. This business report, which summarizes program activities in fiscal year (FY) 2021 (October 1, 2020, through September 30, 2021), gives our customers and partners a snapshot of past activities, current business practices, and future program direction. It is designed to increase our accountability and foster performance-based management of the FIA Program.[1]

The FIA Program has been the Nation's continual forest census since 1930. We collect, analyze, and report information on the status and trends of America's forests: how much forest exists, where it exists, who owns it, how it is changing, how the trees and other forest vegetation are growing, how much has died or been removed, and how the harvested trees have been used in recent years. This information can be used in many ways, such as in evaluating wildlife habitat conditions, assessing sustainability of

current ecosystem management practices, monitoring forest health, supporting planning and decisionmaking activities undertaken by public and private enterprises, predicting the effects of climate change, and providing authoritative data to the forest products industry and other forest-related investments. The FIA Program combines this information with related data on insects, diseases, and other types of forest damage to assess the current health and potential risks to forests. These data are also used by the Forest Service Research and Development (R&D) Resources Planning Act (RPA) Assessment Program to project how forests are likely to appear in 10 to 50 years; various scenarios evaluate whether current forest management practices are sustainable in the long run and assess whether current policies will enable our grandchildren and their grandchildren to enjoy the benefits provided by America's forests as we do today.

As FIA continues to move toward delivering a nationally consistent program, this report remains focused on the program accomplishments and challenges while highlighting opportunities created by the joint efforts of the four regional FIA units housed at the Northern Research Station (NRS), the Southern Research Station (SRS), the Rocky Mountain Research Station (RMRS), and the Pacific Northwest Research Station (PNW), in close collaboration with national program leaders in the Washington Office (WO). While most FIA accomplishments in FY 2021 had a national scope, others remained regional.

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[1] This business report does not include statistical information about the forests of the United States. For this information, contact the appropriate regional or national FIA office listed in appendix A of this report or go to www.fia.fs.usda.gov.

Changes From Previous Years' Business Reports

The FIA annual business report quantifies and adapts performance measures that accurately reflect the program's progress and changes toward meeting the goal of an annualized inventory for all 50 States.

The main change in this year's business report resulted in a new agency budget structure. In FY 2021, based on legislative direction in the Further Consolidated Appropriations Act for FY 2020, the Forest Service adopted to a new budget structure and changed internal budget policy, direction, and practices aimed to increase transparency in the budget and position the agency to deliver current and future expectations effectively and efficiently. This effort, also known as budget modernization, changed the way Congress appropriated funds to FIA and other Forest Service programs. The most significant changes to the agency budget were the elimination of cost pools—replaced by the addition of the new Forest Service Operations account—and the establishment of budget line items for salary and expenses (S&E) in the following accounts: Forest Service Operations, State and Private Forestry, National Forest System, Wildland Fire Management, and Forest and Rangeland Research, which houses FIA.

For 20 years, cost pools, paid with program funds, covered fixed operational costs, such as business services and infrastructure, Worker's Compensation Programs, and Unemployment Compensation Insurance. Under the new budget structure, employee salaries and related expenditures (such as benefits, travel, and training) are no longer paid with appropriated program funds; instead, they are paid through the S&E budget line items. A new operations account (appropriated at $1 billion) covers the FIA operational costs. These changes were intended to improve oversight by ensuring that agency spending is consistent with congressional direction, and will help the Forest Service more clearly articulate financial needs and outcomes.

The new budget structure makes some changes in the way FIA can report on its work. As in previous years, FIA reports on operational funds, also called program funds, allocated to FIA. Under the new S&E budget line item for R&D, the FIA Program was only able to track the funds as they were spent to cover FIA S&E expenditures, which included staff salaries, overtime, benefits, travel, training, and awards. This report presents the financial information under two new tables: the Federal funds invested in FIA Federal salaries and expenditures (table B-2.a); and a financial statement for FIA operational funds appropriated by Congress directly to FIA (table B-2.b).

For the second year, the report presents information about the number of plots sampled for nonnative invasive species using the national protocol adopted by all FIA units in 2013 (table B-9). Nonnative invasive species were recorded on selected FIA plots as early as 1999 in States using regional invasive species protocols—these data are not included in the report.

As a supplement to the FY 2021 Business Report, information related to online FIA data, production and publication dates for 5-year State reports, and links to the reports, as of the end of FY 2021, can be explored interactively for each State online.

Fiscal Year 2021 Program Overview

In FY 2021, the FIA Program completed its 20th year of implementing inventories annually, as outlined in the "Strategic Plan for Forest Inventory and Monitoring," written in response to the Agricultural Research, Extension, and Education Reform Act of 1998 (Public Law 105–185). FIA operations use a systematic survey sample design with a grid of hexagons, 6,000 acres in size, laid over the entire United States, and one plot located within each hexagon. A subsample of the grid plots may also be measured for a broader set of forest ecosystem indicators. The number of plots with various ecosystem indicators is noted in table B-9.

The primary goal of the FIA Program is to measure at least 10 percent of FIA grid plots per year in the Western United States, and 15 percent of FIA grid plots per year in the Eastern United States. Table 1 shows the overall distribution of FIA grid plots for the United States, including Puerto Rico, the U.S. Virgin Islands, and U.S. territories and affiliated islands in the Pacific. These data are for illustrative purposes only and do not include possible additional plots that may be required because of partially forested sample locations, which can increase the number of field-visited plots by 15 to 20 percent.

The base program includes annual compilations of the most recent year's information, with full State-level reporting at 5-year intervals. All States have the option to contribute the resources necessary to bring the program up to the full sample intensity of 20 percent per year, or to make other value-added contributions such as funding new measurements or additional sample locations. In FY 2021, Congress appropriated $17.6 million for FIA operations, in addition to the salary and expenses for FIA staff and all the agency indirect costs of common business services. Congressional direction required the total FIA funding including S&E to be no less than $77 million, which represents around $25.4 million below the target level— adjusted for inflation—to complete the transition from the base program to full implementation of plan options A through C, as outlined in the FIA Strategic Plan.[1]

For a second year, FIA faced the impacts of the COVID-19 pandemic. Despite some travel restrictions and additional personnel safety measures, field operations measured a large part of the FY 2020 plot backlog and some of the plots scheduled for FY 2021. The high rate of vaccinated employees and the experience gained dealing with the pandemic from the previous field season prepared the FIA crews to maintain field production guided by more safe, resilient, and efficient procedures during the second year of the pandemic.

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[1] U.S. Department of Agriculture, Forest Service. 2016. Forest Inventory and Analysis Strategic Plan. FS-1079. Washington, DC: U.S. Department of Agriculture, Forest Service. 46 p.

Table 1. Overview of land area, FIADB forest area, RPA Assessment forest area, percentage of forest area, and FIA grid plots by region in FY 2021.

FIA region	Land area	Forest area (FIADB)	Forest area (RPA)	Forest (FIADB)	FIA grid plots (forest and nonforest)
	Mil. acres	*Mil. acres*	*Mil. acres*	*Percent*	*Plots*
North	607	181	182	30	102,175
South	533	265	245	50	89,771
Interior West	548	153	123	27	91,844
Pacific Coast (California, Oregon, Washington)	204	83	84	42	34,326
Coastal Alaska	39	14	14	35	5,089
Interior Alaska	327	114	114	35	3,373
Islands (including Hawaii)	7	4	4	53	1,300
Total	**2,264**	**814**	**766**	**33**	**327,877**

FIA = Forest Inventory and Analysis; FIADB = Forest Inventory and Analysis Database; FY = fiscal year; Mil = million; RPA = Resources Planning Act.
Note: RPA Assessment total forest area is 1.7 million acres higher than the data published in the *2017 Forest Resources of the United States report* because table 1 includes Puerto Rico, the U.S. Virgin Islands, and U.S. territories and affiliated islands in the Pacific.

Table 2. Number and percent change of FIA plots sampled by unit, FYs 2020 and 2021.

	Pacific Northwest			Rocky Mountain			Southern			Northern			Total		
	2020	2021	Change	2020	2021	Change	2020	2021	Change	2020	2021	Change	2020	2021	Change
Total forest plots	2,340	2,742	17%	1,593	1,906	20%	7,799	7,242	-7%	6,306	6,021	-5%	18,038	17,911	-1%
Base FIA grid	1,308	1,665	27%	1,593	1,906	20%	6,142	5,550	-10%	4,459	4,188	-6%	13,502	13,309	-1%
Spatial intensification	1,032	876	-15%	-	-	0%	398	296	-26%	1,470	1,483	1%	2,900	2,655	-8%
Temporal intensification	-	201	100%	-	-	0%	1,259	1,396	11%	377	350	-7%	1,636	1,947	19%
Urban plots	47	31	-34%	41	-	-100%	181	188	4%	47	2,272	4,734%	316	2,491	688%
Special Studies plots	-	200	100%	17	-	-100%	124	33	-73%	-	-	0%	141	233	65%
Estimated percent of base grid sampled	8%	10%		8%	9%		15%	14%		15%	14%		12%	12%	

FIA = Forest Inventory and Analysis; FY = fiscal year
Note: urban and special study plots include forest and nonforest plots measured.

Outputs and Products

Total investment in the FIA Program allowed delivery of inventory information about the extent and conditions of forests in the United States and provided customer service to its clients in FY 2021. This investment totaled $77.7 million from Federal and FIA partner sources, including agency appropriated funds made available for FIA S&E ($38.7 million), FIA appropriated program funds to deliver FIA operations ($17.6 million), other Federal funds made available for FIA operations and IT-related costs ($9.5 million), and FIA partner contributions ($11.7 million) (table B12).

Table B-1 shows comparisons across FIA regional units of the funds and the performance estimates of implementing the FIA Program. In FY 2021, FIA sampled 13,309 base grid forest plots throughout the 50 States, including Coastal Alaska and the Southwest unit of Interior Alaska (the first unit where all plots are only accessible by air). The estimated percentage of base grid forest plots sampled for the entire United States remained constant from prior year at 12 percent, mostly because the East is home to a prepandemic 5-year average of 70 percent of the grid forest plots annually measured, influencing the national average disproportionally when compared to the West (table 2). While PNW and RMRS base grid forest plot measurements increased by 2 and 1 percentage points respectively, the SRS and NRS dropped by 1 percentage point in FY 2021 (table 2). Spatial and temporal inventory intensification efforts sampled 4,602 forest plots in addition to the base grid plots measured, increasing the total number of plots sampled by 35 percent. Plot data collection for spatial and temporal intensification was financed by State agencies, Forest Service regions, and other Federal agencies using State and contracted crews.

In FY 2020, because of the COVID-19 pandemic, hazardous conditions and poor air quality induced by catastrophic wildfires, and field staff shortages in all units, only 50 percent of all plots scheduled in FY 2020 were measured in the West and 90 percent in the East. In FY 2021, FIA crews prioritized the measurement of the 2020 plot catchup, except in western remote areas where it was not financially efficient to operate. By the end of 2021, NRS and SRS surveyed all 2020 plots except for the U.S. Virgin Islands, RMRS measured 60 percent, and PNW 90 percent. Some of the FY 2021 plots remained unmeasured by the end of FY 2021: 18 percent in SRS and NRS, 43 percent in RMRS, and 55 percent in PNW.

Compared to FY 2020 plot activity, FY 2021 saw a significant increase in the percentage of total forest plots measured (FY 2020 plot catchup and FY 2021 planned): 17 percent in PNW and 20 percent in the RMRS. The base-grid forest plot catchup in the West was prioritized over intensification, urban and nonforest plots, resulting in an even higher increase of 27 percent from the prior year in PNW. The total number of forest plots measured in SRS and NRS decreased by 7 percent and 5 percent respectively in FY 2021, mainly due to an increase in denied-access due to the COVID-19 pandemic. The decrease was even higher when just considering base-grid forest plots: 10 percent in SRS and 6 percent in NRS. Although eastern field operations were not as significantly impacted by the COVID-19 pandemic and the hazardous conditions due to catastrophic wildfires as the West in previous year, some Southern States plot measurements have run behind for several years due, in part, to natural disasters and other State-related issues. The national average for all forest plots dropped by 1 percent due to the larger representation of forest plots in the East, making western plot measurement increases not as significant in the national average. The FY 2020 urban plot catchup and FY 2021 planned urban plots were measured in the East, where most of them are located, during the FY 2021 field season.

Urban forest inventory, implemented in 40 cities across the country, had paused completely in 2020 because of COVID-19 safety concerns in more densely populated areas. Urban FIA managed to complete the FYs 2020 and 2021 plots by the end of the FY 2021 field season with two

exceptions: 100 percent of plots for both years remained to be surveyed in the U.S. Virgin Islands, and about 25 percent for both years remained for Colorado.

Plot data collection continued in the Southwest unit of Interior Alaska where plots are only accessible by air. Since 2020, a total of 237 plots have been measured representing 27 percent of the total plots in this unit.

The conterminous 48 States and Coastal Alaska use an annualized[2] survey, and Interior Alaska, Hawaii, and the rest of U.S. islands implement a periodic[3] survey (figure 1). FIA's legislative direction, most recently from the Forest and Rangeland Renewable Resources Research Act of 1978 (PL 95–307), states that the Nation's Trust Territories

and Freely Associated States are to be treated as States for research purposes. Since 2000, in compliance with this mandate, periodic inventories have been completed in the Commonwealth of Puerto Rico, U.S. Virgin Islands, Federated States of Micronesia, American Samoa, Guam, the Republic of Palau, the Republic of the Marshall Islands, and the Commonwealth of the Northern Mariana Islands, all of which are exempt from the annualized system and have periodic inventories.

FIA monitors approximately 550 inventory field plots throughout Hawaii's forests, both public and private lands every 10 years over a 3-year period. Field plots are on the islands of Hawai`i, Maui, Moloka`i, Lanai, O`ahu, Kaho`olawe, and Kauai. The second measurement of these field plots began in 2019 and it is anticipated to be completed in March 2022, as planned. In an effort to adapt to COVID-19 mitigation and safety protocols while also maintaining field production and data quality goals, data collection occurred year-round. Hawaii's third inventory measurement is planned for 2029–2031.

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[2] Annualized inventory measures 10 percent to 20 percent of all plots in each State each year.

[3] Periodic inventory measures plots once every few years. State-level inventory is based on a full measurement of existing plots.

Figure 1. FIA inventory implementation status, FY 2021.
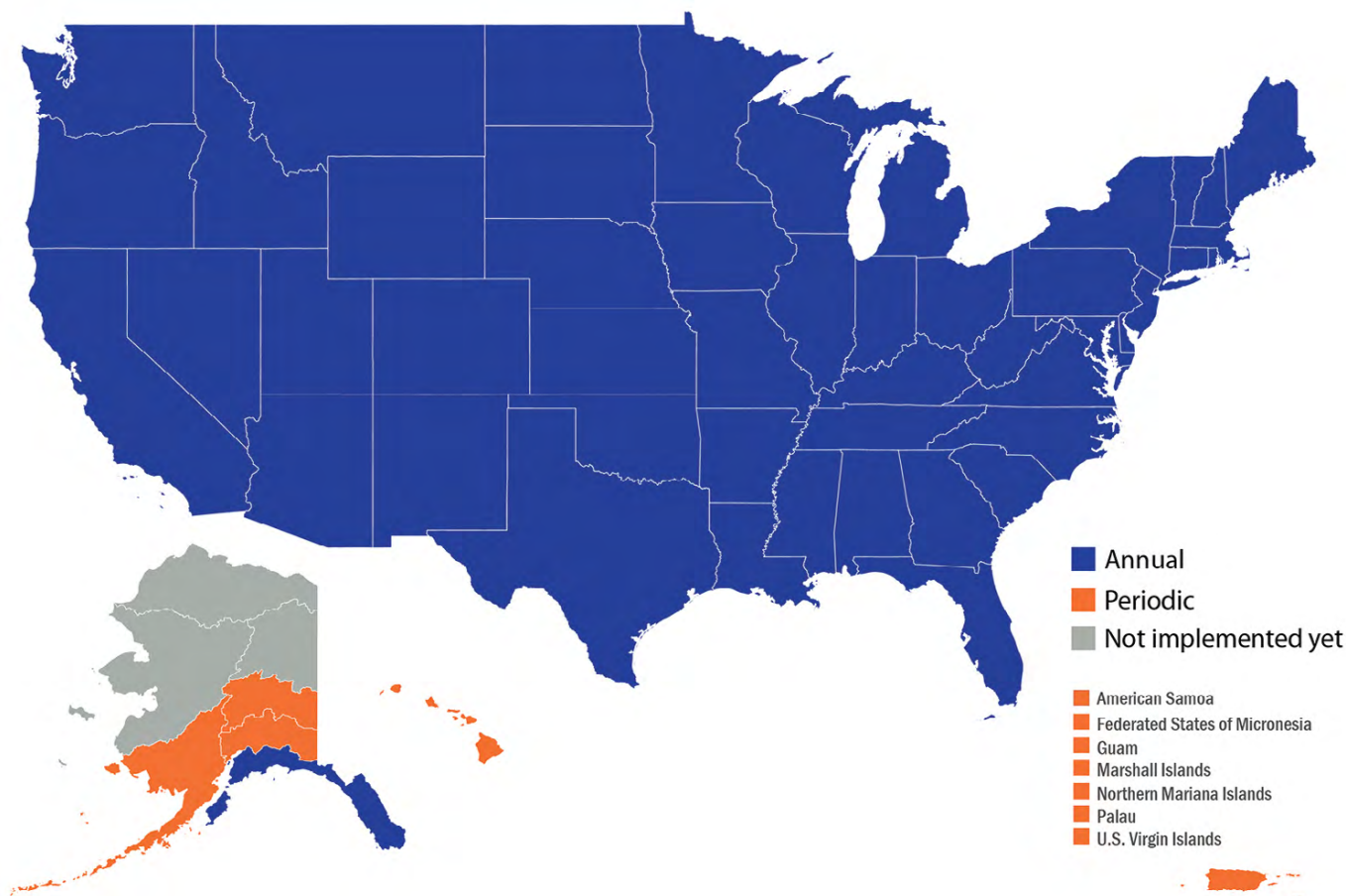
FIA = Forest Inventory and Analysis; FY = fiscal year.

Figure 2. FIA Program available funds and expenses by category, FY 2021.
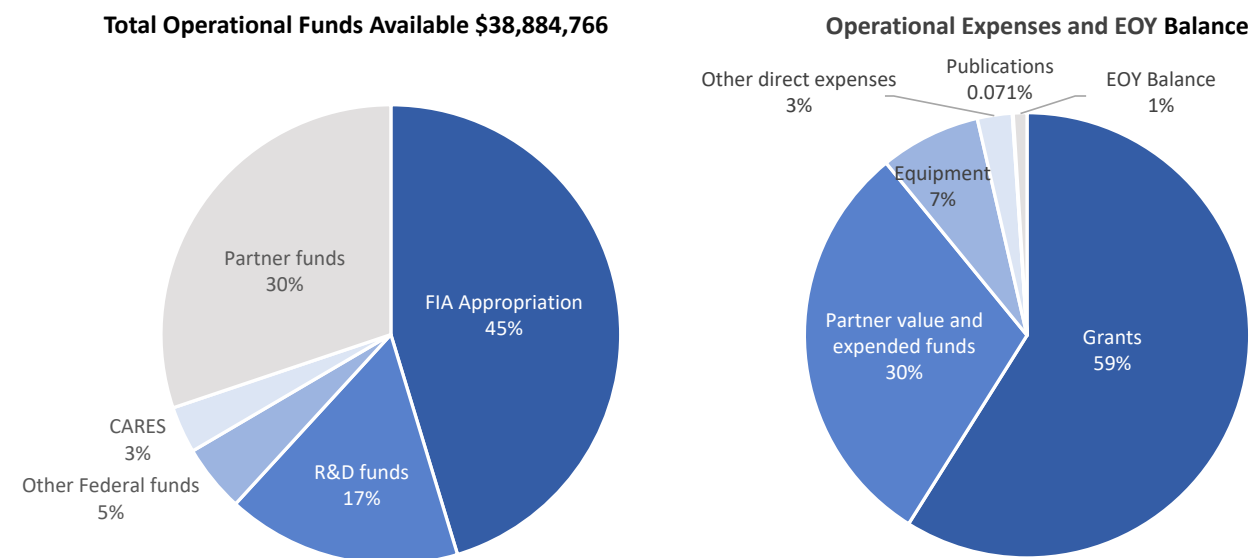
Total Operational Funds Available $38,884,766

Operational Expenses and EOY Balance

CARES = Coronavirus Aid, Relief, and Economic Security Act; EOY = end of year; FIA = Forest Inventory and Analysis; FY = fiscal year; R&D = research and development

The approximately 750 inventory field plots spread across the islands of Puerto Rico (mainland Puerto Rico, Vieques, Culebra, and Mona islands) and U.S. Virgin Islands (St. Croix, St. Thomas, and St. John) have been remeasured every 5 years since the implementation of the nationalized inventory design there in 2001. Puerto Rico is currently on its seventh inventory (two 10-year periodic inventories in 1980 and 1990 preceded the inventories of 2003, 2009, 2014 and 2019[4]) which will be complete in 2024. The forests of the U.S. Virgin Islands have been inventoried three times (2004, 2009, and 2014) but the fourth inventory had to be suspended short of completion due to the COVID-19 pandemic.

During the second year of virtual work environment caused by the pandemic, the total number of FIA publications continued to increase, by 4 percent, from a record high of 239 in FY 2020 to 248 in FY 2021. Of these publications, 97 were core publications consisting of reports specific to a complete survey unit, complete State, national forest, or national reports. Core reports include 5-year State reports required by legislation, island resources reports, annual State resources updates, State timber product output reports, and regional and national resources reports. FIA also published 97 articles in peer-reviewed journals and 8 articles in proceedings from scientific meetings and conferences (table B-1).

In FY 2021, the number of consultations requested by FIA customers decreased by 50 percent, to 696. FIA clients

included government, academia, industry, nongovernmental organizations (NGOs), private landowners, and media. These consultations required 8,285 hours of FIA staff time—equivalent to four full-time staff positions (table B-6). FIA processed 0.9 million online data retrievals in which FIA customers obtained user-defined tables, data downloads, and maps of interest. As the number of consultations, the number of online data retrievals also decreased, by 34 percent, in FY 2021 with respect to the previous year (table B-7).

In addition to this report, national and regional user group meetings have been a complementary mechanism for users and stakeholders to track FIA accomplishments, provide feedback on performance, and present emerging issues and information needs. In FY 2021, FIA held four user group meetings and six management meetings (table B-1). The 2021 FIA National User Group meeting was held virtually and had 189 total registrants, with almost 100 attendees for most sessions. A national meeting on Timber Products Output held virtually attracted 135 attendees. The objectives of the meeting were to: inform users of new developments in the TPO program; better understand the emerging issues, unmet needs, and successes valued by data users; and develop deeper relationships among stakeholders, TPO data users, and TPO staff.

Program Resources

In FY 2021, Congress appropriated $17.6 million for FIA Program operations. Congressional intent, as stated in the Senate Committee on Appropriations explanatory statement, was for FIA to be funded at not less than the enacted level of $77 million, when combining the appropriated $17.6 million in program funds with FIA salaries and expenses.

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[4] Puerto Rico's 2019 5-year report is still in preparation; no link is available yet.

Table 3. Annual FIA appropriations received by the FIA Program and allocation of FIA-appropriated and State-contributed funds for fieldwork, FYs 2010–2021.

Category	Fiscal Year											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	Thousand Dollars											
FIA Program appropriation	71,817	71,452	69,186	65,567	66,805	70,000	75,000	77,000	77,000	78,000*	77,000	17,621
IT funds	-	-	-	-	-	-	-	-	-	-	-	1,500
Direct FIA Salary and Expenses (S&E) invested	-	-	-	-	-	-	-	-	-	-	-	38,665
Total appropriated funds received	71,817	71,452	69,186	65,567	66,805	70,000	75,000	77,000	77,000	78,000*	77,000	57,786
FIA data collection grants to States	7,278	8,002	7,475	5,338	7,098	5,173	8,428	8,945	9,652	10,633	9,755	11,148
Number of States receiving grants	20	17	18	16	17	16	18	17	20	18	18	17
Average grants to participating States	364	471	415	334	418	323	323	526	482	591	542	656
Percent of FIA-received appropriated funding to States for data collection	10%	11%	11%	8%	11%	7%	11%	12%	13%	14%	13%	19%
State contributions for leveraged data collection	5,039	6,192	5,567	3,962	3,919	4,324	5,506	5,205	6,568	5,239	6,809	5,491
Number of fund-contributing States and U.S. islands	45	40	41	38	36	37	34	36	41	37	41	51
Average contribution from States	112	155	136	104	109	117	162	145	151	142	166	108

FIA = Forest Inventory and Analysis; FY = fiscal year; * Includes $1 million supplemental appropriation for hurricane relief.
Note: In FY 2021, the indirect operational costs of operations (former costs pools) were paid through the new Forest Service Operations Treasury Symbol account. The new salaries and expense (S&E) budget line items related to Research and Development paid for the staff providing indirect support at the stations. These indirect costs were previously paid with FIA Program funds.

The total amount of FY 2021 appropriated funds directly invested in the FIA Program to pay for S&E and operational expenditures, including $1.5 million in IT funds and excluding cost pools now directly paid with the new Forest Service operations account, totaled $57,785,945—a shortfall of over $19 million from the $77 million (table B-2 and figure 3). In the previous year, FIA paid $10.4 million for common business services, telecommunications, utilities, overhead of workers compensation program, and unemployment (former costs pools), and about $1 million in building rental and property. If the equivalent of these charges in the new budget structure were to be counted toward a FIA allocation, the budget invested in FIA from FY 2021 appropriated funds would total an estimated $68.2 million.

In addition to the $1.5 million in IT funds received from FY 2021 appropriations, FIA also received $800,000 from other R&D-IT funds, totaling about $2.3 million IT dollars. Although in FY 2020 FIA funds were used to pay charges for the IT maintenance (formerly labeled Information Resources Decision Board, IRDB), in 2018 and 2019 these charges were paid by R&D to help offset the increase in cost pools charged to the program. The IRDB fund manages agency-sponsored IT projects. FIA operations also received an additional $1.3 million for COVID mitigation from the CARES Act:[5] $800,000 from FY 2021, and $500,000 at the end of FY 2020, which were transferred and used in FY 2021. R&D contributed $2.25 million to the FIA operational budget, and the National Forest System and other Federal agencies provided $1.8 million (table B-2). Thus, contributions from State agencies, universities, other Forest Service programs (excluding R&D contributions), other Federal agencies, and NGOs totaled $12.4 million, representing 31 percent of the available operational funds. Partners, including NFS, contributed $4.6 million to the base program and $8 million in added value (figure 2 and table B-4). Partner contributions decreased by a half million from the prior year.

[5] Coronavirus Aid, Relief, and Economic Security Act, (P.L. 116–136).

Figure 3. FIA-appropriated funding level, FYs 2007–2021.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
■ Funding gap	14.40	16.70	15.82	11.68	13.41	18.15	23.17	23.20	20.11	16.24	16.19	18.46	19.19	21.39	25.45
■ Congressional S&E intent															59.379
■ Fed. appropriations	63.61	64.64	65.54	71.82	71.45	69.19	65.57	66.81	70.00	75.00	77.00	77.00	78.00	77.00	17.621
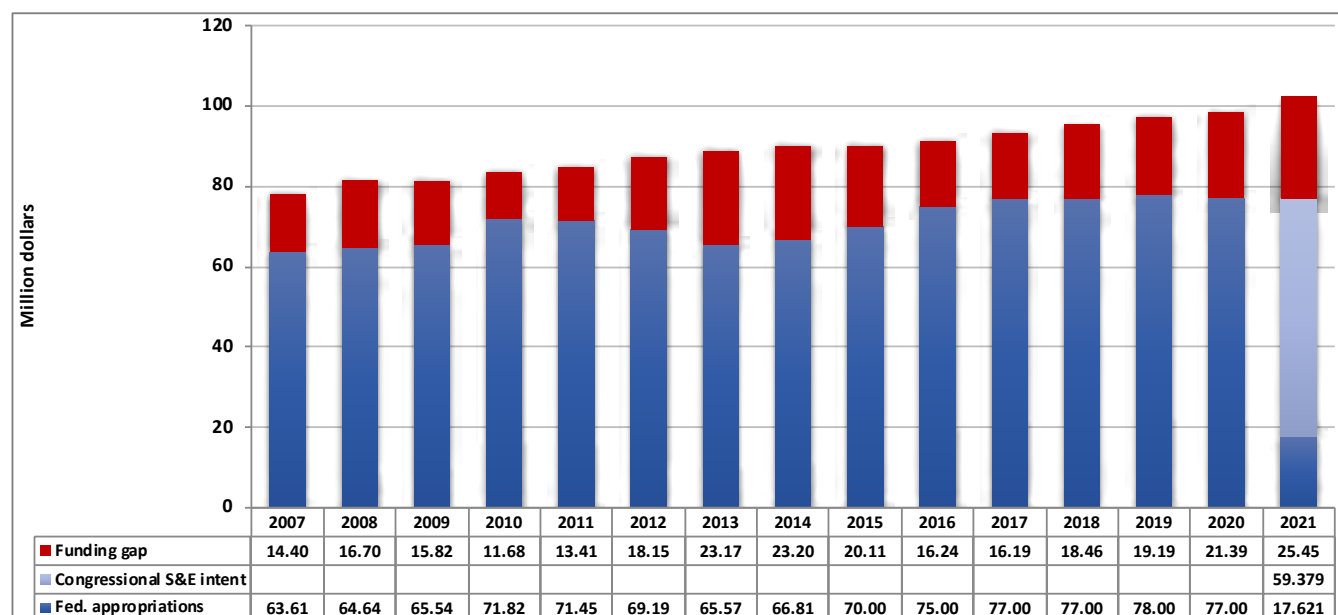
Fed. = Federal; FIA = Forest Inventory and Analysis; FY = fiscal year; S&E = salary and expenses under the new Forest Service budget structure.
Note 1: Estimated total annual funding to fully achieve the 2007 strategic plan was $78 million. The 2014 Farm Bill required a new strategic plan with added items requiring $90 million annually to fully achieve Plan options A through C. Required annual funding levels for full implementation have been adjusted only for inflation each year in this figure and do not include additional costs due to the expansion of the program in some areas. Funding gap is noted in the red segment on the bars.
Note 2: In FY 2021, Congress appropriated FIA operations ($17.6 million) and provided direction for the program to be funded at no less than $77 million when combining the appropriated funds and the S&E invested by the agency on FIA.

In past appropriations, Congress directed FIA to make funds available for collaborating with States and other partners to help implement the FIA Program and FIA still takes this direction to the core. Despite appropriated funds remaining flat since 2017, FIA investment in partners continues to grow, granting $3.7 more in FY 2021 than the previous year. The total amount invested, $22.9 million, represented 84 percent of the FIA Federal operational expenditure and 59 percent of the total operational expenditure (figure 2 and table B-5). Through annual agreements, 17 State agencies received 49 percent of this investment, amounting to $11.1 million, which represented an increase of $1.4 million from prior year (table 3). In turn, State agencies leverage FIA's on-the-ground resources, contracted or dedicated, to contribute funds and in-kind resources for additional data collection and analysis to meet their local needs, reaching $5.7 million in FY 2021 ($1.1 million less than FY 2020). State fieldwork employees, provided through these partnerships (figure 4), made up one-third of the entire FIA workforce. As shown in figure 2, FIA invested 7 percent of all available operational funds in equipment, 3 percent in other direct expenses, and less than 1 percent in publications.

Before the Forest Service budget modernization, research stations charged expenditures to offset the indirect costs to support the FIA Program. Rates of effective indirect

Figure 4. Federal and State FIA Program employees by job group, FY 2021.

FIA-supported employees (564)
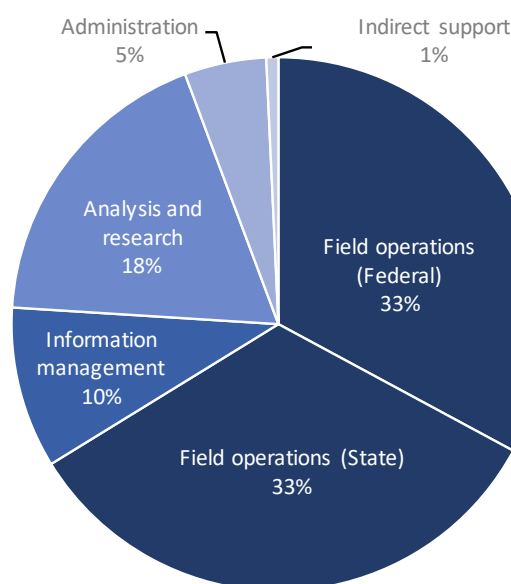
FIA = Forest Inventory and Analysis; FY = fiscal year.

Figure 5. Grants and agreements by recipient group, FY 2021.
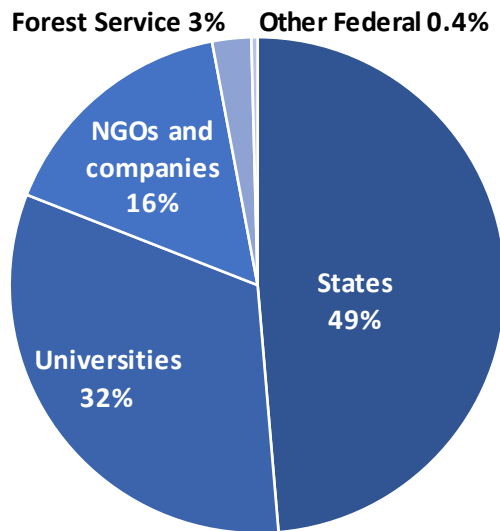
States	11,148,317	17
Universities	7,397,624	32
NGOs and companies	3,692,026	26
Forest Service	583,040	2
Other Federal agencies	92,616	4
Total	**22,913,623**	**81**

NGOs = nongovernmental organizations.

expenses varied over time (averaging 21 percent for the past 5 years) and FIA unit, reflecting differences in sources of funding and research station indirect expense assessments. However, under the new budget structure all Forest Service salaries and expenditures are paid with the new S&E budget line-item funds appropriated by Congress. For transparency, the Forest Service created an internal budget code to track FIA S&E charges within each station. Only 4.1 non-FIA full-time equivalent employees were charged to the FIA S&E tracking code by NRS and PNW combined. These charges were accidental and are not expected to recur.

Figure 3 shows the total appropriated funding for FIA from FY 2007 through FY 2021. Throughout this period, the federally appropriated budget for FIA has been less than the level needed for full implementation—in FY 2021, around $102.5 million (adjusted for inflation). For more trends in performance measures, see table B-12.

In FY 2021, FIA employed the equivalent of 332.3 full-time Federal workers (table B-3a), 46.3 fewer than the previous year. This decrease was in part, due to salaries of Forest Service Research Station workers (i.e., not FIA staff) providing indirect support to FIA were covered by non-FIA S&E funds under the new budget structure. The number of equivalent full-time Federal workers providing direct support to the FIA Program increased from 321.2 in FY 2020 to 328.1 in FY 2021. Cooperators, especially State natural resources agencies, accomplished much of the work done by FIA, contributing an additional 231.8 full-time employees (8.2 more than in FY 2020) for a total FIA workforce of 564. Cooperator employees included 188.1 field employees,

Figure 6. Grants and agreements to State partners, in thousands of dollars, FY 2021.
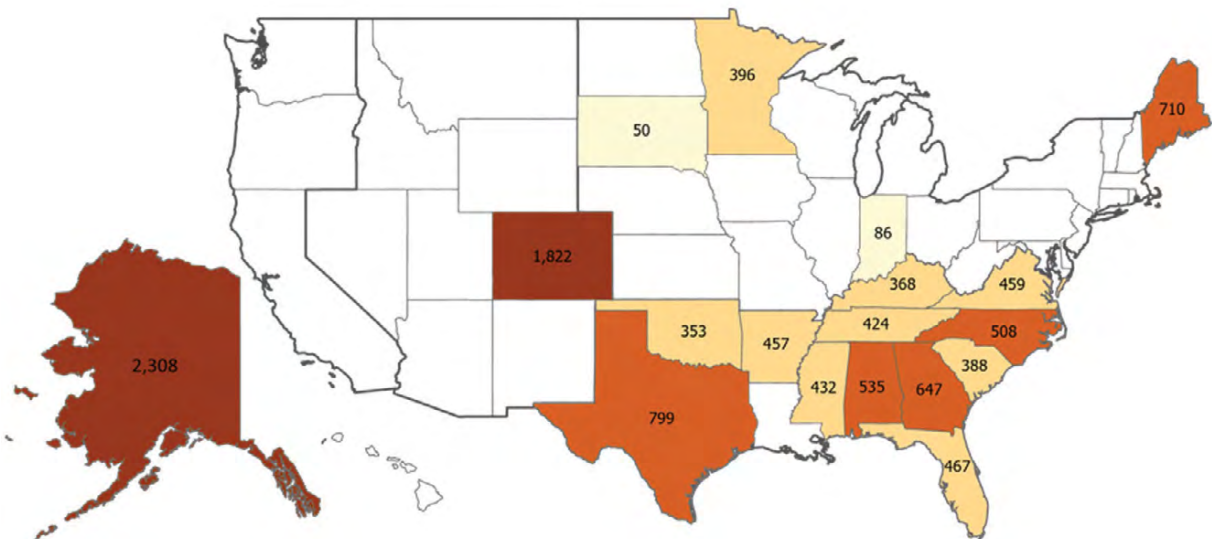
Figure 7. FIA investment in external partnerships through grants and agreements, FYs 1999–2021.
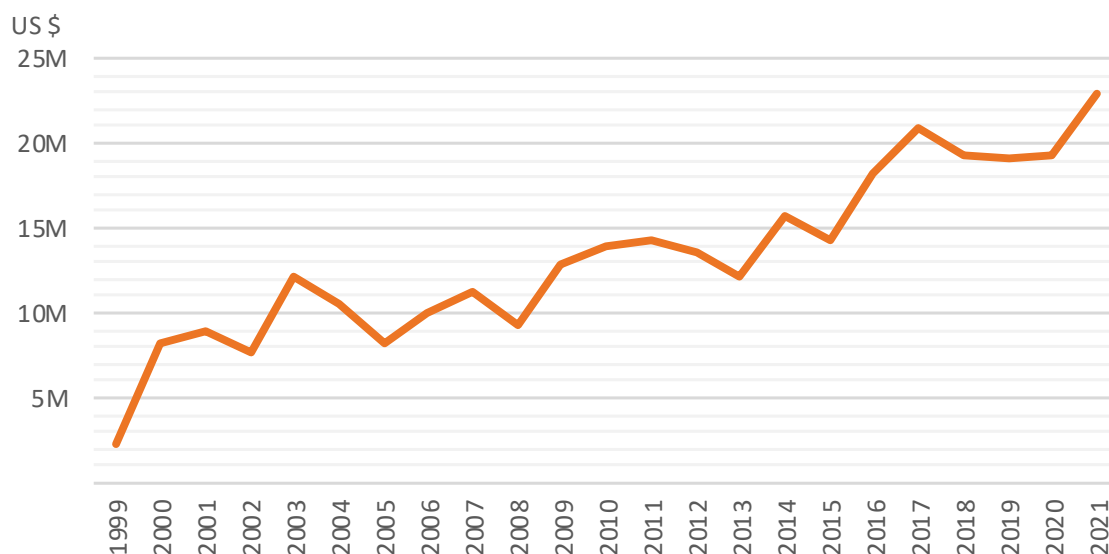
FIA = Forest Inventory and Analysis; FY = fiscal year

13.8 information management specialists, 26.2 analysts and researchers, and 3.4 administrative specialists (table B-3b). Cooperator employees constitute 41 percent of the total FIA workforce.

Of all Federal and cooperator FIA employees, 66 percent were involved in data collection and field support, 18 percent in analysis and research, 10 percent in information management, and 5 percent in program management and administration (figure 4).

FIA Investment in Partnerships and Partners' Contributions

As indicated by the 1998 Farm Bill, the 2014 Farm Bill, and the 2018 Farm Bill, Congress directed the FIA Program to partner with States and other entities. The base Federal commitment is an inventory program that annually collects data from 10 percent of the sample locations in the Western States (10-year cycle) and 15 percent of the sample locations in the Eastern States (7-year cycle), with comprehensive analytical reports for all States produced at 5-year intervals. The following discussion summarizes program grants and partners' contributions.

FIA investment through grants and agreements. Each year, FIA units enter into various cooperative agreements and grants with partners to accomplish specialized work in support of the FIA mission. In some cases, partners provide expertise that complements or is not available within FIA; in other cases, they share the workload in data collection, information management, and research in techniques development. In

FY 2021, FIA invested almost $23 million ($3.7 million more than previous year) through 104 grants and agreements with partners, including 17 State agencies ($11 million), 32 universities ($7.4 million), nongovernment partners ($3.7 million), other Forest Service programs ($583,040), and other Federal agencies ($92,616) (figure 5, table B-5). From the largest recipient group, State governments, the State of Alaska received $2.2 million, which included a $1 million helicopter contract, followed by Colorado with $1.7 million, Texas with $0.8 million, Maine with $0.7 million, Georgia with $0.65 million, Alabama with $0.53 million, and North Carolina with $0.5 million (figure 6). The growing trend of FIA investment in external partnerships over time demonstrates the high reliance of the program on collaborations to efficiently complete the work (figure 7).

The use of various agreement authorities allows FIA managers to augment the program capacity to collect and analyze data as well as report information to individual States.

Partners' contributions to FIA. At their discretion, partners may contribute the resources needed to bring the FIA Program up to the full 20-percent measurement per year (5-year cycle) that is included in the authorizing legislation (1998 Farm Bill). In addition, or as an alternative, partners may choose to contribute resources to enhance the FIA Program from their perspective, such as intensifying the base FIA sample location grid to support analysis at finer spatial resolution, funding additional types of measurements on FIA sample locations, or providing analyses or reporting beyond that provided by FIA. The willingness of partners to contribute resources demonstrates the inherent value of

Figure 8. Partner contributions by FIA region and type, FY 2021.

FIA region	Base program ($)	Value added ($)	Total ($)
Pacific Northwest	803,588	2,207,370	3,010,958
Rocky Mountain	407,306	130,160	537,466
South	2,200,286	261,379	2,461,665
North	976,221	4,772,759	5,748,980
National	200,000	649,384	849,384
Total	**4,587,401**	**8,021,051**	**12,608,452**

FIA = Forest Inventory and Analysis; FY = fiscal year.
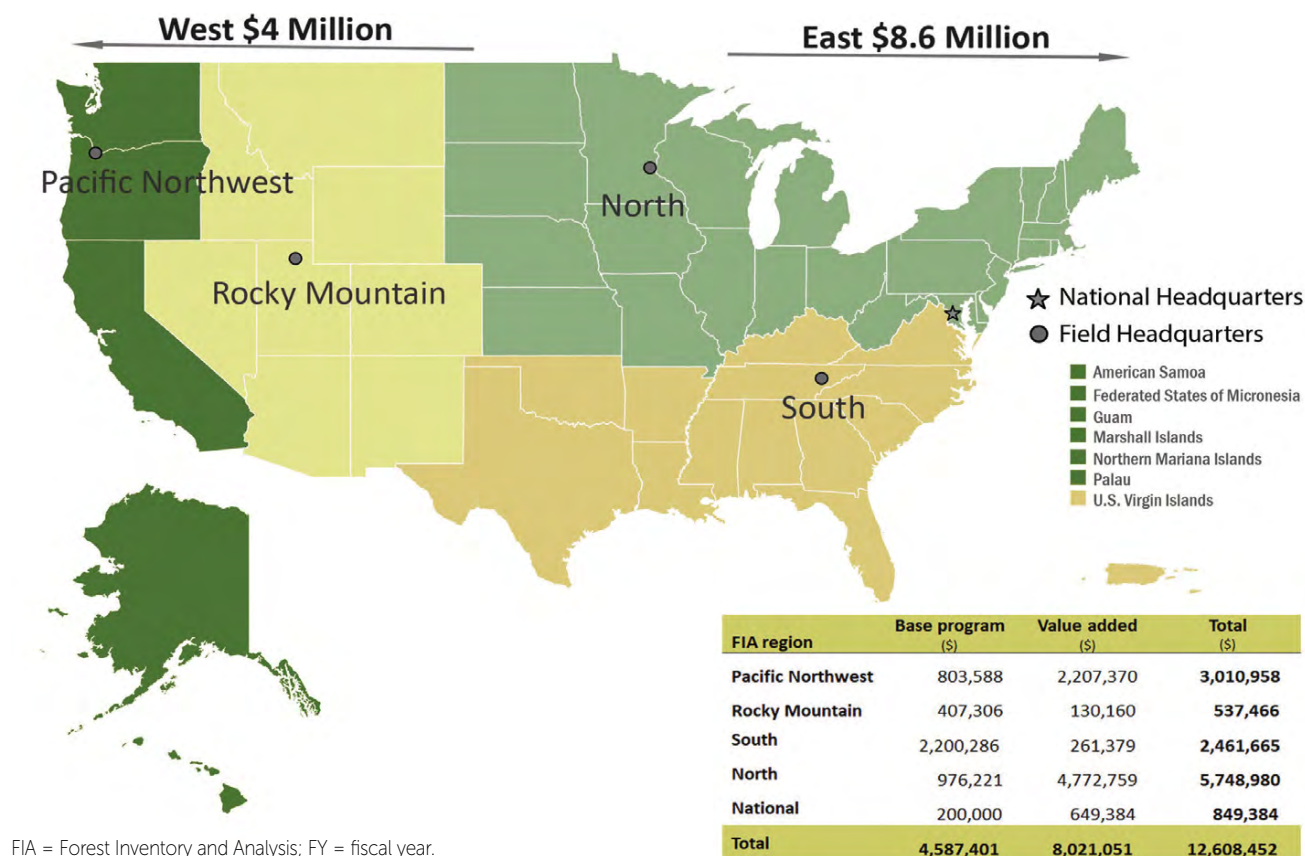
the FIA Program as a flexible framework to supplement resources on issues of interest.

Table B-4 lists 97 agreements with 85 partners that have contributed resources to the FIA Program in FY 2021, through 93 different partnerships, either to achieve the 20-percent level of cost-sharing, often expected of agreements, or to add value to FIA in other ways. These resources include staff time, vehicle use, office space, equipment, travel costs, and other noncash items that support or add value to the FIA Program. For reporting purposes, contributions are assessed in terms of the cost for Federal FIA staff to provide the same service, which may not necessarily be the same as the actual cost to the partner making the contribution.

Overall, partners contributed almost $4.6 million toward the base program (about $0.3 million more than in FY 2020) as defined by option B of the FIA Strategic Plan; this included full 20 percent of target plots measured annually, imagery and photo analysis, and development of core reports. Partners also provided another $7.5 million in contributions that add value to the FIA Program (about $1.1 million less than in FY 2020), for a total of almost $12.1 million or 15

percent of the total available funds. Partner-shared costs vary by region and the ability of States and other partners to contribute each year. Eastern partners provided over 68 percent of the total FY 2021 contributions, or $8.2 million ($3.4 million toward the program base and $4.8 million in value added); western partners contributed 32 percent, or $3.9 million (almost $1.2 million towards the base program and $2.7 million in value-added) (figure 8). An increase in value-added contributions provided most of the net $0.5 million-increase from prior year for Eastern States; fewer value-added contributions from Western States accounted for most of their net $0.3 million decrease.

Contributions from State agencies decreased by $1.1 million: from $6.8 million in FY 2020 to $5.7 million in FY 2021. Forty-two State agencies contributed to leverage FIA data collection: $3.3 million to base program and an additional $2.4 million to add value (table 3). About 73 percent of State agency contributions, $4.2 million, were from the Eastern States (table B-4). California Department of Forestry and Fire Protection was FIA's largest investor, with over $0.8 million ($0.7 million less than previous year) for plot intensification, followed by the States of Florida ($0.55 million), Wisconsin ($0.53 million), Alaska ($0.41 million),

Figure 9. Total State agency contributions to the FIA Program, in thousands of dollars, FY 2021.
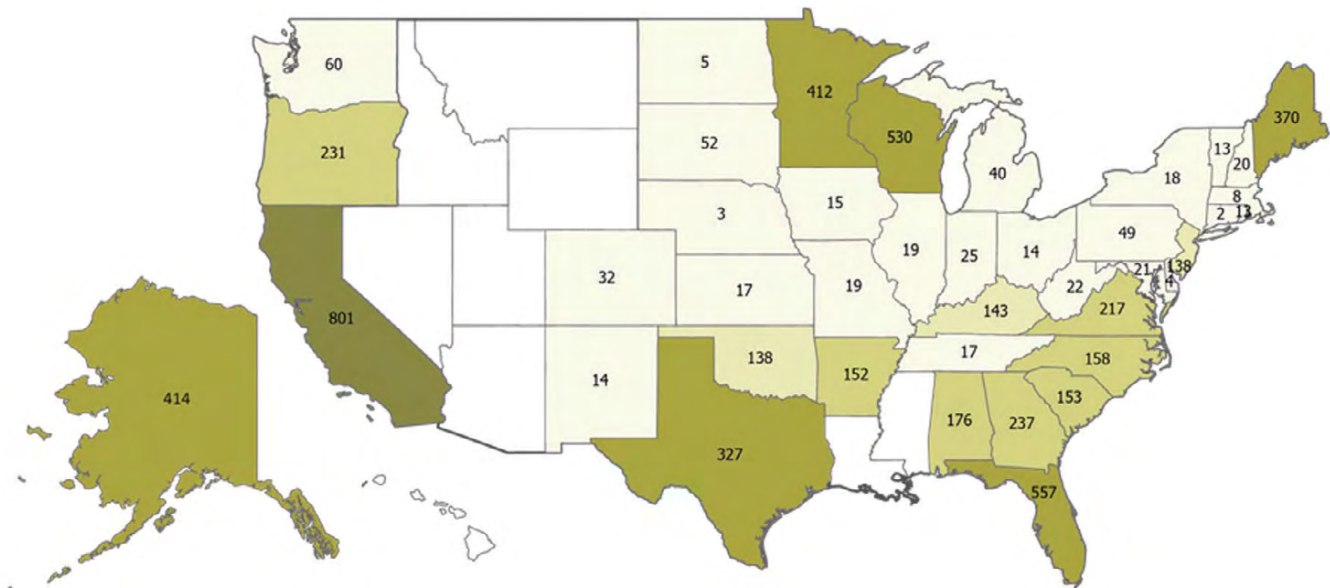
FIA = Forest Inventory and Analysis; FY = fiscal year

and Minnesota ($0.41 million) (figure 9). State contribution decrease was offset by an annual increase in value-added contributions from universities (from $1.4 million to $2.3 million) and the Forest Service (from $2.5 million to $3.2 million) between FY 2020 and FY 2021.

As a national program with operations delivered regionally, the distribution of funds granted to partners and the distribution of investments received vary disproportionally among the four FIA units. In 2021, the Southern Research Station FIA unit invested the largest amount of funds, 31 percent, mostly in agreements with State agencies (table 4). The proportionally larger investment in the South results from the sizeable representation of large private forest ownership, the fast forest growth rates, the importance of the

forest sector, and a different FIA business model that relies heavily on inventory plot data collected through partnerships with State agencies. The Northern Research Station FIA unit managed 20 percent of the granted funds and 24 percent of the total number of grants and agreements. The NRS FIA unit also received and managed the largest percentage of partner contributions, about $5.7 million or 46 percent of the total, followed by the Pacific Northwest Research Station (PNW) FIA unit (24 percent) and the SRS FIA unit (20 percent). The Washington Office (WO) allocated the internal IT-related funds.

Over the last 10 years, FIA has invested over $175.5 million in its partners to implement an efficient inventory. During the same period, partners have contributed $103.7 million

Table 4. FIA grants and agreements to partners, and partner contributions by FIA unit, FY 2021.

Unit	Total FIA G&A				Total partner contributions			
	Amount (dollars)	Percent	Number	Percent	Amount (dollars)	Percent	Number	Percent
PNW	4,681,275	20%	24	23%	3,010,958	25%	53	55%
RMRS	4,388,856	19%	21	20%	426,260	4%	12	13%
SRS	3,403,251	15%	16	15%	2,638,002	21%	5	5%
NRS	6,996,394	31%	23	22%	5,181,201	43%	23	24%
WO	3,443,847	15%	20	19%	849,384	7%	3	3%
Total	22,913,623	100%	104	100%	12,105,804	100%	97	100%

FIA = Forest Inventory and Analysis; FY = fiscal year; G&A = grants and agreements; NRS = Northern Research Station; PNW = Pacific Northwest Research Station; RMRS = Rocky Mountain Research Station; SRS = Southern Research Station; WO = Washington Office.
Note: Percentages may not add to totals because of rounding.

Table 5. FIA grants and agreements to partners and partner contributions by organization group, FY 2012 through FY 2021 (10-year summary).

Group	Total FIA G&A	Average annual G&A	Percent of G&A	Total partner contributions	Average annual contributions	Percent of contributions
	Amount *(dollars)*	Amount *(dollars)*	Percent	Amount *(dollars)*	Amount *(dollars)*	Percent
States/islands	85,160,225	8,516,023	49%	55,336,422	5,533,642	53%
Universities	48,910,100	4,891,010	28%	9,955,607	995,561	10%
Forest Service	12,394,297	1,239,430	7%	26,399,449	2,639,945	25%
Other Federal	2,079,253	207,925	1.2%	8,659,584	865,958	8%
Other partners	26,989,414	2,698,941	15%	3,338,025	333,803	3%
Total	175,533,288	17,553,329	100%	103,689,086	10,368,909	100%

FIA = Forest Inventory and Analysis; FY = fiscal year; G&A = grants and agreements.
Note: Percentages may not add to totals because of rounding.

to leverage Federal dollars, which have reduced inventory cycles, increased the density of plots, and provided for other annual inventory enhancements. Table 5 summarizes FIA grants and partners' contributions by organization group.

FIA Data Availability

The FIA Program mission is to provide continually updated, accurate, and reliable information on the status and trends of the Nation's forested resources. FIA's legislative mandate results in program objectives that include: (1) providing annual access to current and past data for all forested lands sampled as part of the annualized inventory system; (2) producing analytical forest reports for all States on a 5-year cycle; (3) providing information on forestland ownership and the attitudes, behaviors, and other characteristics of America's private forest owners; and (4) delivering data to assess a variety of issues regarding timber resource use.

An interactive map displays the FIA data available online by State, the production and publication years of 5-year State reports with links to them, and the status of future 5-year State reports, as of end of FY 2021.

Figure 10 shows, for each State, the most recent year for FIA data accessible in our public database as of the end of FY 2021. Most of the conterminous States and Coastal Alaska, 88 percent of annualized States, had data less than 2 years old available online, which is the target date for recency of data. Data from Oklahoma, Louisiana, and Tanana Unit in Interior Alaska were 3 years old. Data from Kentucky, Tennessee, Florida, Texas, and Palau were 4 years old. Data from the rest of the islands, Federated States of Micronesia, Hawaii, the Northern Mariana Islands, the Marshall Islands, Guam, America Samoa, Palau, and the U.S. Virgin Islands dated from more than 4 years. The latest forest inventory data for the Hawaiian Islands is available to the public through a State-specific online inventory database. In Interior

Alaska, data collection for the first and second inventory units, the Tanana unit, and the Susitna-Copper unit, were completed and the third unit, the Southwest unit, continued being inventoried. Data collection for the Tanana Valley unit inventory, completed in 2018, was released to the public in 2020 through its own Microsoft Access database. Continued improvements to data processing and in the National Information Management System (NIMS) are paying dividends by enabling FIA to establish a more routine loading schedule. The development of Universal NIMS (UNIMS)—the next-generation replacement for NIMS—to internally store and process plot data, will allow for the flexibility to include newer protocols such as data from Interior Alaska, Hawaii, urban areas, and special studies, among others. Once completed, data from UMINS will be exported to FIA database (FIADB) for use by analysts and software tools as is done currently by NIMS.

Figure 11 shows the most recent inventory year included in the 5-year FIA report for each State, which differs from the year of publication (figure 12). The inventory units with report data less than 7 years old are shaded blue or green: 29 States, Interior Alaska-Tanana Unit, Puerto Rico, and the U.S. Virgin Islands. Blue tones correspond to units with inventory data less than 5 years old (Missouri, Vermont, New Hampshire, New York, Mississippi, Ohio, Virginia, South Carolina, and Washington). Within the conterminous United States, the oldest data included in a current State report were collected in 2009, in Kentucky and Tennessee, followed by data collected in 2010, in Arkansas.

Except for Hawaii, Tennessee, Maryland, Arkansas, Kentucky, and North Carolina, 5-year State reports were published less than 6 years ago, meeting the program objective (figure 12). The Missouri State report was the only one published electronically in FY 2021. Draft versions for Delaware, Maine, and Minnesota State reports were released electronically and are waiting to be officially published

Figure 10. Latest year of availability of online FIA data, FY 2021.
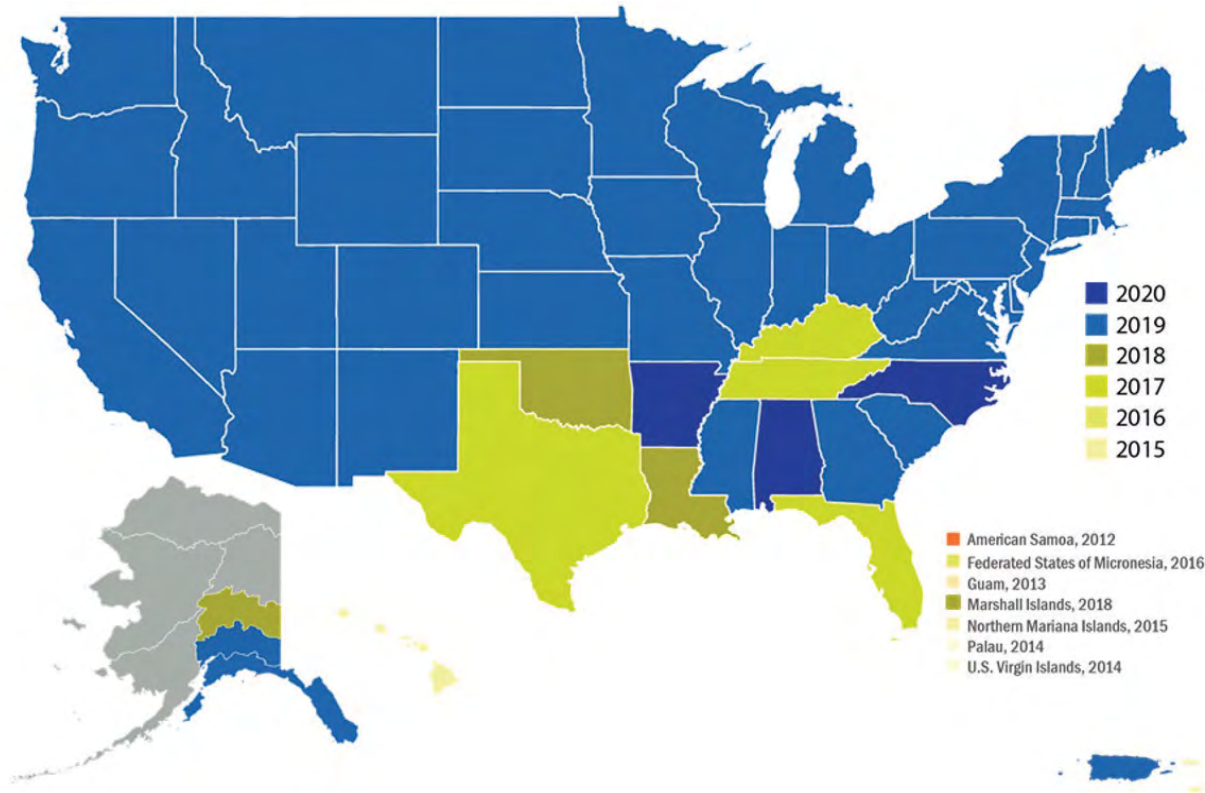
FIA = Forest Inventory and Analysis; FY = fiscal year.
Note: Information related to FIA data, production and publication years of 5-year State reports, and links to the reports as of end of FY 2020, can be explored interactively for each State.

by the Northern Research Station. Maryland's 2013 State report draft was produced electronically, but it is yet to be officially reviewed and published. American Samoa, Guam, and the Virgin Islands reports were published in FY 2020. Although the goal is not to exceed 10-year cycles outside the conterminous United States, Palau had a longer cycle and was not able to report within this time window.

The FIA Program compiles information on forest and woodland ownership through the National Woodland Owner Survey (NWOS). An interactive online tool, the NWOS Dashboard, allows users to explore the latest forest landowner data and make comparisons about States and regions.

The FIA Program also provides a Timber Products Output (TPO) toolkit to deliver estimated data for timber products, logging residue, mill residue, residential fuelwood, and other wood removals. The TPO toolkit includes four reporting tools: TPO Interactive Reporting Tool (available only for Southern States, other U.S. regions expected in the coming years); TPO Data Download and TPO One-Click Fact Sheets (both available only for the Southern States, and planned for Northern States in FY 2022); and TPO Reporting Tool—Legacy.

Quality Assurance

The FIA Program collects, analyzes, and publishes tremendous amounts of data annually. A large part of our work consists of designing, implementing, and carrying out procedures to ensure the data are unbiased and represent the larger landscape. Toward this end, FIA's Quality Assurance (QA) program employs a framework to promote consistency during all stages of the national core FIA inventory process. The FIA "National Core Prefield Guide" and "National Core Field Guide" document the protocols, ensuring consistent prefield and field data collection for core data items. FIA's national field data entry program, the Mobile Integrated Data Acquisition System (MIDAS) is integrated into the overall FIA information management structure and provides consistent logic and error-checking in the field. The Universal National Information Management System (UNIMS) database and UNIMS Compilation System (UNIMS-CS) provide additional error checks, and consistently calculate and provide access to a variety of derived variables using estimation equations that are described in general technical reports. Each field unit uses a system of post collection quality assurance checks to inspect data for anomalies. Feedback from users provides an important step in ensuring

Figure 11. Inventory year of FIA State reports, FY 2021.
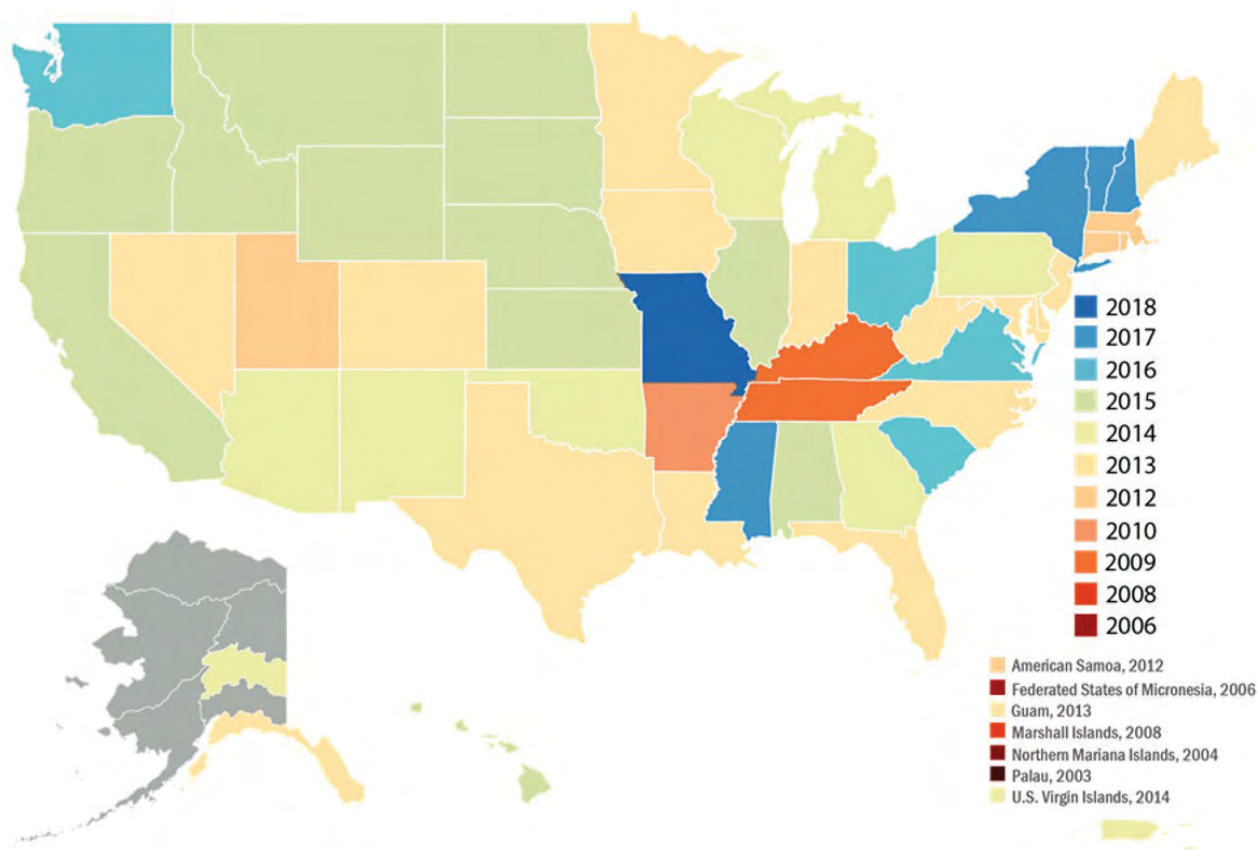
FIA = Forest Inventory and Analysis; FY = fiscal year.
Note 1: Production year refers to the FY that the publication was created, in most cases matching the last inventory year included in the data.
Note 2: Information related to FIA data, production and publication years of 5-year State reports, and links to the reports as of end of FY 2020, can be explored interactively for each State.

the quality of the data. We continue to evolve and automate QA throughout our processes.

To help ensure a consistent program where data and products can be reviewed and compared for quality, a national QA coordinator works with the national FIA Program office to provide direction and coordination through regional and national leads of four teams: the Data Acquisition Band, the Information Management Band, the Analysis Band, and the Techniques Research Band.

The FIA Program promotes process transparency and consistency by extensively documenting methods and procedures, as found at https://www.fia.fs.usda.gov/library/field-guides-methods-proc/index.php:

- FIA's national band system and structure promotes communication across units nationally and across FIA

functional areas. The system and structure were revamped in 2021, leading to increased communication and efforts to resolve national consistency issues.

- The FIA national prefield guides and rigorous QA protocols define a nationally consistent process to collect information about FIA plots before field visits.

- Up-to-date FIA national field guides, ensure consistent core program data collection.

- Though a set of core variables are collected across all units, each region has specific variables collected based on regional needs. See each region's field guide.

- A field-level data collection QA guide assists in promoting field QA consistency from region to region.

- The Forest Inventory and Analysis Database (FIADB) displays standardized output tables and is accompanied by detailed documentation in a recently updated version of the Database Description and User Guide.

Figure 12. Publication year of FIA 5-year State reports, FY 2021.
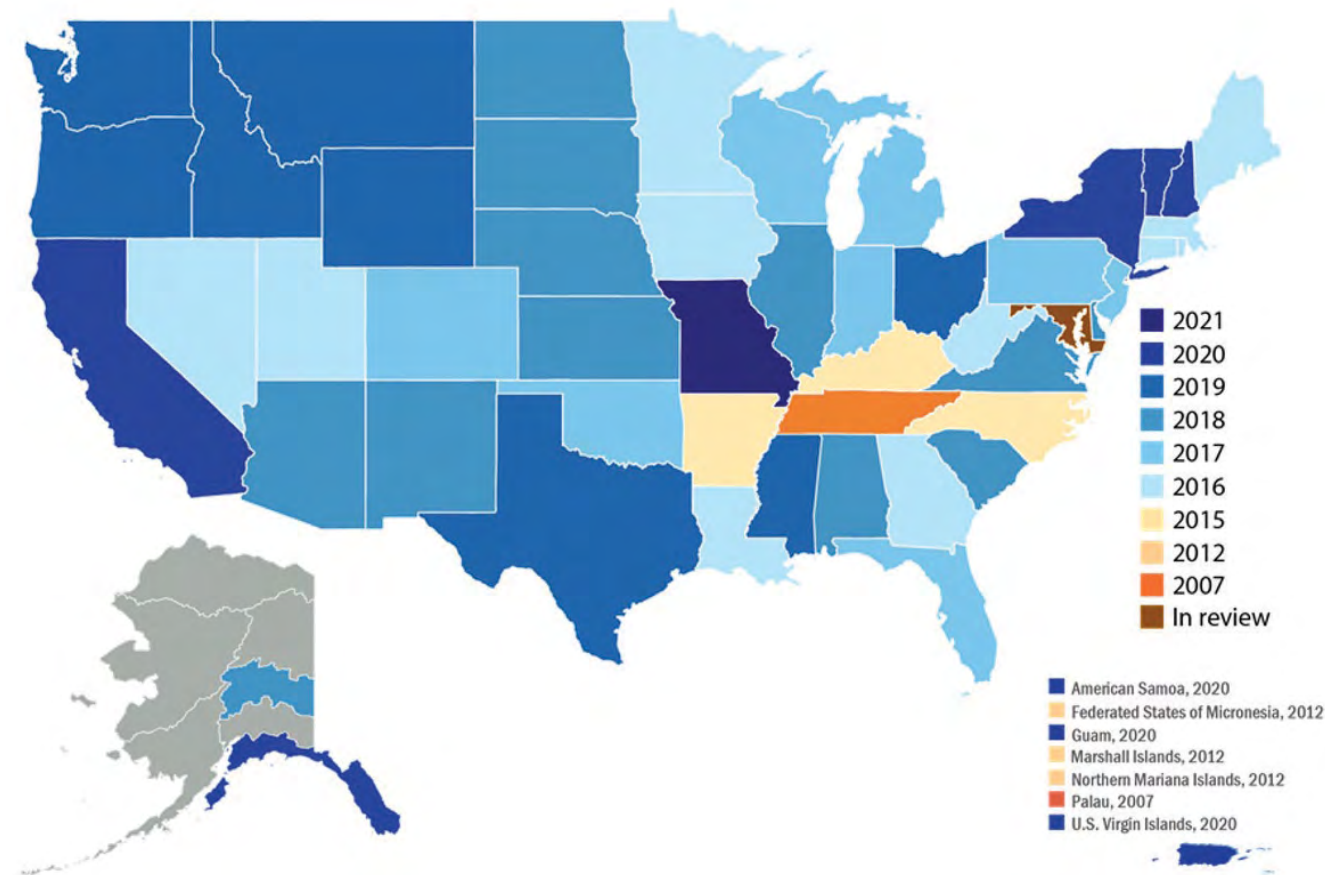
FIA = Forest Inventory and Analysis; FY = fiscal year.
Note 1: Publication year of State report does not match the dates of data shown in the publication.
Maryland's 5-year State report for 2013, produced as a collection of story maps, was published online by the Maryland Department of Natural Resources.
Note 2: Information related to FIA data, production and publication years of 5-year State reports, and links to the reports as of end of FY 2020, can be explored interactively for each State.

- A "National R&D QA Plan" establishes research standards and procedures for all organizational units and personnel within Forest Service Research and Development.
- The "FIA Quality Assurance" factsheet summarizes the processes within the FIA Program, from data collection through analysis, that help ensure consistent data and reporting.

Specific accomplishments related to national quality assurance in FY 2021 include:

- Implementing a new national change management process to identify, resolve, and implement solutions to national issues.
- Identifying issues related to implementing a nationally consistent program and moving through the three-phase national change management process to ensure effective and efficient roll-out of solutions. Some of these issues include:
  ◦ Master Species List 2.0
  ◦ Condition Class and Area of Observation
  ◦ Clarifying field guide language to ensure consistent implementation
- Continuing work on creating a National Single Plot Scoring Tool where all plots are scored against the same criteria to produce a single, nationally comparable score.
- Continuing efforts by the National Training Tools Team to identify training needed by field crews to ensure consistent implementation of field guide protocols.

Ongoing general QA tasks in FY 2021 were aimed at identifying errors and increasing efficiency and consistency in the national inventory. These include:

- Continuing to implement an annualized, national, urban field data collection certification.

- Continuing to develop urban field, compiled, and i-Tree data summary reports to share internally and externally for review data prior to public data release.

- Continuing to develop systematic edit checks of data before public release, including MIDAS logic checks in the data collection phase and UNIMS load error checks.

- Defining rigorous national cold-check field and scoring procedures to allow for equivalent field crew assessments across regions and crew types.

- Developing a national system that performs checks and generates individual check-plot results to assist in comparing quality standards nationally.

- Developing a Master Tree Species List to ensure consistent reporting of tree species across regions, when possible.

- Working across regions and units to identify inconsistencies, find resolutions, and implement changes in prefield and field manual versions 9.2.

- Collaborating, developing, and implementing national data collection staff training standards to ensure consistency, beginning with initial training.

- Developing and documenting UNIMS tables and UNIMS-CS, a consolidated FIA data processing system.

- Working toward improved database systems that connect different components of the inventory (e.g., urban, rural, special studies).

FIA Data Requests and Access for FY 2021

Spatial Data Services

The FIA Spatial Data Services (SDS) Team provides services to clients through a virtual Spatial Data Services Center (SDSC), with staff[1] located in all four FIA regions.

FIA enters into formal agreements with clients when requested data and information are confidential or not publicly available. FIA confidential data includes plot coordinates, landowners' personal identifiable information, and nonpublic business information. In FY 2021, the SDS team used material transfer agreements (MTAs) and memorandums of agreements (MOAs) as the legally binding agreement instruments to establish a framework for cooperation with clients whose access to confidential FIA data was necessary to execute projects that clearly benefited the FIA Program. Terms and conditions included in these

agreements ensure the full protection of FIA confidential data according to current legislation, including the Food Security Act. When plot coordinates are shared, the agreed terms prohibit the cooperator from sharing the coordinates with anyone not covered by the agreement, from using the coordinates for purposes not included in the agreement, and from visiting the plot for the intention of manipulating FIA data or intentionally altering the condition of a plot such that it is not reflective of management conditions in the surrounding area. Additionally, a Data Security Plan is required to document the transfer, storage, use, and disposal of the shared confidential data. Cooperators who are Federal employees are asked to sign a Letter of Intent that reminds them their legal obligations regarding confidential data. Non-Federal employees directly hired by the Forest Service, such as contractors, who have a demonstrated need to access confidential FIA data to perform their work duties must sign a nondisclosure agreement.

During FY 2021, FIA entered into national MTAs with the University of New Hampshire, the University of Idaho, the University of Maryland, West Virginia University, the University of Wisconsin, and regional agreements with many others. SDS work continued with a variety of

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[1] In FY 2021, SDSC staff consisted of:
Tom Thompson, National SDS Team Lead, John Chase, and Brett Davis, PNW.
Justin Holgerson and Liz Burrill, NRS, National and Multi-Regional Projects.
Carol Perry and Tracy Roof, SRS.
Chris Toney and Karen Schleeweis, RMRS.

Figure 13. Spatial data requests made to the FIA Spatial Data Services Center, FY 2021.

257 Requests

By Unit
- PNW 24%
- RMRS 9%
- SRS 37%
- NRS 30%

By Type
- Miscellaneous 5%
- Summary 20%
- Knowledge 24%
- Spatial 51%

By Requestor
- Other 8%
- Industry 12%
- NGO 10%
- Other Federal 16%
- NFS 10%
- State 12%
- Academia 32%
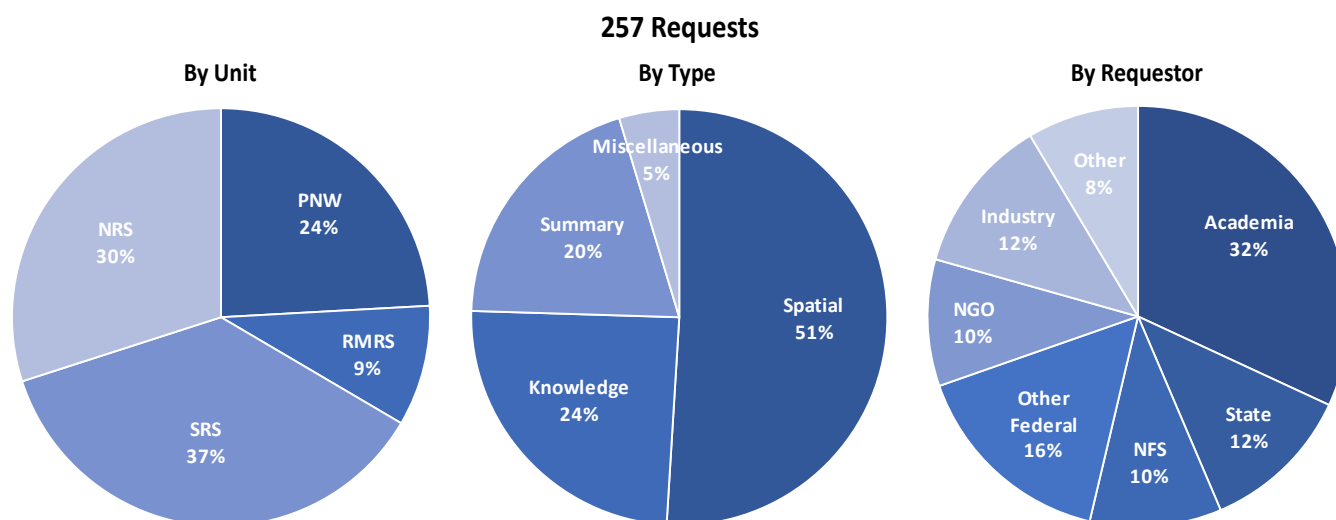
FIA = Forest Inventory and Analysis; FY = fiscal year; NFS = National Forest System; NGO = nongovernmental organization; NRS = Northern Research Station; PNW = Pacific Northwest Research Station; RMRS = Rocky Mountain Research Station; SRS = Southern Research Station.

Table 6. Number of database retrievals using FIA web applications by fiscal year, 2003–2021.

	2003–2010 (Sum)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Number of retrievals	257,323	132,413	94,027	103,211	186,175	170,407	250,559	182,732	313,380	4,456,122	1,372,090	900,055

FIA = Forest Inventory and Analysis.

partners including: the National Aeronautical and Space Administration (NASA), several Department of the Interior agencies, the Oregon Department of Forestry, the University of Washington, other universities, the Cary Institute of Ecosystem Studies, the National Forest System and other non-FIA Programs within the Forest Service such Geospatial Technology and Applications Center, the LANDFIRE program, and the Forest Health Assessment and Applied Sciences Team. An internal agreement was renewed with the Resource Planning Act Assessment Program.

FY 2021 experienced a decrease in requests for FIA data, returning to the levels seen in FY 2019—257 requests were processed (figure 13), down from 324 requests in 2020. National or multiregional data requests totaled 33, accounting for almost 14 percent of all spatial data requests.

Spatial data requests are cataloged as one of four types: spatial, summary, knowledge, or miscellaneous. Spatial requests are those where FIA spatial data are provided without additional analysis. Summary requests refer to FIA data aggregated for a specific geographic area(s). Knowledge requests require additional spatial data analysis by SDS. In FY 2021, spatial requests increased to 51 percent of requests, compared to 43 percent the previous year (figure 13). Knowledge and summary data requests decreased to 24 percent and 20 percent, respectively.

Academia continues to be SDS's largest client, with 32 percent of all new requests. Federal agencies (excluding the Forest Service) accounted for 16 percent of all requests, followed by States and industry with 12 percent each. The Forest Service National Forest System and NGOs comprised 10 percent each. Although the SRS continues to respond to the largest number of spatial data requests, 37 percent of the total (figure 13), the NRS was a close second, followed by PNW and IW.

Web Tools and Use

The FIA Program has come a long way since the FIA Database Retrieval System (DBRS) was introduced in

1996, allowing the public to query regional FIA data sets in eastwide/westwide format. Since then, a variety of web tools have been developed and retired, including the Forest Inventory Mapmaker program, developed in FY 2002 and retired in FY 2009, and the Forest Inventory Data Online (FIDO) tool, developed in FY 2008 and retired in FY 2018, making way for the next generation of data retrieval programs. In FY 2015, a new tool was developed as a partnership between the NFS and FIA, the Design and Analysis Toolkit for Inventory and Monitoring (DATIM). In FY 2021, DATIM had 3,768 retrievals and its version 15.0 was in production by the end of the fiscal year (table B-7). Other currently supported tools that allow access to the FIA data include: EVALIDator; the EVALIDator application programming interface (API), which allows users to enter hypertext markup language (HTML) to query the FIA database (FIADB); the NWOS Table Maker and NWOS Dashboard (NWOS-DASH); and the TPO tool kit. In addition, FIA provides other data access points on the Data and Tools page. These include one-page briefs on each State, datamarts for both urban and rural inventories, and spreadsheets that users can customize to obtain multiple tables in a single workbook. Users can also access My City's Trees (developed with Texas A&M Forest Service) from that page to explore the urban inventory.

Overall, the number of FIA-tool users fell in FY 2021 (table 6). The use decrease was mostly due to the changes in how the EVALIDator API is being incorporated into FIA's reporting, and the impact of the COVID-19 pandemic on universities and related research. EVALIDator API retrievals dropped in FY 2021 to just over a half million, representing half of the retrievals in FY 2020 (table B-7). This is mostly due to the COVID-19 pandemic effects on FIA reporting. This number peaked at almost 4.5 million in FY 2019 due to the high number of hits to the EVALIDator API during the development and release of FIA dashboards applications.

The number of Zip files downloaded from FIADB tables increased from over 275,000 in 2020 to 330,000 in 2021 (table B-7).

Consultations by FIA Staff

Since the earliest days of the FIA Program, consulting with the public has been a priority. In 1930, "consulting" meant face-to-face interaction with landowners and forestry professionals, or answering handwritten questions received in the mail. While the mechanism for interactions between customers and FIA representatives may have evolved, the reasons for cooperation remain the same. The amount of information (both data and analyses) made available on the web continues to increase as customers demand more and varied information from FIA data and analyses. Questions pertaining to a single administrative unit (e.g., a single State or national forest) are frequently referred to partners within that administrative unit (e.g., State foresters or National Forest System analytical staff) who can often provide better context and customer service. When questions span multiple administrative units, FIA staff assist the customer with finding an answer. FIA does not compete with private-sector consultants; rather, we answer questions about our methods and help customers (including private consultants) use FIA data to answer their own or their clients' questions.

A significant consultation is defined as any dialogue with a customer that requires more than 1 hour of FIA staff time and that is not part of the normal course of business in collecting, analyzing, and reporting FIA information. Historically, consultations have fluctuated slightly from year to year, depending on broader outside interests, while showing regional variations. Since 2006, Federal and State Government agencies have consistently remained the program's major client. Consultations from this group include any internal discussions within other Forest Service programs.

In 2021, FIA customers' inquiries decreased to below prepandemic numbers. The number of consultations decreased to almost 700, compared to 1,434 in 2020 and 950 in 2019. The associated number of consultation hours (8,285) was half the hours in 2020 (16,735) and slightly higher than 2019 (7,764). FIA specialists collectively addressed 696 consultations, which required 8,285 staff hours to complete (table 7)—this number is equal to the number of hours worked annually by 8.25 full-time equivalents, not accounting for leave, holidays, and training. Consultations with government agencies accounted for 50 percent, while other major client groups included academia (22 percent), nongovernmental organizations (11 percent), and industry (10 percent). Table B-6 shows the number of significant consultations provided by FIA staff in FY 2021, ordered by type of customer and responding unit.

Table 7. Number and hours of significant consultations by FIA staff, by customer group, FY 2021.

Customer Group	Number	Percent	Hours	Percent
Academic	152	22%	787	9%
Government	348	50%	5,969	72%
Industry	67	10%	371	4%
NGO	74	11%	407	5%
NIPF	2	0%	1	0%
Media	19	3%	106	1%
Other	34	5%	646	8%
Total	696	100%	8,285	100%

FIA = Forest Inventory and Analysis; FY = fiscal year; NGO = nongovernmental organization; NIPF = nonindustrial private forest landowner.
Note: These consultations do not include Special Data Services Center requests.

FIA Program Accomplishment Highlights for FY 2021

This section provides information on selected FIA accomplishments and outcomes throughout the country. Some of these achievements have a nationwide impact, while others are regional, but equally important. More detailed information is available from the respective FIA unit leading the effort, as shown below. (Contact information for each FIA unit also appears in appendix A.)

Development of the First Forest Resource Report for the Tanana Unit in Interior Alaska

Impact: Alaska's boreal forests span 114 million acres, representing 15 percent of total U.S. forest land. Prior to the 2016 implementation of the FIA Program in Interior Alaska, only 15 million acres of the State's forests in the coastal region were consistently inventoried. Alaska's forests play a significant role in supplying resources to local communities and sustaining global energy, water, and carbon cycles, yet the logistical challenges of installing field plots in such remote areas was cost-prohibitive. The Forest Service partnered with local communities, the State of Alaska, and NASA to leverage remote sensing innovations that allow FIA to monitor all of Alaska's forests using a subset of field plots.

Outcomes: Estimates of forest area, volume, biomass, and carbon are now available from more than 800 plots across all owners and forest types throughout the Tanana Unit of Interior Alaska. This unit covers approximately 33.4 million acres, 20.8 million acres (62 percent) of which are forest land managed mostly by State and local governments. Unique to this inventory was the incorporation of soil carbon estimates and the use of remotely sensed attributes to provide model-assisted estimates for some forest attributes. This report summarizes the main outcomes of a detailed survey of forest and nonforest conditions in a region that previously lacked a comprehensive inventory at such a scale, despite its global and regional importance.

Contacts: Sean Cahoon, sean.cahoon@usda.gov; Hans Andersen, hans.andersen@usda.gov

Links:

Publication is currently in press. The online database and associated documentation: https://www.fs.usda.gov/pnw/tools/pnw-fiadb-forest-inventory-and-analysis-databases

Additional information about the Interior Alaska inventory project: https://www.fs.usda.gov/pnw/projects/pnw-fia-interior-alaska-inventory

Processing Forest Inventory Data at 182 Million Pixels Per Second

Impact: Although the FIA Program monitors more than 350,000 plots across the United States and measures hundreds of variables, it cannot measure everything, nor can satellite imagery replace the information collected by "boots on the ground." FIA scientists developed the Big Data Mapping and Analytics Platform (BIGMAP), a spatially enabled database that reorients analysis, reporting, and knowledge delivery through a seamless workflow leveraging cloud-based computing and storage for processing thousands of Landsat images with hundreds of thousands of plots. BIGMAP employs machine learning to transform tens of trillions of pixels into authoritative, national-scale, mapped forest datasets, as well as delivery portals and outreach materials for power users and casual users alike.

Outcomes: The prototype created in a public-private partnership with Esri transitioned to a production Analytics and Decision Support (ADS) environment maintained by the CIO with funding provided by FIA and other major users. FIA is actively producing a set of 30-meter raster maps depicting current forest characteristics from the public FIA database. The agency joins NASA and NOAA in its ability to process large volumes of data and imagery and produce broad-scale mapped datasets on a reliable and regular basis. Beyond FIA, ADS supports geospatial research occurring in other agency programs. These successful collaborations with internal and external partners deliver benefits to the American people, in support of sustaining our Nation's forests and grasslands.

Contacts: BIGMAP is a multi-organization collaboration between the Forest Service-FIA Program, the Forest Service-CIO Geospatial Branch, and ESRI (the world leader in GIS) and is led by the FIA Digital Engagement portfolio.
FIA: Christopher Oswalt, christopher.oswalt@usda.gov; Ty Willson, barry.wilson@usda.gov; David Bell, david.bell@usda.gov; Chuck Werstak, charles.e.werstak@usda.gov; Hobie Perry, charles.h.perry@usda.gov; James Garner, james.garner1@usda.gov.
CIO: Eric Aiello, eric.aiello@usda.gov; Michael Rich, michael.rich2@usda.gov; Joshua Bixby, joshua.bixby@usda.gov.
ESRI: John Steffenson, Andrew Leason, Robert Richard, Greggory Brunner, James Sill, Peter Eredics, Sophia Bogner.

Figure 14. Total forest carbon for the conterminous United States.
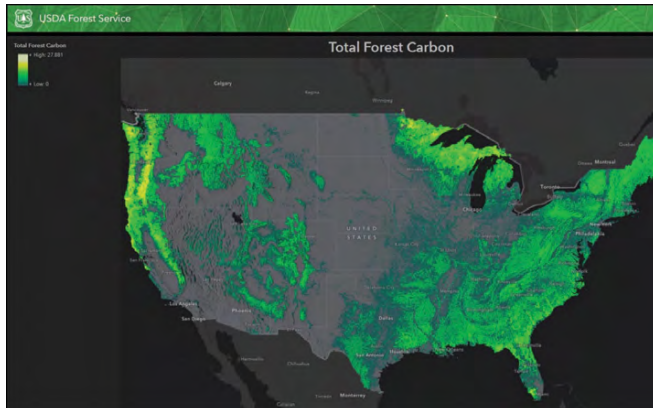
FIA = Forest Inventory and Analysis
Map layer created from FIA plot data collected 2014–2018. Access this map.

Links:

FIA Geospatial Showcase: https://fia-usfs.hub.arcgis.com

ESRI Living Atlas—BIGMAP Layers: https://livingatlas.arcgis.com/en/browse/#q=BIGMAP

Using FIA Data To Understand Habitat Requirements of a Declining Bird Species

Impact: A recent study used FIA data to assess the extent and characteristics of habitats used by pinyon jays, which are year-round inhabitants of pinyon-juniper woodlands in the Western United States. Pinyon jays have shown consistent population declines over the past several decades, despite concurrent increases in the extent of pinyon-juniper woodlands. Recent research showed how and where pinyon jays use pinyon-juniper woodlands, with the aim of identifying the characteristics of habitats that pinyon jays use for foraging, seed caching, and nesting. By combining direct observations of wildlife with FIA data collection protocols, researchers were able to extrapolate from individual habitat sites to the entire landscape.

Outcomes: Researchers used radio telemetry and direct observation to study pinyon jays in three distinct and widely separated study areas. At those sites, as well as at randomly selected control sites, they measured key vegetation attributes using FIA data collection protocols. Results showed that pinyon jays use only a subset of available pinyon-juniper habitat, and they use distinct but overlapping areas for seed caching, foraging, and nesting. Pinyon jay habitat is most concentrated in low-elevation pinyon-juniper forests that are also typical targets for woodland removal projects, which suggests that it is important to consider habitat conservation when planning woodland management projects.

Figure 15. Forest type groups for the conterminous United States.
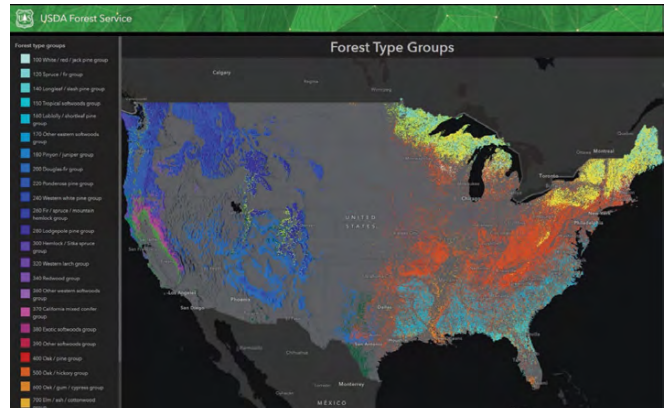
FIA = Forest Inventory and Analysis
Map layer created from FIA plot data collected 2014–2018. Access this map.

Contacts: Chris Witt, Walter.Witt@usda.gov.

Links:

Boone, J.D.; Witt, C.; Ammon, E.M. 2021. Behavior-specific occurrence patterns of pinyon jays (*Gymnorhinus cyanocephalus*) in three Great Basin study areas and significance for pinyon-juniper woodland management. PLoS ONE.16(1): e0237621. https://doi.org/10.1371/journal.pone.0237621.

Somershoe, S.G.; Ammon, E.; Boone, J.D.; Johnson, K.; Darr, M.; Witt, C.; Duvuvuei, E. 2020. Conservation strategy for the pinyon jay (*Gymnorhinus cyanocephalus*). Partners in Flight Western Working Group and U.S. Fish and Wildlife Service. https://partnersinflight.org/resources/pinyon-jay-working-group/.

Great Basin Bird Observatory, 2020. Pinyon Jay Conservation in the Great Basin. https://storymaps.arcgis.com/stories/81faacc7e0384a4da2e83cf2e44d3487.

Using Forest Inventory Plots To Improve Remotely Sensed Burn Severity Assessments

Impact: To support planning before and during fires and to assist postfire recovery, the collection of field and remotely sensed data on fire and burn severity is critical. Burn severity data are also essential for monitoring postfire recovery for carbon accounting purposes, and for assessing the probability of reburns across fire-severity classes. As the frequency and size of wildfires increase, accurate assessment of burn severity is essential to understand fire effects and evaluate postfire vegetation impacts. Remotely sensed imagery allows for rapid assessment of burn severity, and FIA data can be used for validation of those assessments.

Outcomes: This research demonstrated the use of forest inventory plots to provide burn-severity information for the field validation of remotely sensed burn-severity metrics. FIA scientists used two distinct datasets: (1) ground-based inventory data from the United States national forest inventory to calculate ground-based burn severity, and (2) remotely sensed data from the Monitoring Trends in Burn Severity (MTBS) database to calculate different remotely sensed burn-severity metrics based on six weighting scenarios. The analysis also demonstrated that weighted averages of remotely sensed metrics from Landsat can be used for other applications, such as Normalized Difference Vegetation Index (NDVI).

Contacts: Vicente Monleon, Vicente.monleon@usda.gov; Flavie Pelletier, flaviep@student.ubc.ca

Links:

> **Pelletier, F.; Eskelson, B.N.I.; Monleon, V.J.; Tseng, Y.** 2021. Using Landsat imagery to assess burn severity of national forest inventory plots. Remote Sensing. 13(10): 1935. https://doi.org/10.3390/rs13101935.

Improving the Quality of Information Available After Catastrophic Weather Events

Impact: Severe weather events are becoming more common, increasing the potential for damage and mortality in forests. Decision makers at all levels seek rapid yet reliable estimates of such damage to inform disaster funding and to guide response efforts. With its expansive network of permanent plots, FIA Program is uniquely positioned to respond to such requests.

Outcomes: In August 2020, a derecho windstorm struck Iowa and adjacent States, catastrophically damaging structures, crops, and trees. NRS-FIA cooperated with the Iowa Department of Natural Resources to produce a rapid assessment of the windstorm's impact on Iowa forestland. Field plot data combined with a poststorm aerial survey, produced an estimate of 2.7 million trees damaged or killed. FIA data allowed researchers to not only estimate the number of trees damaged and killed but also estimate volume, species affected, and damage type (branch or bole), variables not readily observable in aerial surveys. This work lays the foundation for future rapid assessments, improving access to poststorm information.

Contacts: Thomas Goff, thomas.c.goff@usda.gov; Mark D. Nelson, mark.d.nelson@usda.gov; Greg Liknes, greg.liknes@usda.gov; Scott Pugh, scott.a.pugh@usda.gov; Randall Morin, randall.s.morin@usda.gov; Tivon Feely (Iowa Department of Natural Resources), tivon.feeley@dnr.iowa.gov.

Figure 16. Derecho-damaged forestland near Cedar Rapids, IA, as seen from aerial survey plane.

Iowa Department of Natural Resources photo.

Links:

> **Goff, T.C.; Nelson, M.D.; Liknes, G.C.; Feeley, T.E.; Pugh, S.A.; Morin, R.S.** 2021. Rapid assessment of tree damage resulting from a 2020 windstorm in Iowa, USA. Forests. 12(5): 555. https://doi.org/10.3390/f12050555.

Monitoring Forest Dynamics in Real Time

Impact: Forest landscapes can change in an instant. Imagine the differences in data that would be obtained from a forest inventory conducted immediately before or immediately after a wildfire. Research underway in the FIA Program seeks to understand the dynamics of forested ecosystems through an improved understanding of the effect of time in the analysis of FIA data. Because the mistreatment of time can be the single greatest source of error in a national forest inventory, this research explores methods and models to properly consider the effects of the order of observations in the space-time continuum.

Outcomes: A series of peer-reviewed publications have explored novel approaches to the use of temporally based models in national forest inventories. These approaches have sometimes bridged the gap between the traditional sample-based estimators and model-based estimators. The latest publication in this line of research (Roesch and Schroeder 2021) shows how all of the models used in a national forest inventory can be combined with the sample design and estimation system into an overarching descriptive "wrapper" model that accounts for all sources of error.

Contacts: Francis Roesch, francis.a.roesch@usda.gov; Todd Schroeder, todd.a.schroeder@usda.gov

Links:

> **Roesch, F.A.; Schroeder, T.A.** 2021. The wrapper model for multiobjective forest monitoring systems. Forest Science. 67(3): 256–264. https://www.fs.usda.gov/treesearch/pubs/62741.

A 15-Year Partnership: The LANDFIRE and FIA Programs

Impact: Since its inception, the LANDFIRE program has used FIA data to address critical data needs for wildland fire management. LANDFIRE, like FIA, provides data of consistent quality across all lands and regions. FIA data represents 25 percent of the plots used to generate LANDFIRE's spatial data layers, including information on vegetation, land cover, wildland fuels, fire regimes, and ecological departure from historical conditions, all of which support land management decisions and wildland fire decision support systems. FIA data are particularly useful for several LANDFIRE vegetation maps and models as well as LANDFIRE fuel-loading models.

Outcomes: FIA scientists produced a story map describing the 15-year collaboration between LANDFIRE and FIA. This work recognizes the mutual benefit of this collaboration and describes recent enhancements. In 2019, LANDFIRE began releasing the new 2016 Remap base layers, which included improved plot selection, improved base imagery, more appropriate geographic production units, and incorporation of extensive reserves of lidar data. This update also mapped existing vegetation type using two approaches: ecological systems and national vegetation classification. Additionally, vegetation canopy cover and canopy height were modeled and mapped to provide continuous structural information.

Contacts: Karen Schleeweis, karen.schleeweis@usda.gov

Links:

> **Schleeweis, K.; Werstak, C.; and Toney, C.** LANDFIRE & Forest Inventory and Analysis (FIA): 15 Years of Growing Research and Partnerships. ESRI Story Map: https://storymaps.arcgis.com/stories/ce0c8da1d94a4bdcbd35f4cdf29f2a28.

> **Blankenship, K.; Swaty, R.; Hall, K.R.; Hagen, S.; Pohl, K.; Shlisky H.A.; Patton, J.; Frid, L.; Smith, J.** 2021. Vegetation dynamics models: a comprehensive set for natural resource assessment and planning in the United States. Ecosphere. 12(4): e03484. https://doi.org/10.1002/ecs2.3484.

A Web-Based Tool for Custom Small Area Estimation and Mapping of Forest Inventory Data

Impact: Expansion factors published by FIA are specifically designed to estimate the area of forest within multicounty and/or State-level areas, which are often too big to be used for watersheds, forest management units, and other specific regions that end users are most interested in. As many users of FIA data also lack the expertise to develop and apply new expansion factors, we have created a new online tool, called RegRake, that gives users the ability to develop custom, on-the-fly small area estimates simply by uploading a GIS file into a web-based interface.

Outcome: To simplify the process of delivering small area estimates to end users we have developed a map of strictly positive expansion factors that is used on the backend of a web-based application to develop on-the-fly estimates using a technique known as regularized raking. RegRake allows users to derive consistent spatial and tabular estimates for specific areas of interest without having to directly interact with the FIA database. The estimates produced maintain relatively low levels of uncertainty and scale seamlessly across domains of interest. Currently RegRake supports estimation of forest basal area, volume, and land use in South Carolina.

Contacts: Todd Schroeder, todd.schroeder@usda.gov; Joe McCollum, joseph.mccollum@usda.gov; Nicholas Nagle (University of Tennessee Knoxville), nnagle@utk.edu.

Links:

> Description of the regularized raking estimator in: **Nagle, N.N.; Schroeder, T.A.; Rose, B.A.** 2019. A regularized raking estimator for small-area mapping from forest inventory surveys. Forests. 10: 1045. https://doi.org/10.3390/f10111045.

> The beta version of the RegRake application: http://quetelet.geog.utk.edu/regrake.

Carbon Dashboard for the National Forest System

Impact: The 2012 Planning Rule directs National Forest System units to consider carbon storage and its sensitivity to forest disturbance in the development of forest plans. RMRS-FIA has collaborated with NFS, the Office of Climate and Sustainability, NASA, and NRS-FIA for a decade to provide NFS planners with nationally consistent unit-specific carbon assessments that are constrained by the same FIA data used by NFS for monitoring in other fields. A recently released carbon dashboard highlights key conclusions, facilitating their use in planning documents.

Outcomes: More than 30 national forests have already used data served through the dashboard to support forest plan revision (with more on the way). Prior to this collaboration, NFS had no unified capacity to monitor carbon. The dashboard presents carbon data for 12 categories, including multiple carbon pools, annual disturbances by type, and annual carbon accumulation. The underlying dataset quantifies historical and present-day carbon flows, as well as the carbon still stored in forest products. This tool supports assessments of the impacts of management activities on carbon and quantifies the role of NFS in sequestering and storing carbon.

Contact: Sean Healey, sean.healey@usda.gov.

Links:

Clark, N.; Brewen, J., eds. 2021. Need to manage management decisions about carbon: there is a dashboard for that. Science You Can Use Bulletin. 47(Jan-Feb). Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 14 p. https://www.fs.usda.gov/rmrs/sites/default/files/documents/SYCU_Bulletin_CarbonDashboard.pdf.

Fire and Fungi and Bugs, Oh My!

Impact: Tree damage assessments provide a wealth of information about insects, pathogens, and other factors that affect forest health. However, such assessments made by FIA have varied regionally and undergone revisions over time as information needs and technologies have evolved. Users of FIA data have noted difficulty in interpreting inventory protocols and database codes and asked for better documentation. This research addresses their appeals and is part of an ongoing effort to effectively engage a diverse public.

Outcomes: The study describes recent damages to major tree species in the United States and demonstrates the power of coupling FIA damage assessment data with aerial and terrestrial detection surveys. The resulting publication aims to help the public understand how the inventory can identify where insects, pathogens, and disturbances are damaging trees, where changes in growth and mortality are likely to be significant, and what future forest conditions may be if no management action is taken. By preserving cross-regional institutional knowledge, this work stewards past investments, stimulates current productivity, and fosters future efficiency.

Contacts: KaDonna Randolph, kadonna.c.randolph@usda.gov; Kerry Dooley, kerry.j.dooley@usda.gov; John Shaw, john.d.shaw@usda.gov; Randall Morin, randall.s.morin@usda.gov; Christopher Asaro, christopher.asaro@usda.gov; Marin Palmer, marin.palmer@usda.gov.

Links:

Randolph, K.C.; Dooley, K.; Shaw, J.D.; Morin, R.S.; Asaro, C.; Palmer, M.M. 2021. Past and present individual-tree damage assessments of the U.S. national forest inventory. Environmental Monitoring and Assessment. 193: 116. https://doi.org/10.1007/s10661-020-08796-z.

Urban Forests Count in Missouri

Impact: An inventory in three Missouri urban forests represents the first inventory of the cities' trees by FIA and offers insight into the extent and health of urban forests and their benefits to people. The Missouri data are part of urban FIA's long-term monitoring through a strategic national urban forest inventory, and these data will serve as a baseline from which future measurements will be compared. Urban FIA data for the Missouri cities and for other fully sampled cities are available for exploration on the My City's Trees interactive web app, which will eventually house data for over 100 cities across the United States.

Outcomes: These inventories of St. Louis, Kansas City, and Springfield are the first characterizations of urban forests across the Northern Research Station as part of the national Urban FIA Program that will track urban forest change over time in over 100 U.S. cities. Looking ahead, all NRS's 35 cities and urban areas across 24 States will be active in the 2022 field season. These data join other inventories in the My City's Trees application developed in partnership with the Texas A&M Forest Service. My City's Trees allows users to explore urban FIA data using various spatial themes, comparing tree characteristics and ecosystem service data.

Contacts: Mark Majewsky, mark.majewsky@usda.gov; Tonya Lister, tonya.lister@usda.gov; Lucie Lepine, lucie.lepine@usda.gov

Links:

My City's Trees: https://mct.tfs.tamu.edu/app.
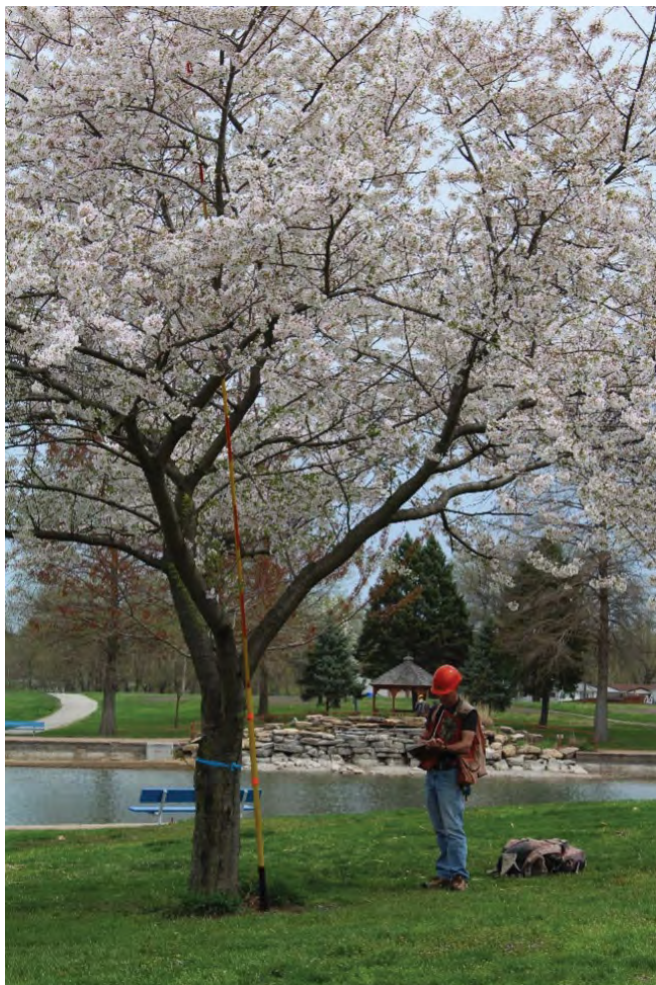
USDA Forest Service photo by Sjana Schanning

Urban FIA website: https://www.fia.fs.usda.gov/program-features/urban.

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

Collaboration Between Micronesia Conservation Trust and FIA To Measure Success of Micronesia Challenge

Impact: The four main island groups of Micronesia are part of a global biodiversity hotspot, and one of the most vulnerable in the world to extinctions. The Micronesia Challenge is an agreement initiated in 2006 by the region's political jurisdictions to conserve marine and terrestrial natural resources. The Micronesia Conservation Trust

partnered with FIA to assess the success of the challenge, measuring additional plots in special areas in Guam, as well as previously unsampled areas in the Federated States of Micronesia and the Republic of Marshall Islands. Results are used to understand the role of management based on indicators of forested areas across the region.

Outcomes: The special management areas generally exhibited more preferred forest conditions compared to unmanaged areas across Micronesia. In Guam and Federated States of Micronesia, special management areas had less forest area disturbed by people, less forest area with invasive plant species present, higher ratios of endemic to invasive tree species, and taller trees than in nonmanagement areas. In Republic of Marshall Islands, special management areas had higher basal area and more forest with higher canopy cover than in nonmanagement areas. FIA developed and shared scripts to facilitate data analysis, and the collaboration has included training and mentorship in both data collection and data analysis, with island partners teaching FIA crews about vegetation identification and ethnobotany.

Contacts: Julian Dendy, jdendy@hawaii.edu; Olaf Kuegler, olaf.kuegler@usda.gov; Ashley Lehman, ashley.d.lehman@usda.gov

Links:

Dendy, J.; Kuegler, O.; Lehman, A.; and Marquez, R. 2020. Forest status across Micronesia from an assessment of Micronesia Challenge Terrestrial Measures and Forest Inventory and Analysis Data. Micronesica. 2020-2: 1-16. https://www.fs.usda.gov/pnw/pubs/journals/pnw_2020_dendy001.pdf.

Managing the FIA Program Nationally

The national office for the FIA Program provides leadership, guidance, coordination, and oversight to FIA field units in strategy and implementing the FIA Program; seeks opportunities to advance the program mission and resources; fosters relationships, transparency, and accountability; coordinates with other Forest Service programs and Federal agencies; seeks input from clients' data needs; and represents FIA in national and international efforts. In collaboration with the field units' leadership, the national office provides strategic program direction and resource allocation to deliver the program in an efficient and effective way.

Through meetings, presentations, policy papers, briefing papers, budget justifications, and other ways to provide input and engage in national and international efforts, the national office provides liaison and strategic planning, showcases the value and impact of the program, and guides the allocation of the human and financial resources needed for the implementation of the program.

Some of the accomplishments in FY 2021 include:

- Provided strategic direction to FIA units on program priorities, budget, and national consistency to improve the overall program efficiencies and accountability.

- Worked with agency leadership to obtain additional funding, including COVID response dollars from the CARES Act, R&D funds to support plot backlog resulting from the COVID-19 pandemic and catastrophic wildfires, and targeted FIA funding to universities to work on operationalizing small area estimation techniques, national vegetation classification development efforts, support national user group and focus group meetings, and support retirees to help on business reports and historic plot measurement data.

- Continued leading implementation and oversight of policy change on agreements. Since FY 2020, the FIA Program adopted changes to protect 325,000 plot locations across 50 States and U.S. islands, landowners' personal identifiable information, nonpublic business data, and unpublished information by exclusively entering into legally binding agreements. In 2021, FIA entered into 35 new MTAs and 1 new national interagency MOA to protect FIA confidential information. Additional agreements not transferring confidential data included: 18 joint venture agreements, 11 interagency agreements, 1 international joint venture agreement, 1 participant agreement, plus 1 memorandum of understanding. In addition, the program developed the data request, agreement, and contract tracking (DRACT) tool to manage and track all FIA agreements.

- Supported developmental details for six FIA employees related to the WO to provide learning opportunities and experiences at national headquarters and station headquarters to strengthen FIA workforce. The research publication Use of Remote Sensing Data to Improve the Efficiency of National Forest Inventories: A Case Study from the United States National Forest Inventory resulted from one of these temporary work assignments.

- Provided leadership and technical expertise in support of the Trillion Trees and reforestation initiative, Black Hills National Forest requests, carbon stocks estimations in the Tongass National Forest and the rest of the country to the USDA, and other data requests related to forest disturbances, climate change research, information technology modernization, and artificial intelligence exploration.

- Created a new task team across FIA units to facilitate the development of a new national strategy for Tribal relations. The Tribal Team will provide a knowledge foundation for Tribal relations regionally and nationally and make recommendations for future strategy.

- Collaborated with the Society of American Foresters and the National Council for Air and Stream Improvement in organizing two virtual meetings: a National User Group

Timber Products Output Focus meeting in February 2021 and a FIA National Users Group meeting in June 2021. Both meetings served as a mechanism for FIA partners, users, and research collaborators to present emerging information needs, track the program accomplishments, and provide feedback on performance. The national users group meeting, with 189 virtual registrants, had 3 focus areas: (1) how the FIA Program responded to the COVID pandemic; (2) forest carbon estimation; and (3) updates on new uses of FIA data for forest management and policy decision making. The rapid advances in forest carbon estimation and its increasing importance to Federal and State policymakers created impetus for a virtual meeting focused on these topics, likely in the spring of 2022. The virtual TPO meeting, with about 135 attendees, addressed how FIA is responding to the major changes previously requested by users and stakeholders and emerging data needs.

- Provided technical expertise on forest carbon inventories and accounting by reviewing drafted legislation, producing communication products including briefing papers, contributing to an emerging carbon investment program for National Forest System, estimating the investments needed to support carbon in the FIA Program including greenhouse gas inventories, and presenting at the White House-hosted workshop on carbon and greenhouse gases.

- Due to the growing demand on carbon and climate data and expertise, a temporary research assignment position was created in the Inventory, Monitoring, and Assessment Research team, where FIA national office staff are members, at the end of the fiscal year to (1) provide science leadership to address urgent carbon-related requests, and (2) develop a strategy and operational plan to provide field leadership and research capacity to address national needs in coordination with the national office.

- Contributed to the ongoing Forest Service initiative to develop a National Monitoring Policy led by the National Forest System, an effort with nearly 35 engagement opportunities across multiple regions that reached an estimated 400 employees in FY 2021.

- Continued partner engagement through the organization of quarterly meetings with the National Management Team composed of external representatives of all U.S. regions, National Forest System, and FIA leadership to report on program progress and to seek feedback on their perspectives, concerns, and opportunities.

- Demonstrated the transparency and accountability of the program by leading the development of this report, coordinating national reporting teams, soliciting input from partners and data users, and working with the Forest Service Budget Office and unit budget officers to ensure accuracy in the FIA charges and transparency in the financial information reported. Additionally, reported program research and scientific accomplishments to the USDA Technology Transfer Annual Report.

- Provided liaison, technical expertise, and data to the Global Forest Resources Assessment conducted by the Food and Agriculture Organization of the United Nations (FAO), and FAO North American Forest Commission; improved global reporting methods of primary forest through participation in workshops and pilot projects in the boreal region; provided support to Forest Service International Programs on activities related to the FAO Committee on Forestry and other international issues.

In addition to the field units and the National FIA Program Office, FIA has a National Operations Team that provides operational coordination and support to field units. Its major responsibilities include communications, operational planning, IT budget management, liaison to the Forest Service CIO, and oversight of the data quality assurance to ensure national consistency. The major accomplishments in 2021 include:

- Developed a new change management process and standard operating procedure consistent for all FIA units as part of the program's quality assurance efforts.
- Partnered with University of Nevada, Las Vegas, and Southern Utah University to provide support in the development of FIA information management tools and 508 testing and compliance.
- Developing a new version of EVALIDator, an external tool that will deliver urban data in addition to the rest of FIA inventory data.
- Continued the development of the next version of the DATIM data delivery tool, which will allow for calculating estimations using custom units.
- Continued the development of internal data processing tools and computations systems with the universal national information management system (UNIMS).
- Upgraded the FIA4FSVeg translation tool and loaded NFS data for all regions upon request to the FSVeg database.
- Reorganized and updated the FIA Program website, which now hosts a new FIA video, updated factsheets, FIA newsletter, and a search function to query FIA publications.
- Supported FIA scientists and users in various CIO activities and IT areas, including policy exceptions to avoid hindering FIA operations, analysis, or research, application acquisition and installation, user profile management, virtual data center, and software release management.

The FY 2021 Director's Awards for FIA Excellence were given to:

- **Sara Maslen** (RMRS) for FIA Outstanding Field Service, including her exemplary work on aviation safety.
- **Charles Barnett, Elizabeth Burrill, Dale Gormanson, Mark Hatfield, Mike Maki, Dacia Meneguzzo, Charles "Hobie" Perry, Scott Pugh, Paul Sowers, Brian Walters, James Westfall, Patrick Miles, Dennis May** (NRS)**, Kyle Dodson** (RMRS)**, Robert Adams, Lynn Kolund, David Thom, and Elizabeth Stiller** for delivering outstanding customer service to national and regional partners within the National Forest System, the Black Hills National Forest (BKNF), the BKNF user community, and other clients in RMRS.
- **Tom Thompson, John Chase, Brett Davis** (PNW)**, Chris Toney, Karen Schleeweis, Justin Holgerson, Elizabeth Burrill** (NRS)**, Carol Perry, and Tracy Roof** (SRS) for their ongoing contributions to the National FIA Spatial Data Services team, exemplifying a commitment to uphold the FIA Program's high standards in research, quality assurance and control, operational efficiency, protection of data confidentiality, and customer service.
- **Sarah Ellison** (PNW)**, Hans Erik Andersen** (PNW)**, Kevin Breitenbach** (Alaska State Division of Forestry) for their contribution to operational efficiency and advancing solutions for a financially sustainable inventory in Alaska's forests.
- **Rachel Simons** (RMRS) for her outstanding contributions to data quality assurance.
- **Kate Legner** (PNW) for her outstanding service to partnerships in Alaska and finding workable solutions to invest the necessary increased funding into the State partnership while accommodating the State's annual budget limitations.
- **Donna Crone** (PNW Research Station) for her outstanding customer service and contributions to operational efficiency. Donna worked as a liaison between FIA employees and station leadership to provide safe access to the office and deliver supplies to field crews.

FIA Program Area Updates for FY 2021

Interior Alaska Inventory

The purpose of the Interior Alaska Inventory is to monitor and report on forestland experiencing rapid change in arctic regions and complete the regular survey of all forestland within the United States.

- Determine the extent and rates of change in forests at high latitudes.
- Understand the carbon flux of present and future Alaskan forests.
- Assess the potential for forest products and their role in sustaining Native communities.
- Enhance partnerships and remote sensing information to develop efficient and cost-effective monitoring strategies.

Objectives

Figure 18. Ongoing field plot progress for Interior Alaska inventory. Fly-over plots were visited via helicopter and deemed nonforest.
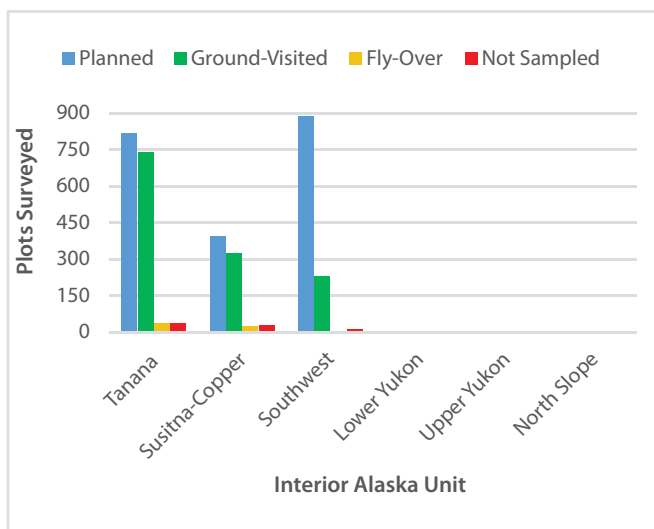
- Inventory of Tanana pilot and Tanana unit completed in 2018 (740 total ground plots measured).
- Inventory of Susitna-Copper unit completed in 2020 (329 ground plots measured).
- Data review for Tanana and Susitna-Copper units completed; data are publicly available online at the PNW-FIADB website.

- Remotely sensed data along strips covering all FIA plots in the Tanana and Susitna-Copper units captured using the NASA G-LiHT platform.
- Southwest unit data collection began in 2020 and is ongoing. Yukon and North Slope units will follow.

FY 2021 Accomplishments and Milestones

- Overcame the complex logistical challenges posed by the first completely off-the-road system. Field crews measured tree, forest, and site information on a total of 237 ground plots—approximately 27 percent of an estimated 889 field plots in the Southwest unit—during the 2020 field season (66 ground plots) and 2021 field season (171 ground plots).
- Co-led a citizen science project and engagement sessions with students and teachers at the Wrangell School and researchers based at the University of Alaska Fairbanks.
- Completed Analytical QA process for Susitna-Copper unit data and published data to PNW-FIADB.
- Released nine publications on Interior Alaska resources and inventory technique development/improvements.
- Developed a general technical report, Forest Resources of the Tanana Unit, currently in press at PNW publication shop.
- Began process of filling the recently vacant Forest Service Interior Alaska data collection coordinator. Additional forester positions hired in the Alaska Department of Natural Resources, Division of Forestry provided increased technical expertise and support for field operations.
- Made substantial progress toward reassessing the data collection strategy and timeframe in Alaska given budget and resource constraints.

Financial Status and Partners

- **Current funding:** $2.2 million from Forest Service and $494,000 from external sources
- **Full-time equivalents (FTEs):** 5 Forest Service and 12 external cooperators
- **Farm Bill request:** $3.7 million per year
- **Partnerships:** Alaska Department of Natural Resources, Division of Forestry; NASA Goddard Space Flight Center; University of Alaska

FY 2021 Publications and Deliverables

Alonza, M.; Dial, R.J.; Schulz, B.K.; Andersen, H-E.; Lewis-Clark, E.; Cook, B.D.; Morton, D.C. 2020. Mapping tall shrub biomass in Alaska at landscape scale using structure-from-motion photogrammetry and lidar. Remote Sensing of Environment. 245: 111841. https://doi.org/10.1016/j.rse.2020.111841.

Baer, K.C.; Cahoon, S.M.P.; Barrett, T.M. 2021. Disturbance in the boreal forests of Alaska. In: Barrett, T.M.; Robertson, G.C., eds. Disturbance and Sustainability in Forests of the Western United States. Gen. Tech. Rep. PNW-GTR-992. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 32–35. https://www.fs.usda.gov/research/treesearch/62126.

Dial, R.; Chaussé, P.; Allgeier, M.; Smeltz, T.S.; Golden, T.; Day, T. Wong, R.; Andersen, H-K. 2021. Estimating net primary productivity (NPP) and debris-fall in forests using lidar time series. Remote Sensing. 13(5): 891. https://doi.org/10.3390/rs13050891.

Dial R.J.; Schulz, B.; Lewis-Clark, E.; Martin, E.; Andersen, H-E. 2021. Using fractal self-similarity to increase precision of shrub biomass estimates. Ecology and Evolution 11(9): 4866–4873. https://doi.org/10.1002/ece3.7393.

Post, E.; Cahoon, S.M.P.; Kerby, J.T.; Pedersen, C.; Sullivan, P.F. 2021. Herbivory and warming interact in opposing patterns of covariation between arctic shrub species at large and local scales. Proceedings of the National Academy of Sciences. 118(6): e2015158118. https://doi.org/10.1073/pnas.2015158118.

Shoot, C.; Andersen, H-E.; Moskal, L.M.; Babcock, C.; Cook, B.D.; Morton, D.C. 2021. Classifying forest type in the National Forest Inventory context with airborne hyperspectral and lidar data. Forest Remote Sensing. 13(10): 1863. https://doi.org/10.3390/rs13101863.

Sullivan, P.F.; Brownlee, A.H.; Ellison, S.B.Z.; Cahoon, S.M.P. 2021. Comparative drought sensitivity of co-occurring white spruce and paper birch in interior Alaska. Journal of Ecology. 109(6): 2448–2460. https://besjournals.onlinelibrary.wiley.com/doi/10.1111/1365-2745.13654.

Watts, A.; Cahoon, S.; Sullivan, P. 2020. Using the past to inform the future: Alaska's changing boreal forest from a tree-ring perspective. Science Findings 230. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 5 p. https://www.fs.usda.gov/treesearch/pubs/60583.

Wurtz, T.L.; Schulz, B.K. 2021. Regional summaries: Alaska region. In: Poland, T.M.; Patel-Weynand, T.; Finch, D.M.; Ford Miniat, C.; Hayes, D.C.; Lopez, V.M., eds. Invasive Species in Forests and Rangelands of the United States: A Comprehensive Science Synthesis for the United States Forest Sector. Heidelberg, Germany: Springer International Publishing: 336–342. Appendix. https://www.fs.usda.gov/treesearch/pubs/61982.

Interior Alaska Database: https://www.fs.usda.gov/pnw/tools/pnw-fiadb-forest-inventory-and-analysis-databases.

Figure 19. FIA units in Interior Alaska.

Small Area Estimation

The purpose of the small area estimation (SAE) work is to improve the statistical precision of estimates at the sub-State level.

- Define user information needs including precision standards, delivery needs, and specific precision targets.

- Conduct SAE research to identify and test appropriate techniques and auxiliary data across a range of ecological, spatio-temporal, and thematic specifications.

- Develop and test SAE delivery tools for transfer of information to the user community.

- Identify cases better suited to project-level solutions

Objectives

Figure 20. Development status of small area estimation objectives.
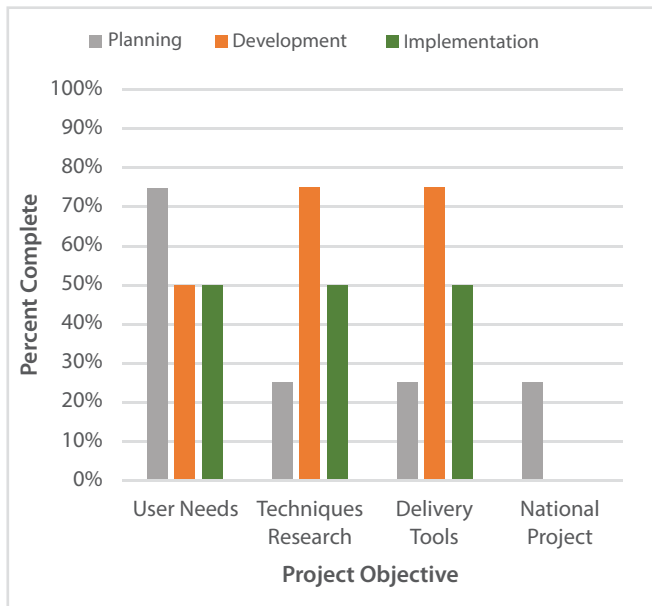
- User needs solicited at SAE Workshop, National User Group Meetings, and through special issue manuscripts.
- Combinations of numerous SAE techniques have been investigated in the special issue manuscripts and elsewhere and tested over State, regional, and national extents.
- Utility and accessibility of FIESTA, BIGMAP, r-FIA, RegRake, and other solutions have been expanded and demonstrated in the special issue and elsewhere.
- Disparity in planning for user needs and techniques research reflects the fragmented R&D activities nationally. Solutions are available but require a funded national project to move developed work into implementation. Select new portfolio leader in winter 2022.

FY 2021 Accomplishments and Milestones

- **User needs:** Accomplishments include perspective papers on NFS and private sector needs, with State papers underway.
- **Techniques research:** Accomplishments include: (1) enhancing the precision of removals estimates; (2) increasing precision of FIA growing stock using NAIP 3D photogrammetry; (3) evaluating performance of Hierarchical Bayesian SAE; (4) determining the data resolution for a modified generalized regression estimator; (5) developing a national ownership map and NWOS county-level estimates; (6) understanding uncertainty in k-nearest neighbor small area estimation across scales; (7) investigating indirect small area estimation of postfire forest regeneration; (8) developing county-level carbon estimates

for the United States; (9) testing eight alternative small area estimators for six FIA attributes for the United States.

- **Delivery tools:** Accomplishments include: (1) FIESTA's model-assisted and small area estimation modules were expanded, demonstration dashboards developed nationally for ecosubsections/counties/watersheds, FIESTA-BIGMAP and FIESTA-desktop delivery advances; (2) Esri accelerated its support of BIGMAP with supplemental access to Amazon Web Services, and the BIGMAP team demonstrated the integration of published SAE methods related to kNN estimation using the R-ArcGIS Bridge; (3) RegRake methodology demonstrated via a dashboard in South Carolina.

Financial Status and Partners

The portfolio currently tracks numerous SAE-related projects funded primarily by their home units and collaborators. Participating organizations:

- **USDA Forest Service:** NRS, RMRS, SRS, PNW, Geospatial Technology and Applications Center, Regions 1–4
- **Universities:** Virginia Tech, Reed College, Missouri State University, Oregon State University, University of Missouri, University of Tennessee, Swarthmore College, Michigan State University, University of Montana, Colby College
- **Industry/Other:** Red Castle Resources, Esri, National Council for Air and Stream Improvement

FY 2021 Publications and Deliverables

Coulston, J.W.; Green, P.C.; Radtke, P.J.; Prisley, S.P.; Brooks, E.B.; Thomas, V.A.; Wynne, R.H.; Burkhart, H.E. 2021. Enhancing the precision of broad-scale forestland removals estimates with small area estimation techniques. Forestry: An International Journal of Forest Research. 94(3): 427–441. https://doi.org/10.1093/forestry/cpaa045.

Guldin, R.W. 2021. A systematic review of small domain estimation research in forestry during the 21st century from outside the United States. Frontiers in Forests and Global Change. https://doi.org/10.3389/ffgc.2021.695929.

Lister, A.J.; Andersen, H.; Frescino, T.; Gatziolis, D.; Healey, S.; Heath, L.S.; Liknes, G.C.; McRoberts, R.; Moisen, G.G.; Nelson, M.; Riemann, R.; Schleeweis, K.; Schroeder, T.A.; Westfall, J.; Wilson, B.T. 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): 1364. 41 p. https://doi.org/10.3390/f11121364.

Moisen, G.G.; Coulston, J.W.; Prisley, S.; Wilson, B.T.; Radtke, P.J. 2021. Small area estimation in forest inventories: new needs, methods and tools. Research Topic Area. Frontiers in Forests and Global Change. https://www.frontiersin.org/research-topics/16045/small-area-estimation-in-forest-inventories-new-needs-methods-and-tools#articles.

Presentations, discussions, and recommendations from the National User Group SAE Focus sessions are available online: https://www.eforester.org/Main/Advocacy_and_Outreach/Main/Issues_and_Advocacy/Issues_And_Policy_Overview.aspx.

Dashboard of small area estimates for CONUS: Counties: https://fia-dash.shinyapps.io/fiesta-counties.

Dashboard of small area estimates for CONUS: Ecosubsections: https://fia-dash.shinyapps.io/fiesta-subsections.

Dashboard of small area estimates for CONUS: Watersheds: https://fia-dash.shinyapps.io/fiesta-watersheds.

Figure 21. Small Area Estimation Dashboard: proportion of forest land by county.
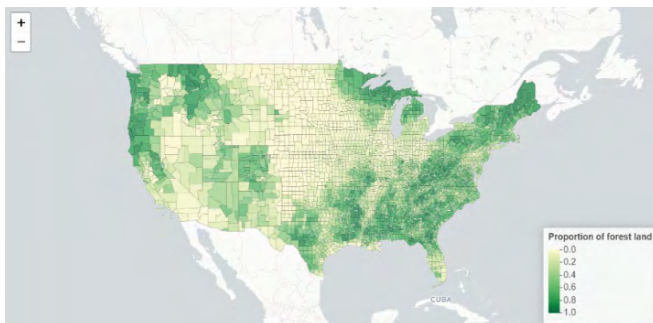
Carbon

The purpose of FIA work on carbon is to advance the science, monitoring, and reporting of greenhouse gas emissions and removals on land with trees in the United States.

- Estimation and accounting compilation systems and tools.
- Carbon pool science (including harvested wood products).
- Leverage FIA remeasurements and auxiliary information for change estimation and attribution across scales.
- Inform carbon management, mitigation, and adaption activities.

Objectives

- Grow FIA contributions to the National Inventory Report and other reporting instruments and efforts.
- Develop more spatially and temporally resolved estimates to inform entity, State, and national assessments, as well as management, mitigation, and adaption activities.
- Employ new RPA projection modeling framework.
- Be more entrepreneurial—expand partners.
- Improve collaboration/cooperation between regions, bands, and portfolios to facilitate reporting consistency, reduce redundancies, and ensure regional applicability.

FY 2021 Accomplishments and Milestones

- Contributed the Forest Land, Woodlands, Harvested Wood Products, and Urban Tree components of the 2021 National Inventory Report (NIR) of greenhouse gas emissions and sinks.
- Included State-level disaggregation in the 2021 Resource Update on FIA contributions to NIR with research datasets.
- Contributed to State-level greenhouse gas inventories (CA, OR, WA, WV, VT, SC, NH, NY, ME, MN, CO, and the list is growing).
- Conducted PNW Carbon Dynamics Project and regional follow-up efforts on HWPs, modeling, and coproduction.
- Continued to lead and contribute to USGCRP reports and reviews (IPCC AR6 review, NCA5, Decadal Survey) and Committee on Earth Observation Satellites activities (e.g., biomass estimation, global stocktake).
- Led the land representation of the United States as part of the 2022 NIR in cooperation with the land use and land cover portfolio.
- Continued leading and contributing to research and applications on nature-based climate solutions.
- Disaggregated harvested wood products estimates for States and regions.
- Contributed to updates on the U.S. nationally determined contribution as part of reentry in the Paris Climate Agreement.
- Created many refereed publications (20+), invited presentations (20+), and organized sessions in FY 2021 documenting advances (e.g., pool science, estimation, modeling, tool development, and applications of FIA data in carbon science and management).

Figure 22. Estimated annual emissions and removals from forest land remaining forest land by carbon pool for each of the conterminous 48 States and Alaska in 2019 (MMT CO$_2$ Eq.).

CO$_2$ = carbon dioxide; Eq. = equivalent; MMT = million metric tons.
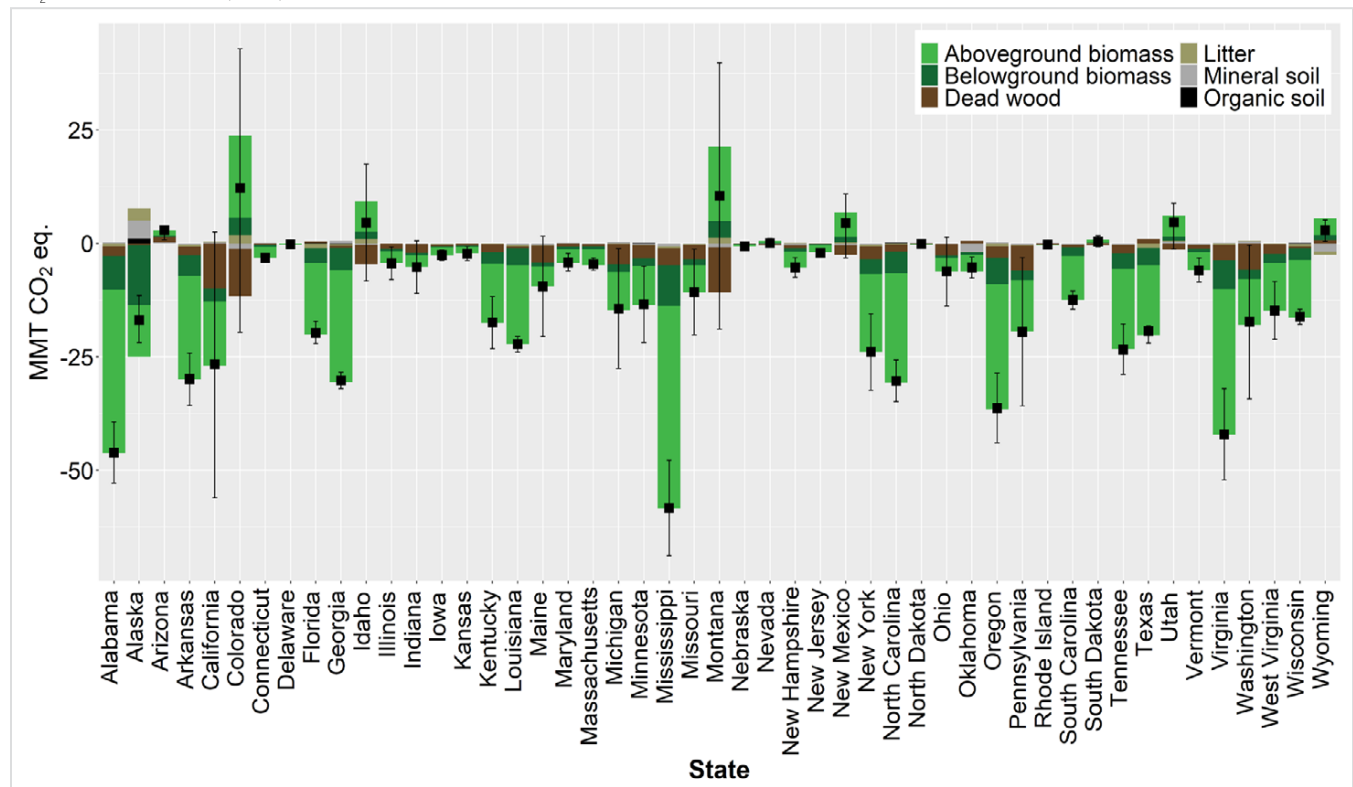
Financial Status and Partners

- **Current funding and capacity for FIA Program carbon activities:** Internal: $1.2+ million (includes Forest Service salaries); external: $2 million+ (NASA, EPA, California Air Resources Board, States, WO); FTE: 9 Forest Service, 10+ cooperators

- **Stakeholders and Partners:** UMN, CSU, Purdue University, MSU, VT, UF, United Nations Framework Convention on Climate Change, U.S. Environmental Protection Agency, Council on Environmental Quality, IPCC, Department of State, NASA, U.S. States, National Council for Air and Stream Improvement, NFS, California Air Resources Board, voluntary carbon registries, American Forests, among many other nongovernment organizations, scientists, policymakers, land managers

FY 2021 Publications and Deliverables

Domke, G.M.; Oswalt, S.N.; Walters, B.F.; Morin, R.S. 2021. Tree planting has the potential to increase carbon sequestration capacity of forests in the United States. Proceedings of the National Academy of Sciences. 117(40): 24649–24651. https://www.pnas.org/doi/10.1073/pnas.2010840117.

Domke, G.M.; Walters, B.F.; Nowak, D.J.; Smith, J.; Nichols, M.C.; Ogle, S.M.; Coulston, J.W.; Wirth, T.C. 2021. Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990–2019. Resource Update FS-307. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 5 p. [plus 2 appendixes].https://doi.org/10.2737/FS-RU-307.

Fitz, L.A.; Russell, M.B.; Domke, G.M.; Knight, J.K. 2021. Modeling land use change and forest carbon stock changes in temperate forests in the United States. Carbon Balance and Management. 16:20. https://cbmjournal.biomedcentral.com/articles/10.1186/s13021-021-00183-6.

Hou, Z.; Domke, G.M.; Russell, M.B.; Coulston, J.W.; Nelson, M.D.; Xu, Q; McRoberts, R.E. 2021. Updating annual state- and county-level forest inventory estimates with data assimilation and FIA data. Forest Ecology and Management. 483(Series D): 118777. 9 p. https://doi.org/10.1016/j.foreco.2020.118777.

Menlove, James; Healey, Sean P. 2020. A comprehensive forest biomass dataset for the USA allows customized validation of remotely sensed biomass estimates. Remote Sensing. 12(24): 4141. https://www.fs.usda.gov/treesearch/pubs/63383.

Nave, L.E.; DeLyser, K.; Domke, G.M.; Janowiak, M.K.; Ontl, T.A.; Sprague, E.; Walters, B.F.; Swanston, C.W. 2021. Land use and management effects on soil carbon in U.S. Lake States, with emphasis on forestry, fire, and reforestation. Ecological Applications. 31(6): e02356. https://www.nrs.fs.usda.gov/pubs/62910.

Nichols, M.C.; Morgan, T.A.; Christensen, G.; Tase, N. 2020. Estimated carbon stored in harvested wood products in Washington, USA: 1906 – 2018. Olympia, WA: Washington Department of Natural Resources. 31 p. https://www.dnr.wa.gov/publications/em_wa_carbon_121420.pdf.

Stanke, H.; Finley, A.O.; Domke, G.M.; Weed, A.S.; MacFarlane, D.W. 2021.Over half of Western United States' most abundant tree species in decline. Nature Communications. 12(1): 451-. https://doi.org/10.1038/s41467-020-20678-z.

Stanke, Hunter; Finley, Andrew O.; Domke, Grant M. 2021. Chapter 7 - Advancing broad-scale forest health evaluation and monitoring with rFIA. In: Potter, K.M.; Conkling, B.L., eds. Forest health monitoring: national status, trends, and analysis 2020. Gen. Tech. Rep. SRS-261. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 143–154. https://www.nrs.fs.usda.gov/pubs/62836.

U.S. Environmental Protection Agency. 2021. Land use, land-use change, and forestry In: Inventory of U.S. Greenhouse Gas Emissions and Sinks. EPA 430-R-21-005. Washington, DC: 6-1–6-148. Chapter 6. https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-chapter-6-land-use-land-use-change-and-forestry.pdf.

Woodall, C.W.; Fraver, S.; Oswalt, S.N.; Goeking, S.A.; Domke, G.M.; Russell, M.B. 2021. Decadal dead wood biomass dynamics of coterminous US forests. Environmental Research Letters. 16(10): 104034. 14 p. https://doi.org/10.1088/1748-9326/ac29e8.

Xu, L.; Saatchi, S.S.; Yang, Y.; Yu, Y.; Pongratz, J.; Bloom, A.A.; Bowman, K.; Worden, J.; Liu, J.; Domke, G.; McRoberts, R.D.; Woodall, C.; Nabuurs, G-J.; De-Miguie, S.; Keller, M.; Harris, N.; Maxwell, S.; Schimel, D. 2021. Changes in global terrestrial live biomass over the 21st century. Science Advances. 7(27): eabe9829. https://www.science.org/doi/10.1126/sciadv.abe9829.

Zhang, Yulong; Song, Conghe; Hwang, Taehee; Novick, Kimberly; Coulston, John W.; Vose, James; Dannenberg, Matthew P.; Hakkenberg, Christopher R.; Mao, Jiafu; Woodcock, Curtis E. 2021. Land cover change-induced decline in terrestrial gross primary production over the conterminous United States from 2001 to 2016. Agricultural and Forest Meteorology. 308-309(9): 108609- https://www.srs.fs.usda.gov/pubs/62892.

Changes in Land Use and Land Cover

FIA analysis of land use and land cover (LULC) focuses on three goals:

- Help FIA leverage its unique dataset to fulfill the mandate to lead national LULC monitoring.

- Create a forum for FIA LULC experts to coordinate research within and outside of the program.

- Maintain communication between LULC researchers and FIA leadership.

Objectives

Figure 23. Landscape Change Monitoring System, launched January 2021. https:// apps.fs.usda.gov/lcms-viewer
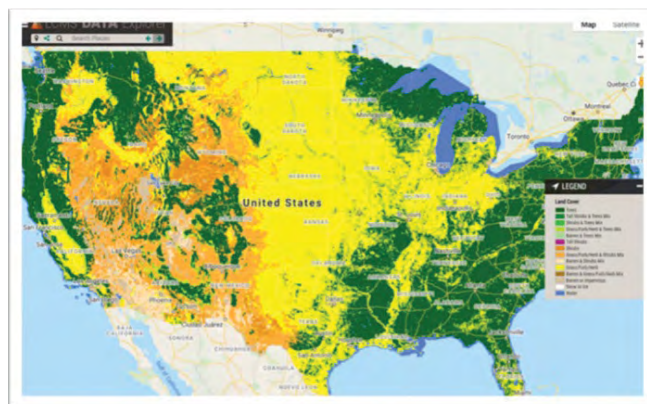
- Increase consistency between ICE (Image-based Change Estimation) and FIA by developing an ICE data collection tool that accesses the latest field- and prefield-based FIA LULC calls.

- Explore access to ICE data for FIA analysts through National Information Management System (NIMS).

- Develop a dashboard that centralizes access to FIA land-use, cover, and change estimates down to the county level.

- A version of the ICE data collection tool that explicitly links ICE observations to past FIA field observations designed by a cross-band, cross-region team working with Geospatial Technology and Applications Center (GTAC).

- A dashboard centralizing land use and land-use change estimates from FIA's core measurements designed by a cross-band, cross-region team working with GTAC.

- Summary of the history of remote sensing to improve FIA efficiency (Lister et al. 2020).

- Summary of forest area change across the United States, 2000–2016 (Riitters et al. 2020).

- Report of results of the LULC Georgia pilot (Moisen et al. 2020) provided to the management team.

- Release of the Landscape Change Monitoring System (LCMS) app. LCMS includes annual (1985–present) maps of land cover, land use, disturbance, and recovery across the United States.

- Map of land-cover class change in eight African countries, 2000–2019, in partnership with NASA and the U.S. Agency for International Development (Bullock et al., 2021).

Financial Status and Partners

The portfolio currently tracks numerous LULC-related projects funded primarily by their home units and collaborators. Participating organizations:

- **USDA Forest Service:** NRS, RMRS, SRS, PNW, GTAC, NFS

- **Universities:** Oregon State University, University of Wisconsin, University of Maryland

- **Industry/Other:** Google; Planet Labs; NASA

FY 2021 Publications and Deliverables

Bullock, E.L.; Healey, S.P.; Yang, Z.; Oduor, P.; Gorelick, N.; Omondi, S.; Ouko, E.; Cohen, W.B. 2021. Three decades of land cover change in East Africa. Land 10(2): 150. https://www.mdpi.com/2073-445X/10/2/150.

Hou, Z.; Domke, G.M.; Russell, M.B.; Coulston, J.W.; Nelson, M.D.; Xu, Q.; McRoberts, R.E. 2021. Updating annual state- and county-level forest inventory estimates with data assimilation and FIA data. Forest Ecology and Management. 483: 118777. https://www.sciencedirect.com/science/article/pii/S0378112720315462.

Lister, A.J.; Andersen, H.; Frescino, T.; Gatziolis, D.; Healey, S.; Heath, L.S.; Liknes, G.C.; McRoberts, R.;

Moisen, G.G.; Nelson, M.; Riemann, R.; Schleeweis, K.; Schroeder, T.A.; Westfall, J.; Wilson, B.T. 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): 1364. https://doi.org/10.3390/f11121364.

Moisen, G.G.; McConville, K.S.; Schroeder, T.A.; Healey, S.P.; Finco, M.V.; Frescino, T.S. 2020. Estimating land use and land cover change in North Central Georgia: Can remote sensing observations augment traditional forest inventory data? Forests. 11(8): 856. https://www.mdpi.com/1999-4907/11/8/856.

Nelson, M.D.; Garner, J.D.; Tavernia, B.G.; Stehman, S.V.; Riemann, R.I.; Lister, A.J.; Perry, C.H. 2021. Assessing map accuracy from a suite of site-specific, non-site specific, and spatial distribution approaches. Remote Sensing of Environment. 260: 112442. https://www.sciencedirect.com/science/article/pii/S0034425721001607.

Randolph, K.C.; Dooley, K.; Shaw, J.D.; Morin, R.S.; Asaro, C.; Palmer, M.M. 2021.Past and present individual-tree damage assessments of the US national forest inventory. Environmental Monitoring and Assessment. 193(3): 1–18. https://link.springer.com/article/10.1007/s10661-020-08796-z.

Riitters, K.; Schleeweis, K.; Costanza, J. 2020. Forest area change in the shifting landscape mosaic of the continental United States from 2001 to 2016. Land. 9(11): 417. https://www.mdpi.com/2073-445X/9/11/417.

Shoot, C.; Andersen, H.-E.; Moskal, L.M.; Babcock, C.; Cook, B.D.; Morton, D.C. 2021. Classifying forest type in the National Forest Inventory context with airborne hyperspectral and lidar data. Remote Sensing. 13(10): 1863. https://www.mdpi.com/2072-4292/13/10/1863.

Landscape Change Monitoring System Tool and Description:https://apps.fs.usda.gov/lcms-viewer.

Forest Ecosystem Health Indicators

The purpose of collecting a suite of forest health indicators in FIA inventory is to quantify complex forest ecosystem processes. These indicators are: crown condition, tree damage, tree mortality, down woody materials, vegetation profile, soil quality, lichen communities, nonnative invasive plants, regeneration and browse impacts, and fragmentation. At minimum, each indicator is assessed on approximately 7 percent to 25 percent of the standard plot grid with a set of

national protocols that are "core" to the indicator program. The intensity of implementation can vary by region based on budget fluctuation. In addition, indicators can be sampled at a variety of intensities including on all plots (e.g., the Vegetation Profile and Down Woody Materials indicators in the Western United States).

Objectives

Figure 24. Development status of forest health indicators objectives.
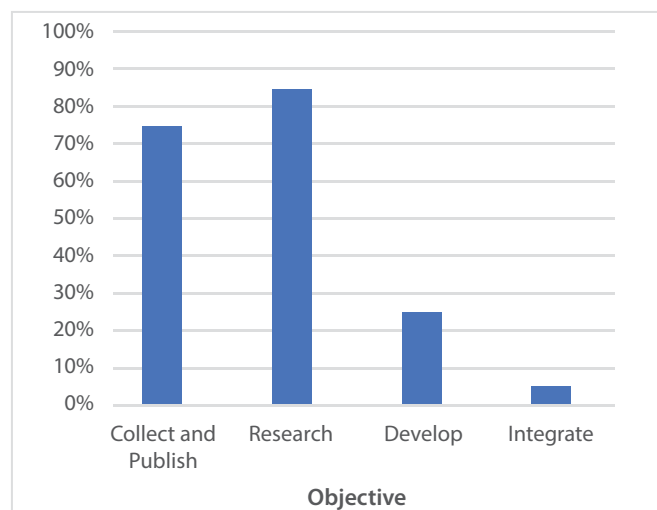
- Collect and publish health indicator data to FIADB annually from each State and contribute indicator analyses to FIA reports.
- Provide research, technical assistance, and tool support for health indicator data access and analyses conducted by partners and users.
- Develop health indicator data with BIGMAP and other online digital tools to help facilitate better access and utility and access for users.
- Integrate FIA health indicator data with forest health data from State and Federal programs.

FY 2021 Accomplishments and Milestones

- Caught up on some pandemic-related delays in data collection with publication of around 75 percent of health indicator data to FIADB for 2019 and 2020 field measurements. Some backlog remains.
- Continued to conduct meaningful science, engage with important partners such as universities and the Forest Service's National Forest System deputy area, publish data and reports related to forest ecosystem health, and assist users with data access and analysis.

- Deployed a variety of online tools that provide interactive data visualizations focused on health indicators; many other tools are in development.
- Initiated an Integration Team with broad membership to increase communication between the FIA and the Forest Health Monitoring programs, improve data alignment and dissemination, and develop integrated services for the public.

Financial Status and Partners

- **Current funding:** The collection of forest health indicators is part of the core function of national FIA Program—no additional funds are allocated to this task. Some of the publications on this topic resulted from individually funded studies.
- **Partnerships:** State, local, and regional forestry agencies, universities, and other Forest Service deputy areas, programs, and teams, including the National Forest System, Forest Health Protection, Forest Health Monitoring, and the Forest Health Applications Applied Sciences Team.

FY 2021 Publications and Deliverables

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Barrett, T.M.; Robertson, G.C. 2021. Disturbance and sustainability in forests of the Western United States. Gen Tech. Rep. PNW-GTR-992. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 231 p. https://www.fs.usda.gov/research/treesearch/62126.

Boone, J.D.; Witt, C.; Ammon, E.M. 2021. Behavior-specific occurrence patterns of pinyon jays (Gymnorhinus cyanocephalus) in three Great Basin study areas and significance for pinyon-juniper woodland management. PLOS One. 16(1): e0237621. https://www.fs.usda.gov/treesearch/pubs/62071.

Brandeis, T.J.; Brandeis, C. 2021. Assessing tree mortality probability in harvested hardwood stands using long-term forest inventory data. Forest Science. 67(2): 231–240. https://www.srs.fs.usda.gov/pubs/62588.

Fajvan, M.A.; Morin, R.S. 2021. Spatial distribution of Chesapeake Bay riparian hemlock forests threatened by hemlock woolly adelgid. Journal of Forestry 119(3): 219–228. https://www.nrs.fs.usda.gov/pubs/62470.

Geiser, L.H.; Root, H.; Smith, R.J.; Jovan, S.E.; St Clair, L.; Dillman, K.L. 2021. Lichen-based critical loads for deposition of nitrogen and sulfur in US forests. Environmental Pollution. 291: 118187. https://pubmed.ncbi.nlm.nih.gov/34563846.

Goeking, S.A.; Windmuller-Campione, M.A. 2021. Comparative species assessments of five-needle pines throughout the Western United States. Forest Ecology and Management. 496: 119438. https://www.fs.usda.gov/treesearch/pubs/62781.

Goff, T.C.; Nelson, M.D.; Liknes, G.C.; Feeley, T.E.; Pugh, S.A.; Morin, R.S. 2021. Rapid assessment of tree damage resulting from a 2020 windstorm in Iowa, USA. Forests 12(5): 555. https://doi.org/10.3390/f12050555.

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Jovan, S.; Haldeman, M.; Will-Wolf, S.; Dillman, K.; Geiser, L.; Thompson, J.; Stone, D.; Hollinger, J. 2021. National atlas of epiphytic lichens in forested habitats of the United States. Gen. Tech. Rep. PNW-GTR-986. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 96 p. https://www.fs.usda.gov/treesearch/pubs/63620.

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Looney, C.E.; D'Amato, A.W.; Jovan, S. 2021. Investigating linkages between the size-growth relationship and drought, nitrogen deposition, and structural complexity in Western U.S. forests. Forest Ecology and Management 497(40): 119494. https://www.fs.usda.gov/treesearch/pubs/62789.

Oswalt, S.; Oswalt, C.; Crall, A.; Rabaglia, R.; Schwartz, M.K.; Kerns, B.K. 2021. Inventory and monitoring of invasive species. In: Poland, T.M.; Patel-Weynand, T.; Finch, D.M.; Miniat, C.F.; Hayes, D.C.; Lopez, V.M. eds. Invasive Species in Forests and Rangelands of the United States: A Comprehensive Science Synthesis for the United States Forest Sector. Heidelberg, Germany: Springer International Publishing: 231–242. Chapter 10. https://doi.org/10.1007/978-3-030-45367-1_10.

Peltier, D.M.P.; Guo, J.; Nguyen, P.; Bangs, M.; Wilson, M.; Samuels-Crow, K.; Yocom, L.L.; Liu, Y.; Fell, M.K.; Shaw, J.D.; Auty, D. Schwalm, C.; Anderegg, W.R.L.; Koch, G.W.; Litvak, M.E.; Ogle, K. 2021. Temperature memory and non-structural carbohydrates mediate legacies of a hot drought in trees across the southwestern USA. Tree Physiology. 42: 71–85. https://www.srs.fs.usda.gov/pubs/63059.

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Puhlick, J.J.; Laughlin, D.C.; Moore, M.M.; Sieg, C.H.; Overby, S.T.; Shaw, J.D. 2021. Soil properties and climate drive ponderosa pine seedling presence in the southwestern USA. Forest Ecology and Management. 486: 118972. https://www.fs.usda.gov/treesearch/pubs/62195.

Randolph, K.C.; Dooley, K.; Shaw, J.D.; Morin, R.S.; Asaro, C.; Palmer, M.M. 2021. Past and present individual-tree damage assessments of the US national forest inventory. Environmental Monitoring and Assessment. 193: 116. https://www.srs.fs.usda.gov/pubs/62179.

Root, H.T.; Jovan, S.; Fenn, M.; Amacher, M.; Hall, J.; Shaw, J.D. 2021. Lichen bioindicators of nitrogen and sulfur deposition in dry forests of Utah and New Mexico, USA. Ecological Indicators. 127: 107727. https://www.fs.usda.gov/psw/pubs/62424.

Rosson, J., Jr. 2021 Arkansas's forests, 2020: annual update. RU FS-321. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 4 p. https://www.fs.usda.gov/treesearch/pubs/62956.

Smith, R.J.; Gray, A.N.; Swanson, M.E. 2020. Peak plant diversity during early forest development in the Western United States. Forest Ecology and Management. 475: 118410. https://www.fs.usda.gov/treesearch/pubs/63052.

U.S. EPA 2020. Metrics for national and regional assessment of aquatic, marine, and terrestrial final ecosystem goods and services (FEGS). EPA/645/R-20/002. Washington, DC: Environmental Protection Agency. 95 p. (report chapter) https://www.epa.gov/eco-research/final-ecosystem-goods-and-services-fegs-metrics-report.

Ward, S.F.; Liebhold, A.M.; Morin, R.S.; Fei, S. 2021. Population dynamics of ash following emerald ash borer invasion. Forest Ecology and Management. 479(2): 118574. https://www.nrs.fs.usda.gov/pubs/61053.

Forest health data dashboards:

Emerald ash borer ESRI dashboard 2019: https://usfs.maps.arcgis.com/apps/dashboards/69cb39e148a64567822f6722a4fa49a8.

Beech bark disease ESRI dashboard 2019: https://usfs.maps.arcgis.com/apps/dashboards/1e2f7343585b4a34b522a453b499e9de.

Hemlock woolly adelgid dashboard 2019: https://usfs.maps.arcgis.com/apps/dashboards/ab0c572409554d0fa6167bbd8661feaf.

NRS Regeneration dashboard 2019: https://usfs.maps.arcgis.com/apps/dashboards/e8eefa0094e24af6a290db37dccdde32.

National crown health dashboard 2019: https://public.tableau.com/views/FIATreeCrownHealthDashboard2019/Dashboard1?:showVizHome=no.

National tree damage dashboard 2019: https://public.tableau.com/views/damage_dashboard_east_us/Dashboard1?:showVizHome=no.

NRS invasive plants dashboard 2019: https://public.tableau.com/views/NRS-FIAIPS2019/IPS_d?:showVizHome=no.

Urban Inventory

The purpose of the FIA urban work is to implement an annualized inventory of trees in urban settings, including the status and trends of trees and forests, and assessments of their ecosystem services, values, health, and risk of pests and disease, according to the 2014 Farm Bill §8301.

Links:

- Urban FIA: https://www.fia.fs.usda.gov/program-features/urban/.

- Implementation Map: https://www.fia.fs.usda.gov/program-features/urban/docs/UFIA_cities_combo_map_09212021v2.pdf.
- My City's Trees App: https://mct.tfs.tamu.edu.
- DataMart: https://apps.fs.usda.gov/fia/datamart/datamart.html
- Briefing paper: https://www.fia.fs.usda.gov/program-features/urban/docs/urban-fia-briefing-paper-2021.pdf.

Objectives

Figure 25. Status of implementing urban inventories.
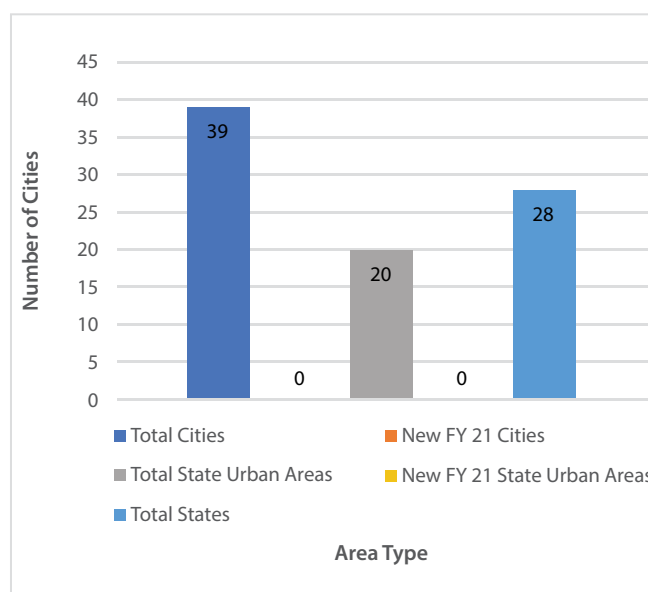
Figure 26. Availability of urban inventory data.

Figure 27. Urban FIA Program: cities and urban areas.

FY 2021 Accomplishments and Milestones

Recent Accomplishments:

- **Data Collection**
  - Upgraded to Field Guide 9.1, and achieved efficiencies through modeling Foliage Absent and Crown Width data.
  - Developed and conducted national virtual training.
  - Completed 90 percent of FY 2020/21 pandemic plots in FY 2021.

- **IM/Data Processing**
  - Published six cities in the DataMart.
  - Achieved intensification in four new cities; reviewed 90 percent of data.
  - Recognized improvements to workflows with release of UNIMS 1.5.

- **Analysis**
  - Sent San Diego report sent to publications shop.
  - Completed draft version of reporting template.

Objectives & Milestones:

- **Data Collection**
  - Develop and implement a "new contractor/partner" outreach plan for data collection.
  - Develop nine "shovel ready" cities for future funding.

- **IM/Data Processing**
  - Publish data for eight additional cities in the DataMart.
  - Develop an Urban EVALIDator with population estimates. Publish population estimate users guide.
  - Initiate work on Urban GRMs.

- **Analysis**
  - Finalize reporting template and start eight city reports.
  - Stand up and start seven additional city reporting teams.

Financial Status and Partners

- **Current funding:** Currently funded: $2,961,168. Shortfall: $6,663,184. Cooperator/Added Value: $390,913

- **FTEs:** Estimated need for about 78 FTEs spread across multiple business models in each region at full implementation

- **Farm Bill request:** Total estimated cost $9,624,352

- **Partnerships:** Texas, Maine, and New Jersey Forest Service; Wisconsin and Minnesota Department of Natural Resources; University of New Hampshire; Portland, OR; Davey Tree Expert Company; Washington, DC Urban Forestry Division; Missouri Department of Conservation

FY 2021 Publications and Deliverables

See figure 27 and table 8.

Table 8. Urban FIA plots by State and metro/urban area, FY 2021.

State	Metro/Urban area	Number of measured plots	Number of plot meassurements used in urban estimations[1]	Number of cities and urban areas
CA	San Diego	12	12	1
CT	Bridgeport, urban areas	97	113	2
DC	Washington	38	38	1
DE	Dover, Philadelphia (PA), urban areas	42	51	3
IA	Des Moines, urban areas	67	74	2
IL	Chicago, St. Louis (MO), urban areas	144	205	3
IN	Chicago (IL)	8	8	1
KS	Wichita, Kansas City (MO)	45	45	2
MA	Boston, Providence (RI), urban areas	84	112	3
MD	Baltimore, Washington (DC), urban areas	81	111	3
ME	Portland, urban areas	65	73	2
MI	Detroit, urban areas	73	90	2
MN	Minneapolis, Fargo (ND), urban areas	183	271	4
MO	Kansas City, Springfield, St. Louis, urban areas	177	204	4
ND	Fargo, urban areas	32	33	2
NE	Lincoln	53	53	1
NH	Manchester, Boston (MA), urban areas	28	34	3
NJ	Trenton, New York (NY), Philadelphia (PA), urban areas	54	81	4
NY	Buffalo, New York, Rochester	169	169	3
OH	Cleveland, Columbus, Toledo, urban areas	192	229	4
OR	Portland	17	17	1
PA	Philadelphia, Pittsburgh	99	99	2
RI	Providence	55	55	1
SD	Sioux Falls, urban areas	61	64	2
TX	Austin, Fort Worth, Houston, San Antonio	158	158	4
VA	Washington (DC)	30	30	1
VT	Burlington, urban areas	37	38	2
WA	Portland (OR)	2	2	1
WI	Madison, Milwaukee, Chicago (IL), urban areas	336	451	4
WV	Morgantown, Washington (DC), urban areas	52	54	3
Total		**2,491**	**2,974**	**71**

[1] Measurements from plots located within overlapping urban boundaries are used in estimations of both areas. Therefore, the total number of times the plot data is used to calculate urban estimations is greater than the total number of measured urban plots.

i-Tree

The purpose of i-Tree is to provide a state-of-the-art, peer-reviewed software suite that delivers urban and rural forestry analysis and benefits assessment tools worldwide. These tools allow people from across the world the ability to assess and quantify the values provided by their local trees and forests, as well as risks to forest health. Since 2006, there have been almost 420,000 users in 149 countries. These tools form the foundation on which the entire tree equity conversation takes place. The primary focus of the program is to provide user supported tools promoting the latest science in support of managing urban forests and the communities that depend on the benefits that these forests provide.

Links:

• i-Tree software suite: https://www.itreetools.org.

Objectives

• **Lead in the delivery of tools** supported by the latest science that will continue to drive, promote, and support the tree equity and environmental justice conversation and associated programs while serving as the international urban forest management standard.

• **Customer service** Expanding existing user base at the local level enabling potential users to advocate for their local urban forests from where they are regardless of their

level of familiarity of urban forest science. Tool design, delivery, and output will meet the needs of both new and experienced users.

• **Free user support** and the **development of free training** to enhance tool usability for all users regardless of background and experience

Figure 28. Development status of i-Tree user base.
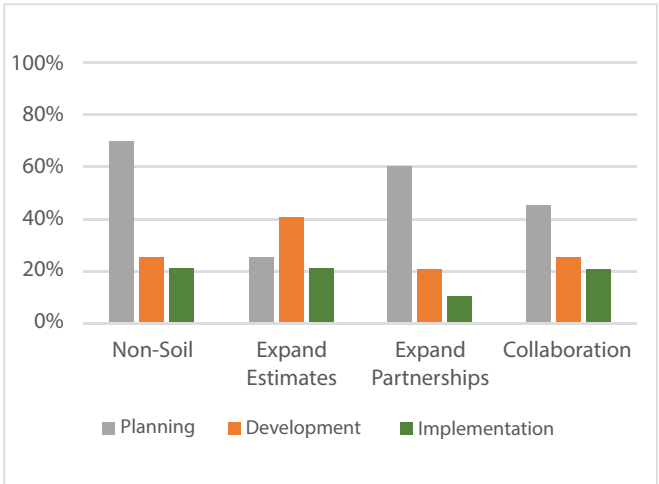
Figure 29. Global i-Tree user distribution, FYs 2006–2021.
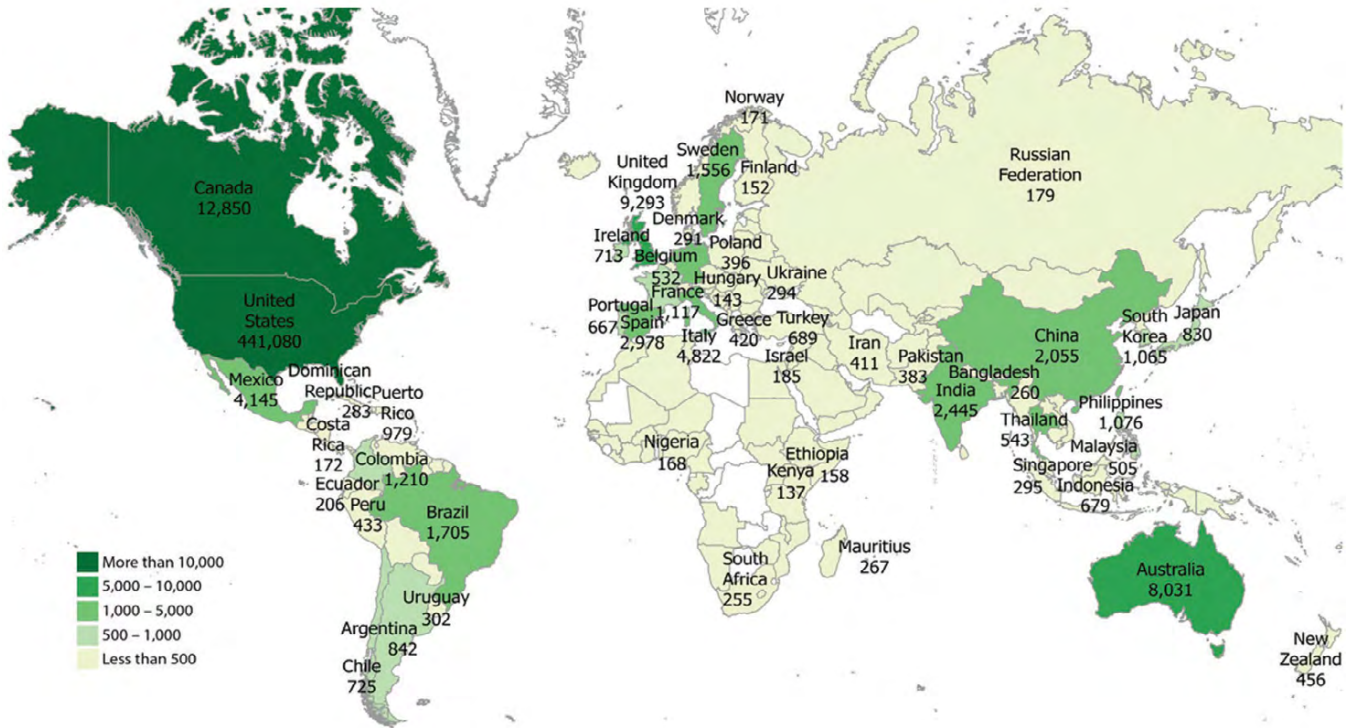
FY 2021 Accomplishments and Milestones

Accomplishments:

- **MyTree** enhanced by adding in cumulative tree benefits of the tree's life span and allowing users to pin the tree locations on Google Maps to create a global tree map.
- **i-Tree Canopy** overhaul to simplify the user experience and enhanced reporting to include maps and hydrologic benefits.
- The **i-Tree API** is available for users to implement i-Tree science and analysis in their own applications.
- **Scientific updates** to improve accuracy of analysis results and to provide additional ecosystem services and values.

Current projects and next steps:

- Enhance i-Tree Landscape with new features to assess and promote environmental equity.
- Simplify the user interface of Landscape Lite and i-Tree Landscape
- Develop a tool to calculate National Stormwater Credits.
- Expand species information included in i-Tree to aid users in making species selections.
- Increase connections to human health and environmental regulations related to air temperature, ultraviolet radiation, and stress reduction.

Financial Status and Partners

- **Current funding:** Currently funded $703,500 (S&E) + $180,000 (operations). Operations shortfall: $670,000
- **FTEs:** 5 Forest Service and 11 Davey Tree Expert Company
- **Farm Bill request:** None
- **Partnerships:** Davey Tree Expert Company, Arbor Day Foundation, Society of Municipal Arborists, International Society of Arboriculture, Casey Trees, and SUNY College of Environmental Science and Forestry. In FY 2021, funding support was also provided by the Great Lakes Restoration Initiative, Treeconomics, and the Korean Forest Service.

FY 2021 Publications and Deliverables

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Lin, J.; Kroll, C.N.; Nowak, D.J. 2020. Ecosystem service-based sensitivity analyses of i-Tree Eco. Arboriculture and Urban Forestry. 46(4): 287–306. https://www.fs.usda.gov/treesearch/pubs/62066.

Lin, J.; Kroll, C.N.; Nowak, D.J. 2021. An uncertainty framework for i-Tree eco: A comparative study of 15 cities across the United States. Urban Forestry & Urban Greening. 60: 127062. 11 p. https://www.fs.usda.gov/treesearch/pubs/62290.

Nowak, D.J. 2021.Understanding i-Tree: 2021 summary of programs and methods Gen. Tech. Rep. NRS-200-2021. Madison, WI. U.S. Department of Agriculture, Forest Service, Northern Research Station. 100 p. plus 14 appendixes. https://www.fs.usda.gov/treesearch/pubs/63636.

Pace, R.; Guidolotti, G.; Baldacchini, C.; Pallozzi, E.; Grote, R.; Nowak, D.J.; Calfapietra, C. 2021. Comparing i-Tree Eco estimates of particulate matter deposition with leaf and canopy measurements in an urban Mediterranean holm oak forest. Environmental Science & Technology. 55(10): 6613–6622. https://www.fs.usda.gov/treesearch/pubs/62545.

Sinha, P.; Coville, R.C.; Hirabayashi, S.; Lim, B.; Endreny, T.A.; Nowak, D.J. 2021. Modeling lives saved from extreme heat by urban tree cover. Ecological Modelling. 449(1): 109553. 19 p. https://www.fs.usda.gov/treesearch/pubs/62532.

Sonti, N.F.; Henning, J.G.; Yesilonis, I.D.; Hoehn, R.E., III; Nowak, D.J. 2021. Baltimore's urban forest, 1999–2014. Resour. Bull. NRS-124. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 38 p. https://www.fs.usda.gov/treesearch/pubs/63637.

Volin, E.; Ellis, A.; Hirabayashi, S.; Maco, S.; Nowak, D.J.; Parent, J.; Fahey, R.T. 2020. Assessing macro-scale patterns in urban tree canopy and inequality. Urban Forestry & Urban Greening. 55(3): 126818. 8 p. https://www.fs.usda.gov/treesearch/pubs/62469.

Timber Products Monitoring

The purpose of Timber Products Monitoring is to deliver a nationally consistent effort that collects, processes, and reports timber products output (TPO) and tree utilization data. Collected data relates to harvests for industrial products, logging and mill residue, residential fuelwood, and other removals.

TPO program conducts surveys of primary wood-processing facilities to quantify the use of roundwood and mill residue by geographic location, tree species, and forest product type.

Tree utilization studies collect data at active logging sites to identify the tree species, size, and primary product destination of the volume removed, as well as the fell volume left on site (logging residue).

Objectives

Figure 30. Development status of timber products monitoring objectives.
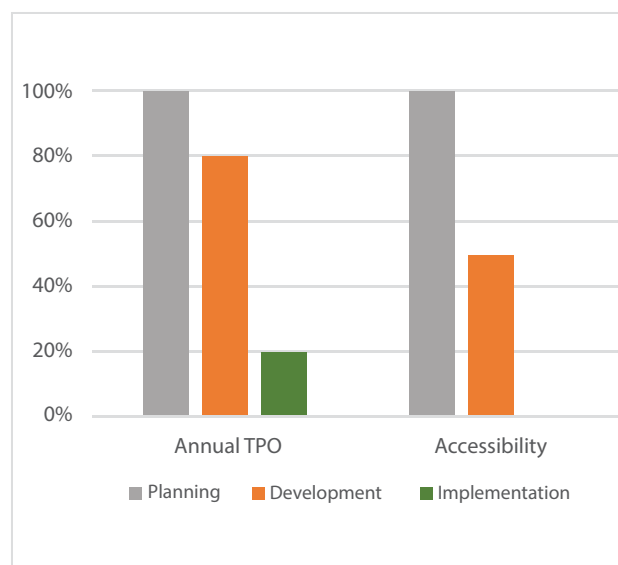
Annual TPO

- Implement annual sample design across all participating States.
- Enhance national compilation system to adapt to sample design.
- Develop strategy to improve residential fuelwood estimates.

Data Accessibility

- Develop TPO data and analysis tools to replace the legacy TPO data retrieval system.
- Develop national factsheet series.

FY 2021 Accomplishments and Milestones

- Timber Products Output Users' Group meeting held February 2–5, 2021, to share the program's progress in its transition to an annual sample design and to assess users' needs and concerns about the program.
- All regions adopted the mill sample design and are currently collecting data on an annual basis (2018 first year for South and 2019 first year for North and West regions).
- Southern region is processing annual sample data through the national compilation system (2019 mill data posted, 2020 data in process).
- A tool replacing the legacy TPO data retrieval system is functional and available at https://www.fia.fs.usda.gov/program-features/tpo.
- One-click factsheets have been developed but are currently populated only for the South. North and West data are not yet processed through the system.

Financial Status and Partners

- **FTEs:** 11.45 Forest Service (8 SRS, 3 NRS, and 0.45 PNW and RMRS); and 9.5 external cooperators
- **Partnerships:** University of Montana, Bureau of Business and Economic Research (joint venture agreement for PNW and RMRS program); University of Massachusetts, Amherst (NRS mill data collection); and multiple State forestry agencies across southern and northern regions (assisting with data collection)

FY 2021 Publications and Deliverables

Publications

Gray, J.A.; Bentley, J.W.; Cooper, J.A.; Cyprian, L.T.; Wall, D.J. 2021. Southern pulpwood production, 2017. Resour. Bull. SRS 228. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 13 p. https://www.fs.usda.gov/research/treesearch/62072.

Gray, J.A.; Bentley, J.W.; Cooper, J.A.; and Cyprian, L.T. 2021. Southern pulpwood production, 2018. Resour. Bull. SRS 229. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 13 p. https://www.fs.usda.gov/research/treesearch/62103.

Gray, J.A.; Bentley, J.W.; Cooper, J.A.; Cyprian, L.T. 2021 (revised October 2021). Southern pulpwood production, 2019. Resour. Bull. SRS-230. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 13 p. https://www.fs.usda.gov/research/treesearch/62502.

Hayes, S.W.; Bingaman, C.A.; Morgan, T.A.; Simmons, E.A.; Marcille, K.C.; Shaw, J.D. 2021. The Four Corners Timber Harvest and Forest Products Industry, 2016. Resour. Bull. RMRS-RB-34. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p. https://www.fs.usda.gov/rm/pubs_series/rmrs/rb/rmrs_rb034.pdf.

Marcille, K.C.; Dillon, T.; Townsend, L.P.; Morgan, T.A.; Shaw, J.D. 2021. Wyoming's forest products industry and timber harvest, 2018. 8. Resour. Bull. RMRS-RB-33. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 28 p. https://www.fs.usda.gov/rm/pubs_series/rmrs/rb/rmrs_rb033.pdf.

Timber Product Output and Use Factsheets: Alabama 2018; Alabama 2019; Arkansas 2018; Arkansas 2019; Florida 2018; Florida 2019; Georgia 2018; Georgia 2019; Kentucky 2018; Kentucky 2019; Louisiana 2018; Louisiana 2019; Mississippi 2018; Mississippi 2019; North Carolina 2018; North Carolina 2019; Oklahoma 2018; Oklahoma 2019; South Carolina 2018; South Carolina 2019; Tennessee 2018; Tennessee 2019; Texas 2018; Virginia 2018; Virginia 2019.

Data Delivery: TPO Toolkit

The TPO One-Click Factsheets allows visitors to view TPO factsheets via an interactive experience. Click on the desired State on the map to produce a real-time fact sheet of that state based on current TPO data. Data include statewide production, products, number of primary mills and types, roundwood exports/imports and retained production.

The TPO Interactive Reporting Tool allows visitors to view TPO data via an interactive experience. Click on the desired State or counties on the map to produce TPO data based on the geographic area and ywear of interest. The TPO Interactive Tool includes estimates of timber products, logging residue, mill residue, residential fuelwood, and other removals based on the selected area.
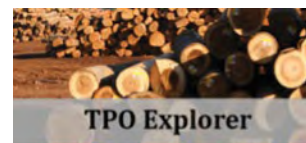
The TPO Explorer (coming soon) investigates the spatial and temporal patterns in roundwood production, logging residue, mill residue, residential fuelwood, and other removals.

The TPO Data Download allows visitors to download Timber Product Output Survey data at the State and county level. Data included for download, in .xlsx file format, are the most granular State- and county-level data publicly available to our users. These files allow visitors to produce estimates of timber products, logging residue, mill residue, residential fuelwood, and other removals at the State and county level.

The TPO Reporting Tool—Legacy allows visitors to produce estimates of timber products, logging residue, mill residue, residential fuelwood, and other removals at the county and State level in table format. This tool includes Legacy data only. Current and newer data are available using the TPO Data Download for non-tabular State and county level data and the TPO Interactive Reporting Tool.

TPO Reporting Tool—Legacy: https://www.fs.usda.gov/srsfia/php/tpo_2009/tpo_rpa_int1.php.

TPO Data Download: https://usfs-public.app.box.com/s/y4ziirdb9v7zardus0cuajh7ziy9b2id.

TPO Interactive Reporting Tool: https://public.tableau.com/views/TPOREPORTINGTOOL/MakeSelection?:showVizHome=no.

National Woodland Owner Survey

The purpose of the National Woodland Owner Survey (NWOS) is to advance the science, monitoring, and reporting of private forest ownerships across the United States by quantifying:

- Who owns the forests of the United States
- How they have used them in the past
- Why they own them
- What they intend to do with them in the future

The NWOS conducts separate surveys or modules for family forest ownerships, corporate forest ownerships, urban landowners, and forest ownerships on U.S. protectorates and territories.

Objectives

Figure 31. Development status of NWOS objectives.
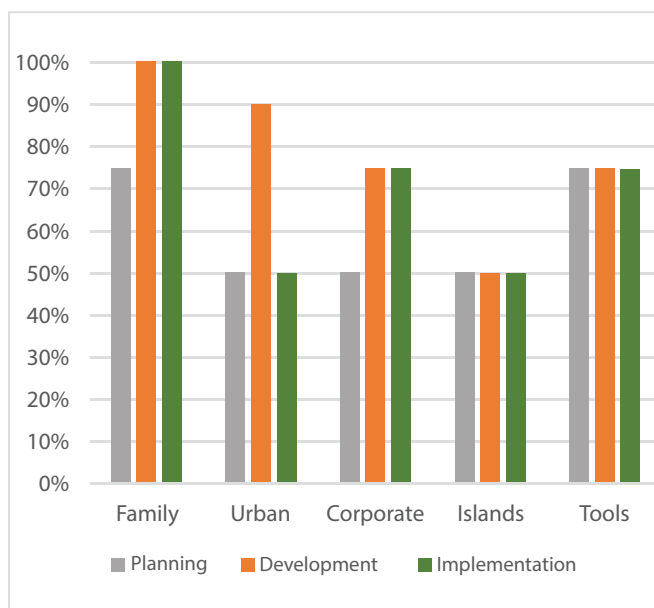
- **General**: Initiate review process for the next NWOS cycle.
- **Family:** Continue annual implementation. Further analyze and distribute results.
- **Urban:** Continue annual implementation. Analyze and distribute results for Baltimore and Houston.
- **Corporate:** Initiate planning for full implementation.
- **Islands:** Implement in the U.S. Virgin Islands. Initiate planning for Puerto Rico.
- **Tools:** Add additional profiles and features (e.g., cross-tabulations).

FY 2021 Accomplishments and Milestones

- Annual implementation of the Family/Base NWOS across the United States (approximately 5,000 contacts per year).
- Annual implementation of the Urban NWOS in six cities.
- Completion of the pilot study for Corporate NWOS.
- Implementation of the NWOS in the U.S. Virgin Islands.
- Publication of a general technical report with results from the 2018 NWOS.
- Publication of a general technical report documenting NWOS methods.
- Publication of two-page summary sheets for United States, regions, and States.
- Release of the NWOS Dashboard data access tool.
- Publication of an updated forest ownership map for the United States.
- Submission of the review package to the Office of Management and Budget for the next iteration of the NWOS.

Financial Status and Partners

- **Current funding:** $650,000 (Forest Service)
- **FTEs:** Two Forest Service and three external cooperators
- **Farm Bill request:** $3.1 million per year (includes full implementation of modules listed above plus new modules for Tribal All Lands and Public)
- **Partnerships:** American Forest Foundation, National Council for Air and Stream Improvement, Society of American Foresters, State forestry agencies, University of Massachusetts, Amherst.

FY 2021 Publications and Deliverables

Butler, B.J. America's Family Forest Owners Washington, DC: Society of American Foresters.

Butler, B.J.; Caputo, J. 2021. Weighting for the U.S. Forest Service, National Woodland Owner Survey. Gen. Tech. Rep. NRS-198. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 24 p. https://doi.org/10.2737/NRS-GTR-198.

Butler, B.J.; Caputo, J.; Robillard, A.L.; Sass, E.M.; Sutherland, C. 2021. One size does not fit all: relationships between size of family forest holdings and landowner attitudes and behaviors. Journal of Forestry. 119(1): 28–44. https://doi.org/10.1093/jofore/fvaa045.

Butler, B., J.; Butler, S.M.; Caputo, J.; Dias, J.; Robillard, A.; Sass, E.M. 2021. Family forest

ownerships of the United States, 2018: results from the USDA Forest Service, National Woodland Owner Survey. Gen. Tech. Rep. NRS-199. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 52 p. [plus 4 appendixes]. https://doi.org/10.2737/NRS-GTR-199.

Danley, B.; Caputo, J.; Butler, B.J. 2021. A burning concern: family forest owner wildfire concerns across regions, scales, and owner characteristics. Risk Analysis. 42(5): 1056–1072. https://doi.org/10.1111/risa.13816.

Harris, V.; Caputo, J.; Finley, A.; Butler, B.J.; Bowlick, F.; Catanzaro, P. 2021. Small-Area Estimation for the USDA Forest Service, National Woodland Owner Survey: creating a fine-scale land cover and ownership layer to support county-level population estimates. Frontiers in Forests and Global Change. 4:745840. https://doi.org/10.3389/ffgc.2021.745840.

Holt, J.R.; Butler, B.J.; Borsuk, M.E.; Markowski-Lindsay, M.; MacLean, M.G.; Thompson, J.R. 2021. Using the theory of planned behavior to understand family forest owners' intended responses to invasive forest insects. Society and Natural Resources. 34(8): 1001–1018. https://doi.org/10.1080/08941920.2021.1924330.

Murray, H.; Catanzaro, P.; Markowski-Lindsay, M.; Butler, B.J.; Eichman, H. 2021. Economic contributions from conserved forests: four case studies of the USDA Forest Service Forest Legacy Program. Forest Science. 67(6): 629–632. https://doi.org/10.1093/forsci/fxab039.

Pandit, K.; Bevilacqua, E.; Newman, D.H.; Butler, B.J. 2021. Understanding the spatial pattern and driving factors associated with timberland ownership change in the northern United States. Journal of Forestry. 119(4): 376–392. https://doi.org/10.1093/jofore/fvab017.

Sass, E.M.; Markowski-Lindsay, M.; Butler, B.J.; Caputo, J. Hartsell, A.; Huff, E.; Robillard, A. 2021. Dynamics of large corporate forestland ownerships in the United States. Journal of Forestry. 119(4): 363–375. https://doi.org/10.1093/jofore/fvab013.

Family Forest (10+ acres) Ownership Characteristics: National, Regional, and State: Two-page summaries. https://www.fia.fs.usda.gov/nwos/results.

NWOS Dashboard Tool: https://ffrc.shinyapps.io/NWOSdashboard.

National Inventory and Monitoring Applications Center

The National Inventory and Monitoring Applications Center (NIMAC) is responsible for providing technical assistance on all aspects of forest inventory for FIA, as well as National Forest System, Federal agencies, State governments, and other countries. Inventory and monitoring goals are accomplished through development of leading-edge forest ecosystem monitoring methods and tools designed for use by land managers across ownerships at landscape to national scales.

Objectives

Figure 32. Development status of NIMAC objectives.
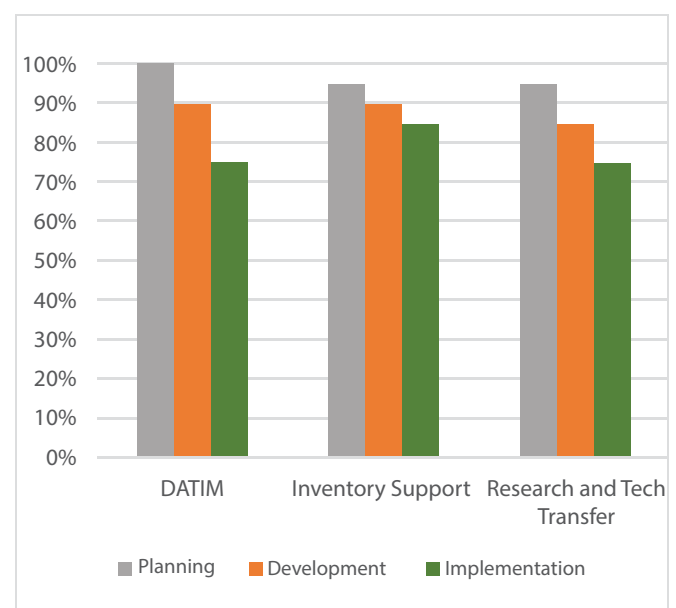
- Continue development of DATIM (Design and Analysis Toolkit for Inventory and Monitoring).
- Provide technical assistance, annual data processing, and analytical tool support for forest inventories conducted by State and Federal agencies.
- Conduct research and technology transfer that benefits forest inventory and monitoring efforts around the globe across various spatial scales and diverse ranges of objectives.

FY 2021 Accomplishments and Milestones

- **Design and Analysis Toolkit for Inventory and Monitoring (DATIM).** The National Forest System and FIA continued to fund NIMAC to develop DATIM in FY 2021. DATIM allows users to create custom, static analyses that can then be tailored by adding spatial attributes using geographic information system (GIS) software. Those spatial attributes can then be incorporated into analytical queries. In FY 2021, version 15.0 was the most recent release, with subsequent versions already

in development for release early in FY 2022. DATIM is publicly available at: https://www.fs.usda.gov/emc/rig/DATIM/index.shtml

- **State and Federal agency forest inventory technical assistance.** NIMAC assisted 3 State-sponsored annual forest inventories (Indiana, Wisconsin, Missouri) and forest inventory projects on 3 new (18 total) U.S. Fish and Wildlife Service refuges. NIMAC had representation on the Pennsylvania State forest land CFI review committee.

- **Research projects.** NIMAC completed several forest inventory and monitoring research projects during FY 2021 (see publications below), with several more studies already near completion for FY 2022.

Financial Status and Partners

- **Current funding:** $56,000 (external sources)
- **Partnerships:** National Forest System, Fish and Wildlife Service, Wisconsin Department of Natural Resources, Indiana Department of Natural Resources, Missouri Department of Conservation, SilvaCarbon, Forest Service International Programs, University of Nevada-Las Vegas, Southern Utah University.

FY 2021 Publications and Deliverables

DATIM versions 13.1, 14.0, 14.1, and 15.0 released during FY 2021.

Lister, A.J.; Leites, L.P. Designing plots for precise estimation of forest attributes in landscapes and forests of varying heterogeneity. Canadian Journal of Forest Research. 51(10): 1569–1578. https://doi.org/10.1139/cjfr-2020-0508.

Lister, A.J.; Leites, L.P. 2021. Cost implications of cluster plot design choices for precise estimation of forest attributes in landscapes and forests of varying heterogeneity. Canadian Journal of Forest Research. 52(2). https://doi.org/10.1139/cjfr-2020-0509.

Lister, A.J.; Andersen, H.; Frescino, T.; Gatziolis, D.; Healey, S.; Heath, L.S.; Liknes, G.C.; McRoberts, R.; Moisen, G.G.; Nelson, M.; Riemann, R.; Schleeweis, K.; Schroeder, T.A.; Westfall, J.; Wilson, B.T. 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): 1364. https://doi.org/10.3390/f11121364.

Westfall, J.; Lister, A.J.; Coulston, J.W.; McRoberts, R.E. 2021. Realized and potential efficiency for post-stratified estimation in a national forest inventory. Canadian Journal of Forest Research. 51(10): 1450–1457. https://doi.org/10.1139/cjfr-2020-0379.

Westfall, J.; Lister, A.J.; Scott, C.T. 2021. Evaluation of mapped-plot variance estimators across a range of partial nonresponse in a post-stratified national forest inventory. Canadian Journal of Forest Research. 52(2). https://doi.org/10.1139/cjfr-2021-0159.

Digital Engagement

The purpose of the digital engagement work is to improve FIA analysis, reporting, and knowledge delivery through:

- Deep collaboration with agency and external partners and stakeholders to develop and publish relevant and authoritative data supporting their identified needs.

- Analytical and reporting application development relying upon solutions that leverage agency and partner competencies and investments, reduce development times, and increase the potential for collaboration.

- Deployment of a secure cloud computing environment providing scalable resources necessary to store, process and share analyses conducted at national scales.

Objectives

Figure 33. Development status of digital engagement objectives.
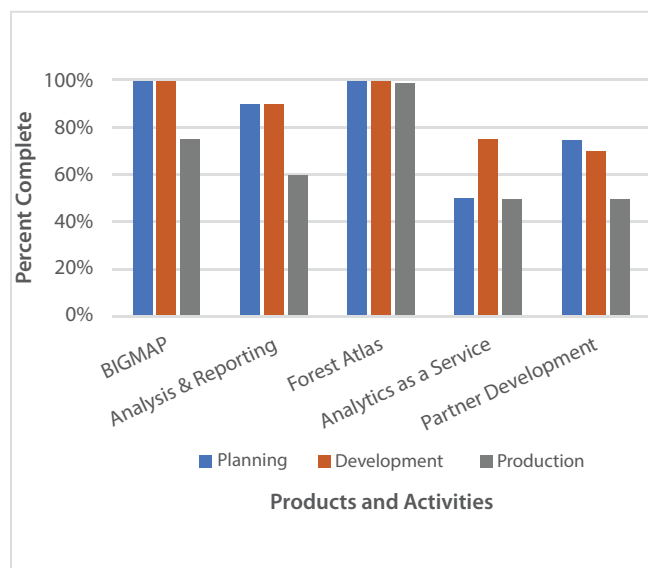
- Place the Analytics and Decision Support (ADS) on a permanent chief information officer (CIO) funding line.

- Continue push for flexible computing, decision-support, and reporting technologies.

- Leverage cooperating research and development agreement with Esri for content and app production.

- Set direction and deploy diverse national reporting applications.

- Develop the next version of the National One-Click reporting application.

- Complete the One-Click Wood-Movement reporting application.

- Increase content.

- Develop apparatus and capacity for mass production of imputed data products.

- Identify new partners for continued build-out of issue-focused applications.

FY 2021 Accomplishments and Milestones

- Moved BIGMAP (pilot project) to full production in a FIA and CIO-managed cloud environment (ADS).

- Developed six major digital products to deliver FIA information (see deliverables below).

- Continued developing FIA PlotMap, a single-plot imputation product that aids users to downscale the FIADB to a 30-meter resolution. FIA PlotMap offers all users a geospatially enabled FIADB.

- Delivered invited plenary remarks at Esri International User Conference.

- Pushed the print Atlas to the final stage of publication (awaiting copies)

- Aided in identifying and resolving 25+ software bugs in Esri core and Esri Raster Analytics software.

- Curated over $500,000 in funding for digital engagement portfolio-related activities. (CARES Act, SRS-FIA, WO, National Operations.)

Financial Status and Partners

- **Current funding:** Over $1 million, including $500,000 invested in the BIGMAP environment, $443,000 in universities, and $125,000 in GTAC. These investments are being challenged in the new IT environment even as they continue to support partners, including:

  ◦ FIA analysts, who improve the technical capacity for raster data processing and reporting
  ◦ Agency stakeholders, who access to authoritative geospatial raster data for forest planning
  ◦ External partners, who use high-profile tools supporting sustainability assessments by multinational brands (e.g., Mars, McDonald's) and their forest products supply chains

- **FTEs:** a total of 11 Forest Service employees, including 5 scientists and 6 technical experts

- **Partners:** Esri, Purdue University, Virginia Tech, the Wilderness Society, Harvard Forest, Locana, Xentity Corporation, Forest Service Forest Health and Applied

Sciences Team, GTAC, Forest Service Center for Forest Restoration and Management

FY 2021 Publications and Deliverables

FIA high-quality raster products are now delivered through the Esri Living Atlas, a premiere repository for geospatial data, https://livingatlas.arcgis.com/en/browse/#d=2&q=BIGMAP.

FIA Geospatial Showcase: https://fia-usfs.hub.arcgis.com.

First FIA digital 5-year report for the State of Missouri: https://storymaps.arcgis.com/collections/39bfe27dcaae456999b93ec5394d9c5f.

TPO Woodflow dashboarding applications: https://experience.arcgis.com/experience/f1c4981f19c24756854ff8a4b7fc5e27.

BIGMAP Layer Catalog application: https://experience.arcgis.com/experience/97e7d151e986420a82e0cb6e5c99389c.

SAE GeoSpatial Toolbox (not available to the public yet)

Note: Some links currently require login credentials, so demonstrations are available upon request.

Community Engagement

The purpose of the Community Engagement team is to facilitate efficiency through increased communication, product sharing, and collaboration between units, and to maintain relevancy by showcasing FIA products, internally and externally. Additionally, the team makes concerted efforts to outreach to and recruit diverse candidates.

The main objectives of the program area are:

- Increase internal communication by facilitating information sharing via newsletter and Teams channel.

- Increase external communication by updating the national website and increase social media presence.

- Showcase FIA products through social media posts and informational videos.

- Create a FIA recruitment video and develop material that will aid in recruitment.

Objectives

Ongoing efforts include:

- Develop and share social media content reflecting FIA accomplishments (handle #USDA_FIA). Maintain and facilitate contact with station communication shops.
- Update FIA staff and partners on the FIA Program through a newsletter shared internally and on national website. Continue outreach for materials and making them accessible to programs through the FIA Resource Center.
- Update content for the FIA national website.
- Continue outreach efforts to underserved communities for diversity recruits.
- Create FIA video on "value-added" with FIA Program and data.
- Instagram FIA spotlight. Create instagram material to assist in FIA product-sharing and reaching larger audiences for recruitment purposes.

FY 2021 Accomplishments and Milestones

- Created Microsoft Teams channel (FIA Resource Center) for communication across all of FIA.
- Updated FIA Outreach Plan (i.e., communication plan) by identifying issues and making suggestions to address those issue.
- Produced monthly newsletter featuring FIA national portfolios, program news, change management, and community engagement events.
- Created Treesearch search engine capable of returning all FIA-related publications. Tool is now available on website for all users to access.
- Created and published an FIA recruitment video.
- Updated the website to include a hiring page that provides information, instructions, and links for potential candidates.
- Continued updates to the website and FIA factsheets to ensure the most-up-to-date information is available for FIA staff and clients.

Financial Status and Partners

- **Current funding and capacity for FIA Program community engagement activities:** No program funding is invested in this area or work other than the salary and expenses of involved team.
- **FTEs:** The time invested by the eight FIA members of this team is equivalent to one FTE.

Spanning Cultures

The FIA engagement with communities is a critical component to program success. FIA crews are based in rural, local, and/or Indigenous communities for months at a time. This requires the program to build critical relationships and draw a connection between data collected and community needs and priorities. The FIA Program has an ongoing citizen science component to help cultivate relationships between Native communities and FIA crews, including FIA, State, and contracted personnel. FIA staff also coordinate with an array of partners to complete fieldwork and host a wide variety of community presentations at events, schools, community centers, and via webinar.

Objectives

Figure 34. Development status of spanning cultures objectives.
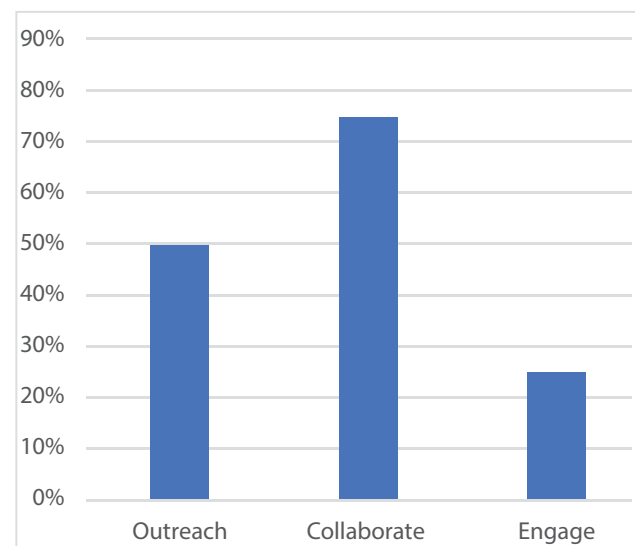
- **Outreach:** Provide written materials (posters, brochures, flyers) to community members to provide information about FIA and updates on local project work.
- **Collaborate:** Work closely with Tribal coalitions, Tribes, and Alaska Native corporations to understand needs, share data, and access lands for field data collection.
- **Engage:** Increase engagement and communication with Tribes and other indigenous communities through activities of national team consisting of Tribal liaisons from each FIA region.

FY 2021 Accomplishments and Milestones

- Formed a national team consisting of Tribal liaisons from each FIA region to increase engagement and communication with Tribes and other Indigenous communities.
- Developed a plan for updated outreach materials specifically for indigenous communities and other Tribal entities.

- Began planning a FIA/Tribal webinar and organized a session for the 2022 FIA Science Stakeholder meeting.

Financial Status and Partners

- **Current funding:** Core function of national FIA Program, so no separate funding. Some deliverables below resulted from individually funded projects.
- **Partnerships:** Tanana Chiefs Conference, Pacific Islands local governments, Northern Tribal Homelands Working Group, Ojibwe Tribes of the Great Lakes, Bad River Tribe, The Great Lakes Indian Fish & Wildlife Commission, and Bureau of Indian Affairs.

FY 2021 Publications and Deliverables

- Continued participating in the Northern Tribal Homelands Working Group.
- Formed a national team consisting of Tribal liaisons from each FIA region to increase engagement and communication with Tribes and other indigenous communities.
- Continued leveraging the partnership with Ojibwe Tribes of the Great Lakes to assess the supply and quality of large paper birch within the territories ceded in the treaties of 1836, 1837, 1842, and 1854.
- Engaged in planning a study regarding birch planting and growth in Lake States clay with the Bad River Tribe, MI Tech, The Great Lakes Indian Fish & Wildlife Commission, and Bureau of Indian Affairs.
- Participated in a collaborative presentation on paper birch bark through an Office of Sustainability and Climate webinar.
- Delivered summaries of the data collected from plots on Tribal lands to numerous Tribes.
- Led conversations with the Rocky Mountain Research Station Tribal liaison to discuss opportunities for future recruitment of Tribal members and the development of analysis and reporting products that meet the needs of Tribal foresters.
- Continued partnering with Pacific Islands local governments in six culturally unique jurisdictions, working with diverse staff who speak over nine different languages.
- Continued building FIA and local capacity through joint trainings and workshops on the use and collection of the data, while increasing awareness of broadscale changes in local forest ecosystems.
- Continued partnerships with local NGOs and universities to enhance our connection with local land managers as they can provide local updates, trainings, and workshops at regional meetings on the inventory information.
- Hired a joint position with the Pacific Southwest-Institute of Pacific Island Forestry (IPIF) to assist with local management of field data collection in Hawaii and provide a stronger connection between FIA and research scientists at IPIF.
- Delayed in-person data use workshops in Hawaii due to COVID-19 pandemic travel challenges and office closures.
- Continued ongoing partnership with the Tanana Chiefs Conference to implement forest inventory in Interior Alaska.
- Initiated partnership with Alaska Native Science and Engineering Program to develop an internship program at the Anchorage Forestry Sciences Lab for students of the University of Alaska system.
- Developed a successful working relationship with the village of Nikolai to provide logistic support services to our field crew as a satellite hub during the 2021 field season in Interior Alaska. Also, continued to form partnerships with the villages of Sleetmute, Lime Village, and McGrath.
- Organized and initiated a 4-hour training and presentation on forest inventory techniques to the teachers at McGrath School.
- Collaborated with Kate Spellman at University of Alaska-Fairbanks to do presentations on FIA and introduce a citizen science project to the students of Wrangell School.
- Continued partnerships with local NGOs and universities in the Micronesia region to enhance our connection with local land managers as they can provide local updates, trainings, and workshops at regional meetings on the inventory information.
- Provided updates to a Micronesia Challenge webtool developed by the Conservation Biology Institute with information on forest inventory data for terrestrial monitoring.
- Enhanced opportunities for interns and staff throughout the Pacific Islands to build on their knowledge of forest monitoring through a newly implemented joint venture agreement with the Micronesia Conservation Trust.
- Produced an online publication for Pacific Island forest managers of the data from a special project that leverages the FIA plots in the Pacific Islands to monitor forest status from conservation efforts from the Micronesia Challenge program: https://micronesica.org/sites/default/files/dendyetal2020.pdf.
- Partnered with six Tribes across Oregon, Washington, and California to grant access to FIA plots on Tribal lands.

Program Safety

In every way—physical, psychological, and social—safety is a [core value](#) uniting Forest Service employees, both on and off the job. Employees are entitled to a workplace environment where they treat one another with respect, empower one another, model integrity, protect one another, and learn from mistakes. FIA takes these values seriously and makes these commitments whether in the field, the office, or working remotely.

In 2016, Forest Service safety programming began a transition period and cultural reorganization promoting critical thinking and speaking, inviting a reversal of the lingering hierarchical command that historically characterized the agency. In 2018, the Forest Service introduced

organizational changes in the wake of the agency's public reckoning with sexual misconduct, including a revamped harassment-reporting center, changes to investigation procedures, an updated statement of codes and commitments, and the creation of the Work Environment and Performance Office (WEPO) within the Office of the Chief. WEPO's mission is to "improve and sustain a workplace culture where all employees feel safe, valued, respected, and supported."

Along with WEPO's mission, the FIA Program has evolved the scope of safety and continues to work toward an improved vision of employee well-being and work environment. Program managers and safety teams within FIA units actively monitor and address physical, psychological,

Table 9. FIA Program estimates for Federal employee hours worked, miles driven, aircraft hours flown, and safety incidents reported, FY 2021.

Category	FIA Unit					Total
	Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	
Base data						
Federal FTE employees[a]	87	82	67	94	2	**332**
Total estimated hours worked[b]	181,696	169,609	139,984	196,059	3,744	**691,092**
Total vehicle miles driven	309,588	386,499	415,318	517,465	0	**1,628,870**
Total flight hours logged	457	2	0	0	0	**459**
Incidents by class						
OSHA recordable injuries[c]	3	3	0	3	0	**9**
Chargeable motor vehicle accidents[d]	4	1	1	1	0	**7**
Aircraft accidents[e]	0	0	0	0	0	**0**
Aircraft incidents[f]	3	0	0	0	0	**3**
Safety incident frequency rate						
Recordable injury rate per 100 FTEs	3.4	3.7	0.0	3	0	**2.7**
Motor vehicle accidents per million miles driven	12.9	2.6	2.4	2	0	**4.3**
Aircraft accidents per 100,000 flight hours	0	0	0	0	0	**0**

[a] Based on appendix B-3 estimated number of Federal employee full-time equivalents (FTE).
[b] Based on appendix B-3 number of Federal employees times 2,080 hours per FTE. Note: a small percentage of overtime is not included in estimate.
[c] Work-related injury or illness resulting in any of the following: death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness.
[d] Any occurrence involving the use of a Government-owned or Government-leased motor vehicle (automobile, truck, or bus) that results in a total combined damage of $1,500 or more. This definition also applies to privately owned vehicles when used on official Government business.
[e] Aircraft accidents are those resulting in death, serious injury, or where the aircraft is substantially damaged.
[f] Aircraft incidents are those affecting, or which could affect, the safety of aircraft operations. (New metric introduced in FY 2020 per safety committee recommendation)

FIA = Forest Inventory and Analysis; FTE = full-time equivalent; OSHA = Occupational Safety and Health Administration.

and social safety issues and concerns as they emerge, through annual staff surveys and direct reporting.

Our job hazard analyses (JHAs) and training for field and office staff are continually reviewed and improved. These include watercraft safety, working alone or in hostile environments, urban field safety, lightning hazards, bears, illicit grow sites, road and backcountry travel, psychological safety and harassment, bystander intervention on inappropriate behavior, and check-out/check-in systems for field and office. Office safety focuses on workstation ergonomics, filtering eyewear for computer work, travel safety, active shooter, sexual harassment, bystander intervention, bullying, cybersecurity, preparedness for earthquakes, lightning strikes, and other weather disasters, and first-aid training including cardiopulmonary resuscitation and use of an automatic external defibrillator. Field crews are equipped with mobile phones, InReach devices, ergonomic data recorders, and satellite phones. Personal protective equipment includes hard hats, safety goggles, gloves, safety boots, and aerosol sprays for wild and domesticated animals. International security training is required for all international trips.

Our people are our greatest asset—all take great pride and responsibility for their own and other's safety.

In FY 2021, the total annual number of vehicle accidents increased to seven from a record low of three in the previous year when the pandemic decreased the total number of miles driven in the field (figure 35). Since 2016, the total number of work-related injuries and illnesses reported each year has been 10 or fewer for the entire FIA Program (figure 36). Table 9 summarizes the program's safety record for FY 2021 with 0 aircraft accidents, 2.7 hours lost due to illness and injury per 100 full-time employees, and 8.6 vehicle accidents per million miles driven.

Program Safety Highlights

Since the COVID-19 pandemic was declared in early 2020 and through FY 2021, FIA prioritized the safety of crews above established annual program objectives and field data collection targets by adopting additional mitigation measures, field requirements, and travel limitations. Each FIA unit embraced a revised set of goals determined primarily by State and regional pandemic status, while also complying with guidance from OSHA and the Centers for Disease Control and Prevention (CDC). In summary, some of the common mitigation efforts across all FIA units included:

- Development of regional deliberative risk assessments for conducting field work that mitigate risk to employees and the communities where they work.
- Distribution of CDC-recommended personal protective equipment.

Figure 35. Number of chargeable motor vehicle accidents by FIA region, FYs 2010–2021.
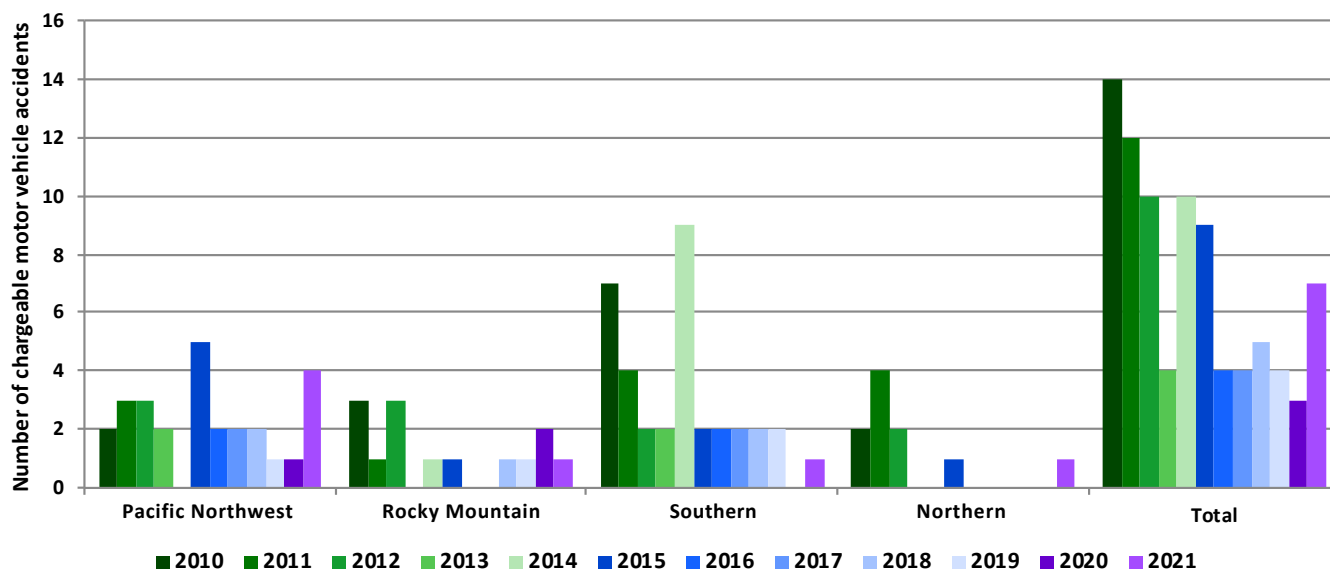
FIA = Forest Inventory and Analysis; FY = fiscal year
Note: A chargeable motor vehicle accident is any occurrence involving the use of a Government-owned or Government-leased motor vehicle (automobile, truck, or bus) that results in a combined total damage of $1,500 or more. This definition also applies to privately owned vehicles when used for official Government business.

- Revision of vehicle-use standards to accommodate one crew member per vehicle, in order to comply with social-distancing guidelines.
- Encouraged vaccination of all FIA personnel, including Federal and non-Federal field crew members.

Pacific Northwest Research Station

PNW-FIA continued to learn along an enduring safety journey through another year of pandemic and historic fire activity. In FY21 the unit:

- Enhanced COVID-19 mitigations to reduce the potential transmission among staff while allowing for continued fieldwork. Mitigations included enhanced protective equipment, masks and cleaning supplies, reduced travel in shared vehicles, and use of telework and remote options. Implemented full risk evaluation and use of new tools such as the "go, no-go checklist" to evaluate rapidly changing conditions and risk, and included air quality checks prior to field work.
- Increased information, communication, and support of employee well-being through trainings, webinars, and support of employee wellness plans. For example, training included the Stress First Aid program in a session at our annual operations planning meeting for all program staff.
- Empowered employees to voice concerns about their safety through surveys, implement actions to address concerns through leadership, reevaluated contracts, and encouraged stress-safety standdowns as appropriate.

Rocky Mountain Research Station

RMRS-FIA achieved success in the area of safety in FY 2021, according to monitored metrics. This year there were fewer total injuries, fewer serious injuries reported, and no serious vehicle accidents. Some of the unit efforts to provide a safe environment included:

- Granted multiple safety awards for employees' proactive safety attitudes, behaviors, and actions.
- Shared learning stories and periodically called employees to stay connected.
- Offered virtual "water cooler" meetings to foster communication and held regular staff meetings in which well-being and mental health were directly discussed. Encouraged the use of agency resources like Comprehensive Well-Being and Resilience (CWB&R) Mindfulness Based Stress Reduction (MBSR), and Employee Assistance Program (EAP) services.

Initial training for new employees and refresher training for experienced employees was an important administrative control for managing risk that has been challenging to navigate in recent years. Training engagement was high even though most was delivered virtually. The 2-week virtual training for data collection employees in the spring included aviation training, wellness related sessions on breaking the stigma of mental health, and Stress First Aid. New data collection employees required a carefully planned in-person training that resulted in no COVID-19 cases. Other new

Figure 36. Number of OSHA-recordable injuries by FIA region, FYs 2013-2021.
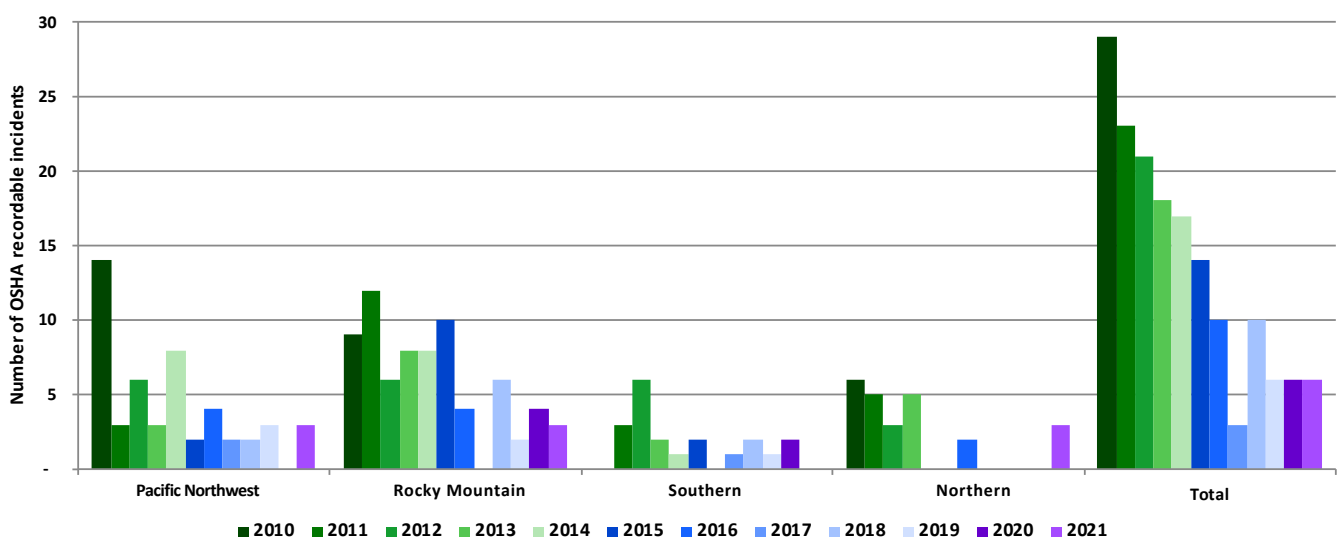
FIA = Forest Inventory and Analysis; FY = fiscal year; OSHA = Occupational Safety and Health Administration.
Note: An OSHA-recordable incident is a work-related injury or illness resulting in any of the following: death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness.

FIA employees took training virtually to decrease the risk of COVID-19 transmission.

Additional efforts were adopted to welcome and connect new staff with their virtual colleagues. One way the program encouraged employee engagement was through the program's Safety Committee, which met 10 times during FY 2021. The committee explored and implemented multiple employee suggestions for improving safety and efficiency. These improvements included the purchase and use of electric bikes, metal detectors for finding plot monumentation, and light field gear that is customized to employees' sizes; the review of our annual data collection debriefing survey; thoughtful discussions regarding data collection amidst the pandemic; and an update to the unit aviation safety plan. The Safety Committee has always been a virtual team and focused on maintaining connections by making time for personal check-ins at every meeting.

Southern Research Station

SRS Safety Committee continued to put forth editorials to enhance staff knowledge of the Green Book, address safety concerns and clarify safety protocols and messages. In these times of fast-changing rules, the FIA unit worked on getting clear messages out as quickly possible to keep our employees well-informed.

Across the 425,000 miles driven by FIA crews in FY 2021, only one reportable vehicle incident occurred and, more importantly, zero reportable injuries. The unit continued to supply COVID-19 personal protective equipment, including N-95 masks, gloves, and alcohol wipes as necessary. A number of staff members contracted COVID-19 and we lost one of our employees to this disease. While the COVID-19

pandemic slowed operations, our employees, supervisors, and managers continued to look out for each other while traveling the highways of the South.

Northern Research Station

The Northern Research Station staff met virtually on a regular basis to discuss program updates, announce station and agency news, and maintain a sense of comradery that could have been lost while office occupancy was not allowed. Data collection employees were empowered to work in the field on travel plots, local plots, or complete telework projects depending on their level of comfort. As COVID-19 pandemic restrictions loosened, an approval process incorporating national guidance was developed to allow voluntary field travel.

The data collection crew continued to work hard to maintain safe driving practices. Collectively, program employees drove over 517,000 miles safely with no traffic accidents; only one instance of cosmetic damage to a vehicle was reported. Two injuries and one insect-borne illness were reported among data collection employees.

The Safety and Health Committee (comprised of field, office, and management staff) continued to ensure staff is current on all safety and health related trainings. In addition to monthly meetings, committee members annually review job hazard analysis (JHA) documents to incorporate the changing needs of office and field staff. One member of the Safety and Health Committee met regularly with other FIA regional representatives to share coping strategies, concerns, sources of personal protective equipment, and other topics related to the COVID-19 pandemic.

Fiscal Year 2022 Anticipated FIA Program Direction

The FIA Program will continue inventory operations in 50 States, with Alaska focused on an annualized survey in Coastal Alaska, and a periodic survey including integration of remote sensing data for efficiency in Interior Alaska (figure 37). However, Alaska's inventory redesign continues to be a priority for the program to ensure the best use of available resources given the high costs of those vast units only accessible by air. FIA partners continually rate "complete the core" as their number one priority, and therefore it remains the number one priority for FIA. This means completing surveys on time, making the data available online, and publishing reports.

In FY 2022, the FIA Program will need additional support to overcome the 2-year-long impacts of the COVID-19 pandemic and other natural disasters, including wildfires in the West, and meet annual data collection and delivery targets, as well as long-term research needs of our partners. With additional support, FIA has plans to complete all FY 2020 unmeasured

plots, over 90 percent of FY 2021 plots in the West and all in the East, and make substantial progress with FY 2022 plots. Remaining unmeasured urban plots from FYs 2020 and 2021 in Colorado, Oregon, and California are also planned to be completed.

Although the Southern plot data collection was not impacted as hard as the West by the COVID-19 pandemic, catastrophic wildfires, hurricanes, other natural disasters, and State hiring challenges have led to additional plot delays. It is anticipated that data collection in most Southern States will be back on track by the end of FY 2024. Hiring temporary workers is the main strategy proposed to catch up.

Field operations will continue from remote hubs in the Southwest Unit of Interior Alaska, where about one-third has been already measured for the first time. The cost of inventory operations in Interior Alaska is expected to be high in remote hubs where access is only by air, and where

Figure 37. Planned FIA implementation status, FY 2021.
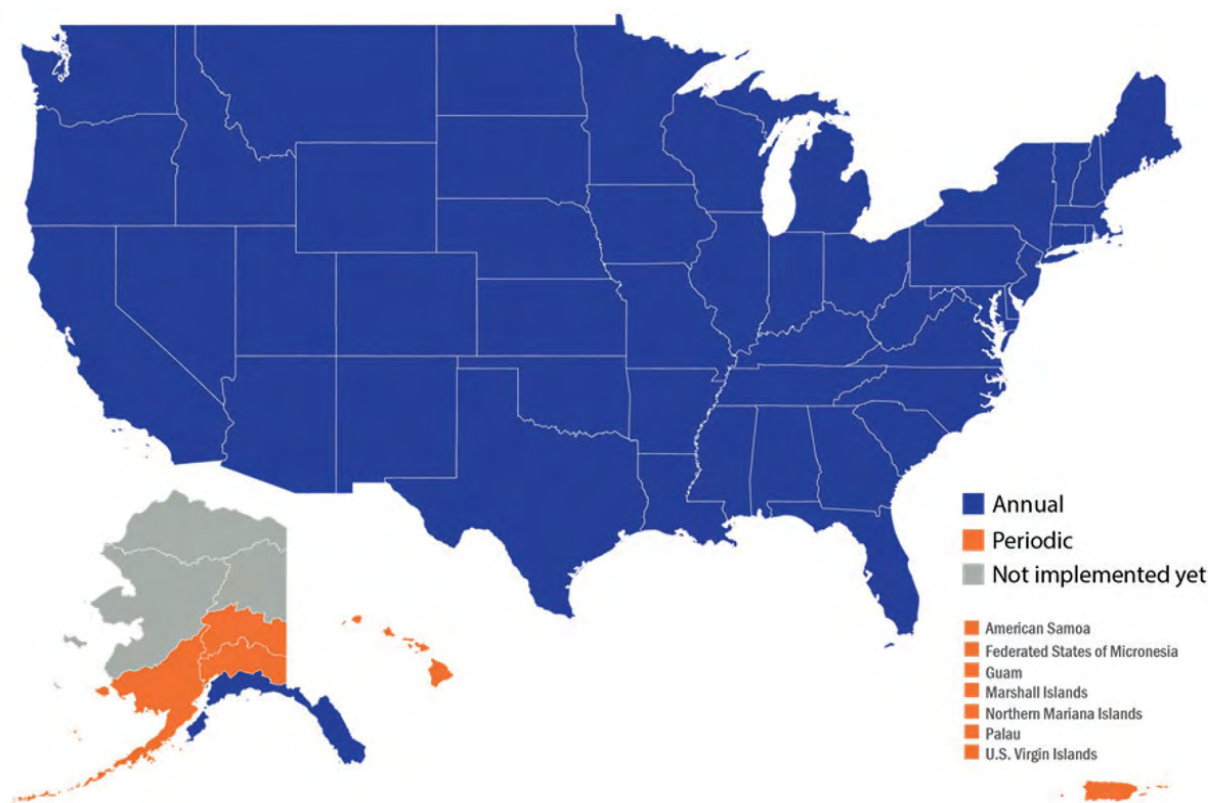
FIA = Forest Inventory and Analysis; FY = fiscal year.

fuel, medicine, communications, food, and other supplies are limited. Due to travel restrictions from the COVID-19 pandemic, the acquisition of G-LiHT data across the Southwest was on pause throughout FYs 2020 and 2021; it is expected to resume during the summer of FY 2022.

Other major activities planned for 2021 and beyond include: achieving full compliance of State 5-year reports; publishing results from the most recently completed cycle of NWOS Base and Urban; release of the interactive NWOS dashboard; continuing to modernize the program's TPO operations and reporting through the release of another interactive tool—the TPO Explorer; continue developing user-friendly applications for small area estimations that will leverage access to new computing libraries, including nationwide runs at improved speed, and automated reporting; development of EVALIDator 2.0, the next generation of FIADB searching; and populating FIA Urban DataMart and My City's Trees applications as urban data become ready. Accomplishment of these goals will depend on the continued strong support of partners, their commitment to an efficient and productive FIA, and the adequate funding for full program implementation of 2014 Farm Bill options A through C.

In response to the Further Consolidated Appropriations Act for FY 2020, the Forest Service is eliminating cost pools from its budget for FY 2021. For 20 years, cost pools have covered fixed operational costs, such as business services and infrastructure, Office of Workers' Compensation Programs, and unemployment compensation insurance. The FIA Program will continue to adapt to the new budgeting system in FY 2022. The FIA Program will also continue to work through information technology modernization, to comply with agency implementation of the Federal Information Technology Acquisition Results Act.

Long-Term Strategic Direction

The FIA Program initially intended to implement the "Forest Inventory and Analysis Strategic Plan" by achieving a base Federal program of 10 percent per year in the West and 15 percent per year in the East by FY 2003. Since then, financial support from partners has enabled FIA to get close to a 20 percent target—that is, remeasuring plots in a 5-year cycle—in some Eastern States. State support has been impacted as Federal budgets fluctuated yet remained essentially flat, at $77 million, since 2017. Even under the new budget structure of FY 2021, congressional intent was for FIA to continue to be funded at not less than the prior years' level of $77 million. Impacts in State government budgets have also affected their matching funds and in-kind contributions to the program. Stronger Federal support is needed to continue and expand as partners find exceptional value in leveraging Federal resources to provide improved information and service to their constituents. The program remains underfunded to fully deliver Farm Bill demands and emerging data needs. And this gap has steadily increased since 2017.

In late 2013, FIA drafted a new strategic plan to update the 2007 plan, in response to the 2014 Farm Bill and its requirements for FIA. This plan is forward-looking and attempts to balance emerging client demands for new information, tools, and values with necessary decisions on priorities and budget constraints. The FIA strategic plan was developed in cooperation with partners and stakeholders and identifies the base program, potential enhancements to the base, priorities for new programs, and areas for increased flexibility in the future. The plan was delivered to the agency and USDA in mid-2014, with a final submission delivered to Congress in March 2015.

Passage of the 2014 Farm Bill and FIA Requirements

On February 7, 2014, Congress passed the Agricultural Act of 2014 (Public Law 113–79), also referred to as the 2014 Farm Bill. Section 8301 of this legislation required the Forest Inventory and Analysis Program to revise its previous strategic plan, approved by Congress in 1999, and submit the new plan to the Committee on Agriculture of the House of Representatives and the Committee on Agriculture, Nutrition, and Forestry of the Senate within 180 days of the passage of the law.

Farm Bill provisions that were addressed in the revised strategic plan:

1. Complete the transition to a fully annualized forest inventory program and include inventory and analysis of Interior Alaska.

2. Implement an annualized inventory of trees in urban settings, including the status and trends of trees and forests, and assessments of their ecosystem services, values, health, and risk from pests and diseases.

3. Report information on renewable biomass supplies and carbon stocks at the local, State, regional, and national levels, including by ownership type.

4. Engage State foresters and other users of information from the Forest Inventory and Analysis in reevaluating the list of core data variables collected on FIA plots, with an emphasis on demonstrated need.

5. Improve the timeliness of the TPO program and accessibility of the annualized information on that database.

6. Foster greater cooperation among the FIA Program, research station leaders, State foresters, and other users of information from the Forest Inventory and Analysis.

7. Promote availability of and access to non-Federal resources to improve information analysis and information management.

8. Collaborate with the NRCS, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, and the U.S. Geological Survey to integrate remote sensing, spatial analysis techniques, and other new technologies in the FIA Program.

9. Understand and report on changes in land cover and use.

10. Expand existing programs to promote sustainable forest stewardship through increased understanding, in partnership with other Federal agencies, of the more than 10 million private forest owners, their demographics, and the barriers to forest stewardship.

11. Implement procedures to improve the statistical precision of estimates at the sub-State level.

Passage of the 2018 Farm Bill, FIA Requirements, and Ongoing Implementation

On December 11, 2018, Congress passed the 2018 Farm Bill. Section 8632 directed the FIA Program to find efficiencies through the improved use and integration of remote sensing technologies and to partner with States and interested stakeholders.

To comply with congressional direction, FIA scientists continue to investigate and develop promising techniques and applications of remote sensing for improving estimations of forest resources and collaborate with other researchers in the geospatial and remote sensing community. A long-term project called BIGMAP (Big Data, Mapping, and Analytics Platform), entered the full production phase, developed six major digital products, and will deliver FIA PlotMap, a single-plot imputation product that aids users to downscale the FIADB to a 30-meter resolution in FY 2022. BIGMAP incorporates the capabilities of ESRI Raster Analytics and ArcGIS Enterprise to support the integration of plot data and satellite data in order to add value to the FIA Program.

As the national lidar acquisition program (known as 3DEP) continues to make progress toward a complete coverage for all land in the conterminous United States, FIA is exploring

how to best incorporate lidar data to improve estimation that has the potential to yield substantial benefits, especially in small area estimation of biomass and carbon. Additionally, the FIA Program seeks to capitalize on these resources along with photogrammetrically derived point clouds including NAIP-3D by extracting lidar point clouds over fuzzed FIA plots to facilitate new and ongoing research to develop tree canopy height products and to meet additional needs for characterizing forest structure, including recovery from disturbance and assessment of trees-out-of-forest conditions.

Since 2016, FIA has supported and advanced a methodology designed to efficiently inventory the boreal forests of Interior Alaska, a region that occupies about 114 million acres. To increase the precision and efficiency of the inventory estimates, as mandated by Congress, the relatively sparse field plot sample (one plot every 30,000 acres rather than

Table 10. National performance measures of the FIA Program by fiscal year, 2013–2021.

Goal	Performance measure	FY2013 level (%)	FY2014 level (%)	FY2015 level (%)	FY2016 level (%)	FY2017 level (%)	FY2018 level (%)	FY2019 level (%)	FY2020 level (%)	FY2021 level (%)	Target
Inputs											
Maintain sufficient funding to support the base Federal FIA Program[a]	Percentage of total Federal funding necessary for annualized inventory received	85	85	89	82	82	82	84	82	68	100
Outputs											
Include 100 percent of U.S. forest lands in the FIA sample population	Percentage of Nation's forestland included in the target FIA sample population	100	100	100	100	100	100	100	100	100	100
Keep fieldwork current	Percentage of States actively engaged in the annualized inventory program	100	100	100	100	100	100	100	100	100	100
Make data accessible to national forest customers	Percentage of national forestland for which FIA data are loaded into NRIS	100	100	100	100	100	100	100	100	100	100
Outcomes											
Keep analysis current	Percentage of States with FIA State report less than 6 years old	88	90	94	96	96	96	90	94	88	100
Keep online data current	Percentage of States with FIA data available online less than 2 years old	92	96	96	96	96	96	88	90	88	100
Partners' participation	Partners' financial contributions expressed as percentage of total program funds	10	10	10	12	16	16	13	14	16	20

FY = fiscal year; NRIS = Natural Resource Information System.
[a] Revised percentage based on congressional target of $97.2 million, adjusted for inflation, for 2014–2018 FIA Strategic Plan options A, B, and C in FY 2019.

one plot every 6,000 acres as in the rest of the FIA base grid) was augmented with strip samples (covering 5 percent of the land area) of remotely sensed data collected from the G-LiHT integrated system. The airborne imaging system comprises several sensors that combine lidar, hyperspectral imaging spectroscopy, thermal imagery, and high-resolution multispectral imagery. G-LiHT allows for the mapping of composition, structure, and function of terrestrial ecosystems at high resolution. During FY 2021, G-LIHT and field data continued being collected for the first time in the third of the six units of Interior Alaska, the Southwest Unit. An effort started in this unit in FY 2020 and will continue throughout FY 2022. This is a significant step toward improving the use and integration of remote-sensing technologies in the FIA Program.

FIA continues to prioritize and enhance the collaboration with States, Federal agencies, and universities to improve and efficiently provide assessment and analysis of fundamental information for the Nation's forest resources and investments.

FIA Backdrop

During its entire 90-year history, FIA has spent a grand total of $1.4 billion from U.S. taxpayers for inventory, monitoring, and assessment of U.S. forest lands. During that time, billions of dollars have been invested by forest industries and tens of thousands of jobs created from logging, primary wood processing, and manufacturing, construction, and retail sales of wood-based products. Since 2000, FIA has invested more than $303 million into partnerships and agreements with States, dozens of universities, nongovernmental organizations, and others to collect data, conduct research, and perform analyses to improve program efficiency and support client information needs. Since 2000, FIA partners have contributed about $195 million to leverage the program to collect and process more data and information to meet local needs. FIA is a proven, cost-efficient partnership program that has consistently delivered significant value added to the taxpayers for more than eight decades. The following summaries outline the range of implementation opportunities provided in the current strategic plan. In the coming year, Congress will review these options, ask questions, and suggest adjustments that will determine its future support for the FIA Program.

OPTIONS A and B, Status Quo Option: This option maintains the 7-year East (15 percent), 10-year West (10 percent) paradigm for measurement, and these combined options place the program at the previous strategic plan target funding level.

OPTION C, National Core Option: This option maintains the 7-year East (15 percent), 10-year West (10 percent) paradigm for measuring base plots with improved remote-sensing support plus continuing the timber product output and ownership studies with enhancements and implementation of the urban forest survey.

OPTIONS D and E, Full Farm Bill Option: This option implements the full 5-year (20 percent) measurement program nationally for base plots with improved remote sensing, continued timber product output and ownership studies with enhancements, and all the other items except small area estimation based on sample intensification.

OPTION F, Leveraged Partner Option: This option is a partner opportunity. Currently States and other partners contribute nearly $11 million annually to intensify data collection, research, and analyses to improve estimates for smaller planning areas. FIA processes, maintains, and distributes the enhanced data and information.

The Government Performance and Results Act (GPRA) of 1993 directs Federal entities to develop long-term goals and performance measures to monitor progress toward those goals. Although intended for application at the agency level, the GPRA framework also provides an excellent tool for guiding progress at the project level. Table 10 shows our key goals, performance measures, and benchmarks for the FIA Program for 2013 through 2021 and targets for a fully implemented program. In FY 2021, 88 percent of all States with annualized inventories had inventory data available online less than 2 years old, a drop of 3 percentage points from previous years due to the impact of the COVID-19 pandemic in data collection during FY 2020 field season.

Conclusions

We, the FIA Program, continue to operate in an era of partnership and collaboration in which Federal and State agencies and other cooperators and stakeholders work together to plan, manage, implement, and continually improve the FIA Program. We are gathering and disseminating information on a wide array of ecological attributes, while continuing to serve our traditional customers who require timely information on forest resources. We are increasing the timeliness of our surveys and of our reporting to provide a continually updated, publicly accessible information base that includes meaningful reports, analyses, and elemental data for others to use. We are exploring and leveraging the latest technologies, including remote sensing, to expand the scope of our products and to deliver them more efficiently. We are also openly reporting on our financial information, progress, accomplishments, successes, and challenges.

In summary, the FIA Program is committed to working collaboratively with all partners to deliver the best program possible with the available resources. This report is intended to provide a transparent view of the business practices of the FIA Program, to help FIA improve business practices and to provide information to partners to help improve the program with feedback.

Glossary of Terms Used in Appendixes

■ **base Federal FIA Program**—A level of FIA Program delivery that includes sampling 10 percent of base grid (Phase 2) plots per year in the Western United States, 15 percent of base grid plots per year in the Eastern United States, with data compiled and made available annually and complete State analyses done every 5 years. A subsample of these plots also provides data on key ecosystem health indicators.

■ **base grid plots sampled**—The base grid consists of one sample location per approximately 6,000 acres (Phase 2) and one location per approximately 96,000 acres provides data on key ecosystem health indicators. Some partners chose to intensify beyond the base grid.

■ **buy down**—Plots installed at State expense to reach 20-percent implementation level of the base grid.

■ **core reports**—A class of publications that summarizes forest status and trends for a complete administrative unit, such as a whole State or a national forest. Examples include survey unit reports, State statistical and analytical reports, and national forest reports. Congressionally required 5-year State reports are part of the FIA's core reporting.

■ **direct expenses**—All expenses directly attributable to the FIA unit incurred as a part of doing FIA business. Excludes indirect business costs (such as rent, telephones, and administrative overhead outside the FIA unit staff), which are included in the "effective indirect expenses" definition. Includes work done for other units as a normal part of FIA business and the following items:

> **equipment.** Costs for durable goods used for FIA, includes the following:
>
> > **computer/telecommunications.** Additional computer hardware, software, communications costs.
> >
> > **imagery.** Aerial photos, satellite imagery data files.
> >
> > **field equipment.** Measurement tools and equipment, such as data recorders, carried by field crews.
> >
> > **other.** Any cost that does not fit into one of the previous equipment categories.
>
> **vehicles.** All vehicle costs, including items such as operating costs, depreciation, and leases.

■ **grants and agreements**—Cost of cooperative grants and agreements that directly support the FIA mission.

■ **office space and utilities**—Charges for rent, lease, or other real estate costs for FIA staff, plus utilities.

■ **other direct expenses**—Any cost that does not fit into one of the previous categories, including training costs, unemployment, office supplies, postage, awards, moving expenses, and other expenses related to delivering the FIA Program.

■ **publications**—Costs for laying out, editing, printing, and distributing publications.

■ **salary**—Includes direct salary and costs, plus benefits charged to the FIA unit, broken into the following categories:

> **administration.** Program manager, project leader, and administrative staff.
>
> **analysis and research.** Staff who analyze satellite imagery for statistical stratification, analyze collected field data, write publications, and conduct FIA-related research on methods and techniques.
>
> **field operations.** Staff who interpret photos and high-resolution images to determine forested areas and increase the efficiency of field work; collect, coordinate or support the collection of field data; and conduct quality assurance (QA) control at least 50 percent of their time.
>
> **information management.** Forestry data managers and data compilers with support staff to build data views and analytical data queries.

■ **travel**—Broken into the following categories:

> **field/QA travel.** Travel costs for field and QA crews.
>
> **office travel.** Travel costs for all staff except field and QA crews.

■ **effective indirect expenses**—Include items such as research station management and administrative salaries, operating expenses, research station budget shortfalls, and other items for which the FIA unit is assessed by their research station. Each station has its own means for determining these assessments. Rather than reporting the different rates, we simply calculate the "effective indirect expenses" item by subtraction:

Effective indirect expenses = (total available funds) – (total direct FIA expenses + end of year balance)

■ **effective indirect rate**—Effective indirect expenses divided by total available funds, which is not necessarily the same as the standard station overhead rate; instead, this rate reflects the total indirect cost as a fraction of the total funds available to FIA.

■ **ecosystem indicators**—Data collected on a subset of Phase 2 sample locations measured for a more extended set of ecosystem attributes, including tree crown condition, lichen community diversity, soil data, and down woody debris.

■ **FY (end-of-the-year) balance**—Funds reported in the previous fiscal year business report as unspent at the end of that fiscal year and presumably available for use in the current fiscal year.

■ **intensification**—Plots installed at the expense of State, National Forest System, or other partner to achieve higher-quality estimates for smaller areas or to buy the base Federal sample down to a 5-year cycle.

■ **management meetings held**—Number of national or regional management team meetings held by each FIA unit. Each regional management team consists of partners who share in funding and implementing the FIA Program. The team typically consists of representatives from the FIA unit, NFS regional offices, State and Private Forestry offices, and State forestry agencies.

■ **NGO (nongovernmental organization)**—A class of customers with whom FIA staff are asked to consult, includes environmental organizations, professional societies, and other, generally nonprofit, organizations.

■ **NIPF (nonindustrial private forest landowners)**—Private individuals or organizations that own forest land for purposes other than industrial operations.

■ **percentage of full funding**—Total available funds divided by the funding needed to fully implement the base Federal program for a given year's target funding.

■ **percentage of region covered by annual FIA**—Sum of forested acres in States currently implementing annual FIA, divided by the total number of forested acres in each FIA region; a measure of the degree to which the FIA region has moved from periodic to annual inventory.

■ **percentage of total plots sampled**—Total number of base grid plots sampled divided by the total number of plots in the base grid. Set by Congress, the current target in the East is 15 percent and 10 percent in the West.

■ **publications**—Number of publications per unit, by type of publication, as reported in official agency attainment reports. Publications are among the major outputs of the FIA Program. Types of publications include:

> **core report.** A report pertaining to reporting inventory results for a complete geographic entity. Includes the following:
>
>> **national forest report.** A complete analysis for a single national forest.
>>
>> **national report.** A report for the entire Nation, such as the Resources Planning Act Assessment.
>>
>> **regional report.** A report for a group of States or other contiguous unit larger than a single State, such as a regional assessment.
>>
>> **State resource report.** A complete statistical or analytical summary of the forested resources within a single State.
>>
>> **State timber product output (TPO) report.** A complete analysis of TPO data for a single State.
>
> **other.** Publication that does not fit into any of the previous categories, such as an abstract, book, or other government publication.
>
> **other station publication.** A manuscript published by the Forest Service, for example, a general technical report.
>
> **peer-reviewed journal article.** An article appearing in a refereed or peer-reviewed journal.
>
> **proceedings paper.** An article appearing in the proceedings from a meeting or symposium.

■ **significant consultations**—Cases in which an FIA staff person spent at least 1 hour in discussion, analysis, or research to address a specific question or need raised by an external FIA Program customer, and which is not part of our normal course of business in collecting, analyzing, and reporting FIA information.

■ **total available funds**—Total funds available for delivering the FIA Program, including funds appropriated by Congress for the FIA Program, other funds made available by Forest Service partners, and previous year carryover funds. These funds are a measure of Federal funding for the base Federal program.

■ **users group meetings held**—Number of users group meetings sponsored or attended by each FIA unit. A users group meeting is an open meeting in which a complete regional cross-section of FIA partners and customers are invited to attend. Users group meetings differ from the usual smaller meetings with one or two partners that all FIA units call as a normal course of business.

Appendix A: Contacts

For information about the status and trends of America's forests, please contact the appropriate office below.

Northern FIA Program
Program Manager, FIA
USDA Forest Service
Northern Research Station

1992 Folwell Avenue
St. Paul, MN 55108

☎ 651–649–5191

Southern FIA Program
(includes Commonwealth of
Puerto Rico and the U.S. Virgin Islands)
Program Manager, FIA
USDA Forest Service
Southern Research Station

4700 Old Kingston Pike
Knoxville, TN 37919

☎ 865–862–2000

National FIA Program Office
National Program Leader, FIA
USDA Forest Service

201 14th Street, SW
Washington, DC 20250

☎ 703–605–4177

Rocky Mountain FIA Program
Program Manager, FIA
USDA Forest Service
Rocky Mountain Research Station

507 25th Street
Ogden, UT 84401

☎ 801–625–5407

Pacific Northwest FIA Program
Program Manager, RMA (FIA)
USDA Forest Service
Pacific Northwest Research Station

620 SW Main St., Suite 502
Portland, OR 97205

☎ 503–808–2019

All regional internet home pages and a
wealth of statistical and other information
are available through the national
FIA home page at
https://www.fia.fs.usda.gov/.

Figure A-1. Forest Inventory and Analysis (FIA) Program regions (also called "units" in this report) and headquarters

Appendix B: Tables

Table B-1. Performance measures for the FY 2021 FIA Program.

	Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	Total
Total Federal funds directly invested in FIA salary and expenses						$38,664,945
Total Federal funds directly invested in FIA operations	$5,112,648	$4,043,587	$8,323,759	$5,095,374	$4,580,600	$27,155,968
Total FY21 appropriated funds directly invested in FIA operations	$3,738,441	$2,423,252	$6,404,592	$3,928,915	$2,625,800	$19,121,000
Appropriated as % of 2014 Farm Bill target[a]						22%
Contributions from partners (operations):						
Supporting the 20% FIA Program	$803,588	$395,231	$2,200,286	$976,221	$0	$4,375,326
Value-added contributions	$2,207,370	$130,160	$261,379	$4,772,759	$649,384	$8,021,051
Total partner contributions	$3,010,958	$525,391	$2,461,665	$5,748,980	$649,384	$12,396,377
Total available operational funds	**$8,123,606**	**$4,568,978**	**$10,422,824**	**$10,734,354**	**$5,229,984**	**$39,079,745**

	Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	Total
Forest plots sampled:						
Base FIA grid	1,665	1,906	5,550	4,188	-	13,309
Spatial intensification	876	-	296	1,483	-	2,655
Temporal intensification	201	-	1,396	350	-	1,947
Total forest plots sampled	2,742	1,906	7,242	6,021	-	17,911
Forest plots with one or more health indicators[b]	2,742	1,906	7,242	613	-	12,503
Number of base forest quality assurance plots	103	29	732	369	-	1,233
Percent base forest quality assurance plots	6%	2%	13%	9%	-	9%
Urban plots (forested and nonforest)	31	-	188	2,272	-	2,491
Special Studies plots (forested and nonforest)	200	-	33	-	-	233
Total base grid plots and percent sampled:[c]						
Total base grid plots	43,824	91,282	88,839	101,140		325,085
Average percent of land with forest cover	37%	24%	46%	29%		34%
Estimated percent of forest base grid sampled	10%	9%	14%	14%		12%
Percentage of States with annual FIA activity[d]	100%	100%	100%	100%		100%
Number of publications:						
National Forest System reports	-	-		-	-	-
State/island resource reports	-	-	7	1	-	8
State Timber Product Output reports	1	2	23	-	-	26
State National Woodland Owner Survey reports	-	-	-	53	-	53
Regional reports	-	-	4	2	-	6
National reports	-	-	1	2	-	3
5-Year State reports	-	-		1	-	1
Subtotal – core reports	1	2	35	59	-	97
Peer-reviewed journal articles	20	16	11	50	-	97
Proceedings articles		3		5	-	8
Other station publications	2	-	8	1	-	11
Other publications	1	5	3	26	-	35
Subtotal – nonreport publications	23	24	22	82	-	151
Total publications	**24**	**26**	**57**	**141**	**1**	**248**
Number of publications per Federal FTE	0.3	0.3	0.8	1.5	0.6	0.7
Number of publications per analyst and researcher	1.6	1.3	4.3	5.0	-	3.2
Consulting activities:						
Number of significant consultations	57	46	94	474	25	696
Total hours of significant consultations	2,565	1,646	893	2,471	710	8,285
Meetings:						
User-group meetings held	1	1	-	1	1	4
Management meetings held	1	-	-	1	4	6

FIA = Forest Inventory and Analysis; FTE = full-time equivalent; FY = fiscal year.
[a] Farm Bill target adjusted for inflation.
[b] Health indicators measured include crown condition, vegetation diversity and structure, down woody material, forest soils, nonnative invasive plant species, and lichen communities.
[c] Includes all plots where trees were measured, except denied-access and hazardous plots.

Table B-1. Performance measures for the FY 2021 FIA Program, continued.

[d] Base grid targets shown are 20 percent of samples per year as stated in the Farm Bill. Congressional conference notes recommended annual Federal targets of 15 percent in the East and 10 percent in the West. Interior Alaska as well as the Caribbean and Pacific Island inventories are periodic and excluded from the annualized mandate in compliance with congressional recommendations. The total number of grid plots does not match table 1 because table 1 also includes Puerto Rico, the U.S. Virgin Islands, and U.S. territories and affiliated islands in the Pacific.
Note: NFS funding contributions are reported as part of the total Federal funds directly invested in FIA operations and not as partner contributions. Partner funding data in this table does not match Table B4 where all NFS contributions (funding and in-kind contributions) were included.

Table B-2a. Federal funds received by the FIA Program to pay for salary and expenses, FY 2021.

		Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	Total
FIA Salary and Expenses (S&E)[a]		Dollars					
	Salary	8,201,970	8,465,648	8,109,093	11,657,304	389,312	36,823,327
	Administration	578,448	683,955	708,242	733,088	389,312	3,093,045
	Data collection/QA	4,491,255	3,760,402	3,922,740	5,172,515		17,346,912
	Information management	901,777	1,482,703	1,377,730	1,459,926		5,222,136
	Analysis & Research	2,230,490	2,538,588	2,100,381	4,291,774		11,161,234
	Travel	730,010	274,050	106,566	62,110	-	1,172,736
	Office travel	226	4,213	-	335		4,774
	Field/quality assurance crew travel	729,784	269,837	106,566	61,775		1,167,962
	Other (awards, training, overtime, boot replacement)	359,469	158,904	146,176	4,333		668,882
	Total direct FIA S&E	**9,291,449**	**8,898,602**	**8,361,835**	**11,723,747**	**389,312**	**38,664,945**
	Indirect FIA Station S&E[b]	354,875	-	0	297,075	-	651,950
	Total FIA S&E	**9,646,324**	**8,898,602**	**8,361,835**	**12,020,822**	**389,312**	**39,316,895**

EOY = end of year; FIA = Forest Inventory and Analysis; FY = fiscal year; R&D = Research and Development.
[a] Funds made available to pay for S&E charges from FIA staff.
[b] S&E from station's non-FIA staff charged towards FIA S&E.

Table B-2b. Financial statement for FIA operational funds, FY 2021.

	Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	Total
Available Federal operational FIA funds	Dollars					
Previous year end-of-year balance	169,162	448,016	92,505	182,804	0	892,487
Post-year adjustments[a]	415,045	136,044	257,495	167,196	0	975,780
Subtotal pre-year adjustments	584,207	584,060	350,000	350,000	-	1,868,267
FY21 appropriated FIA operational funds						
Initial FIA funds added to base	3,738,441	2,327,252	6,226,592	3,928,915	1,040,800	17,262,000
Secondary FIA funds added to base[b]		96,000	178,000		85,000	359,000
IT funds	-	-	-	-	1,500,000	1,500,000
Subtotal FY21 appropriated operational funds	3,738,441	2,423,252	6,404,592	3,928,915	2,625,800	19,121,000
Other Forest Service R&D funds	500,000	500,000	500,000	252,000	500,000	2,252,000
Other Forest Service R&D-IT funds	40,000				754,800	794,800
Other Federal funds[c]		266,275	941,291	434,459	200,000	1,842,025
CARES funding FY20–21[d]	250,000	270,000	127,876	130,000	500,000	1,277,876
Subtotal additional Federal funds	790,000	1,036,275	1,569,167	816,459	1,954,800	6,166,701
Total available Federal operational funds	5,112,648	4,043,587	8,323,759	5,095,374	4,580,600	27,155,968
Direct operational expenses						
Equipment--	457,459	560,132	351,614	338,633	1,136,753	2,844,591
Imagery	-	-	-	3,355	425,000	428,355
Vehicles	291,868	313,072	206,893	165,058		976,891
Field equipment	105,018	224,188	40,295	91,256	391,753	852,510
Information technology/communications	21,737	15,390	-	17,608		54,735
Other	38,836	7,482	104,426	61,356	320,000	532,100
Publications	-	7,414	-	20,118		27,532
Grants and agreements[e]	4,388,856	3,403,251	6,996,394	4,681,275	3,443,847	22,913,623
Field work/data	*3,991,380*	*2,468,911*	*5,836,044*	*2,386,457*	*210,000*	*14,892,792*
Information management	*-*			*250,000*	*1,930,000*	*2,180,000*
Research	*397,476*	*934,340*	*1,160,350*	*2,044,818*	*1,303,847*	*5,840,831*
Office space and utilities		8,991	15,984			24,975
Other direct expenses	244,107	30,717	684,931			959,755
Total direct operational expenses	5,090,422	4,010,505	8,048,923	5,040,026	4,580,600	26,770,476
EoY operations balance	22,226	33,082	274,836	55,348	-	385,492
Total FIA Federal operational expense	5,112,648	4,043,587	8,323,759	5,095,374	4,580,600	27,155,968

CARES = Coronavirus Aid, Relief, and Economic Security Act; EOY = end of year; FIA = Forest Inventory and Analysis; FY = fiscal year; R&D = Research and Development.

[a] Some bookkeeping is not completed until after the new FY begins, which may affect beginning balances. These adjustments include items such as carryover, return of unused prior-year grants and agreements, Station adjustments, etc.

[b] Midyear additions to base funding from national office-FIA.

[c] Includes funding from National Forests and other Federal agencies.

[d] Includes funds from the Coronavirus Aid, Relief, and Economic Security Act (CARES) received at the end of FY 2020 and in FY 2021.

[e] Grants and agreements include general allocation of grants to basic thematic categories and funds paid to the Forest Service Information Resources Decision Board (IRDB). The IRDB fund manages agency-sponsored information technology projects.

Table B-3a. Federal staffing, in full-time equivalent (FTE) hours, for the FY 2021 FIA Program.

	Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	Total
Administration	4.2	6.4	5.9	6.0	1.8	24.3
Field operations	58.8	43.5	36.0	47.2	0	185.4
Information management	7.4	11.1	12.1	10.8	0	41.3
Analysis and research	15.5	20.0	13.4	28.2	0	77.1
Indirect support[1]	1.6	0.5	0.0	2.0	0	4.1
Total	**87.4**	**81.5**	**67.3**	**94.3**	**1.8**	**332.3**

FIA = Forest Inventory and Analysis; FY = fiscal year.
[1] Indirect support FTEs are research station salary and expenses charged toward the tracking FIA salary budget code.

Table B-3b. Estimate of cooperator staffing, in full-time equivalent (FTE) hours, funded by FIA grants and agreements for the FY 2021 FIA Program.

	Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	Total
Administration	0.5	1.0	1.9	0.0	0	3.4
Field operations	27.7	15.1	119.3	26.0	0	188
Information management	0.1	2.4	4.3	7.0	0.0	13.8
Analysis and research	3.0	6.9	1.3	15.0	0.0	26.2
Total	**31.3**	**25.4**	**126.8**	**48.0**	**0.3**	**231.8**

FIA = Forest Inventory and Analysis; FY = fiscal year.

Table B-3c. Estimated total federally funded staffing, in full-time equivalent (FTE) hours, for the FY 2021 FIA Program.

	Pacific Northwest	Rocky Mountain	Southern	Northern	National Office	Total
Administration	4.7	7.4	7.8	6.0	2.1	28.0
Phase 1 production work	86.5	58.6	155.3	73.2	0	373.5
Information management	7.5	13.5	16.4	17.8	0.0	55.1
Analysis	18.5	26.9	14.7	43.2	0.0	103.3
Indirect support	1.6	0.5	0.0	2.0	0	4.1
Total	**118.7**	**106.9**	**194.1**	**142.3**	**2.1**	**564.0**

FIA = Forest Inventory and Analysis; FY = fiscal year.

Table B-4. Partner contributions toward implementing FIA in FY 2021.

Unit	Partner	Contributions toward the base program	Contributions that add value
		Dollars	
Rocky Mountain	Colorado State University, Colorado Forest Service	31,770	
	New Mexico State Forestry	13,500	
	USDA Forest Service Region 1	172,000	155,480
	USDA Forest Service Region 4	7,880	
	University of Montana, Bureau of Business and Economics Research	45,630	
Rocky Mountain total		**270,780**	**155,480**
National Office	Southern Utah University		81,605
	University of Nevada, Las Vegas		567,779
	USDA National Forest System	200,000	
National Office total		**200,000**	**649,384**
Northern	Alabama A&M University		30,284
	American Forest		100,000
	American Forest Foundation		155,400
	California Air Resources Board	200,000	
	City of Delta, British Columbia		6,875
	Connecticut Department of Conservation	2,000	
	Davey Tree Expert Company		333,487
	Delaware Department of Conservation	4,392	
	Environmental Protection Agency		238,000
	Illinois Division of Forestry	19,039	
	Indiana Department of Natural Resources	25,453	
	Iowa Department of Natural Resources	15,203	
	Kansas State Forest Service	16,938	
	Maine Forest Service	169,195	200,392
	Maryland Department of Natural Resources	20,730	
	Massachusetts Department of Conservation and Recreation	7,700	
	Michigan Division of Forest Management	40,200	
	Michigan State University		74,786
	Minnesota Department of Natural Resources	126,388	285,550
	Missouri Department of Conservation		18,996
	National Aeronautics and Space Administration		144,239
	National Institute for Forest Science (South Korea)		40,120
	Nebraska Department of Forestry, Fish and Wildlife	3,174	
	New Hampshire Department of Resources & Economic Development	19,600	
	New Jersey Forest Service	21,249	117,234
	New York Department of Environmental Conservation	18,195	
	North Dakota Forest Service	4,590	

Unit	Partner	Contributions toward the base program	Contributions that add value
		Dollars	
	Ohio Department of Natural Resources	13,687	
	Pennsylvania Department of Conservation & Natural Resources	43,083	6,123
	Plymouth State University		11,752
	Purdue University		28,700
	Rhode Island Department of Environmental Management	6,471	6,471
	South Dakota Department of Forestry & Natural Resource Management	51,763	
	State University of New York		22,463
	Syracuse University		8,250
	Trout Unlimited		68,622
	University of Florida		73,445
	University of Maine		18,750
	University of Massachusetts-Amherst		166,295
	University of Minnesota		80,085
	University of Minnesota		105,000
	University of New Hampshire		24,521
	U.S. Fish and Wildlife Service		24,840
	USDA Forest Service Geospatial Tech and Applications Center		70,000
	USDA Forest Service National Forest Systems (R9)		110,000
	USDA Forest Service Research & Development		650,000
	USDA Forest Service Resource Planning Act		50,000
	USDA Forest Service State and Private Forestry	61,800	395,096
	Vermont Department of Conservation	8,500	4,000
	Washington Department of Natural Resources		60,204
	West Virginia Division of Forestry	22,271	
	Wisconsin Department of Natural Resources	54,600	475,000
Northern total		**976,221**	**4,204,980**
Pacific Northwest	Alaska Department of Natural Resources	413,760	
	Alaska Pacific University		9,650
	Bureau of Land Management		231,079
	CALFIRE	71,564	729,759
	Institute of Pacific Island Forestry	12,000	
	Micronesia Conservation Trust	38,500	10,000
	NASA Goddard Space Flight Center	20,000	
	North Carolina State University		9,000
	Oregon Department of Forestry		230,630
	Oregon State University		75,613
	Portland State University		19,141

Table B-4. Partner contributions toward implementing FIA in FY 2021, continued.

Unit	Partner	Contributions toward the base program	Contributions that add value
		Dollars	
	State of Hawaii Division of Forestry and Wildlife	13,000	
	University California Berkeley		26,467
	University of Alaska Anchorage	50,131	
	University of Hawaii	22,422	
	University of Montana	152,211	
	University of Washington		20,579
	USDA Forest Service Pacific Northwest Research Station		136,500
	USDA Forest Service Region R10, Alaska	10,000	
	USDA Forest Service Region R6		708,952
Pacific Northwest total		**803,588**	**2,207,370**
Southern	Alabama Forestry Commission	176,337	-
	Arkansas Forestry Commission	152,296	-
	Florida Forest Service	557,385	-
	Georgia Forestry Commission	236,621	-
	Kentucky Division of Forestry	143,118	-
	North Carolina Forest Service	-	158,218
	Oklahoma Department of Agriculture, Food & Forestry	137,610	-
	South Carolina Forestry Commission	152,677	-
	Tennessee Division of Forestry	-	16,744
	Texas A&M Forest Service	286,129	41,289
	United States Geological Survey	12,600	-
	USDA Forest Service Region 8 (plot intensification)	350,000	-
	Virginia Department of Forestry	171,850	45,128
Southern total		**2,376,623**	**261,379**
Total, all FIA units		**$4,627,212**	**$7,478,592**
Grand total (base program and added value)			**$12,105,804**

Note: National Forest System (NFS) funding contributions included in this table are also included in table B2, they are not additional. NFS in-kind contributions are only reported here.

Table B-5. Grants and agreements entered into by FIA units, FY 2021.

Unit	Amount	Recipient	Purpose
Rocky Mountain	120,982	American West Forestry	Field Data Collection
	60,000	Colorado State University	National Tree Canopy Cover
	1,762,398	Colorado State University, Colorado State Forest Service	Field Data Collection for Colorado and Wyoming
	65,080	David Landrum	Field Data Collection
	98,040	Forest Service R&D Forest and Woodland Ecosystem Program	Soils analyses
	243,165	Integrated Resource Inventories	Field Data Collection
	18,271	Jefferson National Resources	Field Data Collection
	124,240	Native Resource Perseverence	Field Data Collection
	13,860	Paul Patterson	Statistical Consulting
	134,775	Skylight Forestry	Field Data Collection
	96,000	The Nature Conservancy—Nature Serve	Development of National Vegetation Classification System for Western FIA
	53,440	University of Maryland	National Tree Canopy Cover
	430,000	University of Montana, Bureau of Business and Economic Research	Timber Product Output
	75,000	University of Vermont	National Tree Canopy Cover
	98,000	Utah State University	Tree Ring Analyses, carbon monitoring
	10,000	Weber State University	Assessing Postfire Water Quality using FIA and Disturbance Data
Rocky Mountain total	3,403,251		
National Office	125,000	Alaska Department of Natural Resources	Field Data Collection
	175,000	GTAC	Support to the Dig Engagement Portfolio
	120,000	GTAC	Land Use Land Cover ICE programming
	140,000	GTAC	Small Area Estimation Portfolio
	25,000	GTAC	Professional Tableau service
	25,000	GTAC	Dashboarding Disturbance
	82,147	Oregon State University	Support to land-use/land-cover change
	50,000	Oregon State University	Tree Canopy cover
	40,000	Portland State University	BioSum work
	50,000	Purdue University	Invasive dashboarding
	30,000	Society of American Foresters	User Group and Timber Product Output meetings
	200,000	Southern Utah University	508 testing
	100,000	Texas A&M	My City Trees
	16,200	University of Maryland	Tree Canopy cover LiDAR
	195,500	University of Massachusetts	NWOS
	160,000	University of Minnesota	Volume and biomass modeling
	1,250,000	University of Nevada Las Vegas (UNLV)	FIA IM and Data Management support
	450,000	University of Nevada Las Vegas (UNLV)	FIA IM and Data Management support

Table B-5. Grants and agreements entered into by FIA units, FY 2021, continued.

Unit	Amount	Recipient	Purpose
Unit	Amount	Recipient	Purpose
	125,000	University of New Hampshire	Urban Development
	85,000	University of Tennessee	TPO support
National Office total	3,443,847		
Northern	11,520	AccessAbility, Inc.	Plot Packet Production for Western States
	50,000	Alabama A&M University	Integration of National Forest Inventory and Ancillary Geospatial Data
	83,310	Bergstrom, Thomas	FIA Data Collection, North and South Dakota, Urban
	250,000	Board Of Regents Nevada System Of Higher Education	Research And Development Support The FIA National Information Management System
	123,735	Chestnut Ridge Forestry	Urban FIA Data Collection
	411,687	Colorado State University	Green House Gas (GHG) emissions. Canopy cover of Eastern Red Cedar in Kansas
	405,000	Davey Tree Expert Company	i-Tree Development
	354,000	DJM Ecological Services, Inc.	Urban FIA data collection in MD, DC, DE, IA, MO, OH, IL and MA
	92,050	Huberty, Daniel	FIA Data Collection, Kansas
	86,097	Indiana State Dept. of Natural Resources	FIA Data Collection, Indiana
	375,464	Johnson, Chandler	FIA Data Collection, MI, NE, IA, and MO
	709,647	Maine Dept Of Agriculture	Annualized Forest Resource Inventory
	104,600	Mark Webb	FIA Data Collection, OH and WV
	100,000	Michigan State University	Small domain estimation using FIA data and auxiliary information. Biomass models for urban FIA
	395,618	Minnesota Dept. of Natural Resources	FIA Data Collection, Minnesota Prefield/ Rural/Urban
	10,000	National Park Service	USDA Forest Service Lease Of USDI National Park Service Office Space
	309,796	Oak Ridge Associated Universities, Incorporated	Postgraduate research associates
	49,153	Purdue University	Linkages between forest structure and land use
	113,605	University of Minnesota	Forest biometrics research. Improved estimations of land area, ecosystem services, and dynamics
	70,000	The Research Foundation for The State University of New York	Assessing forests and their benefits
	50,416	South Dakota Dept. of Agriculture	Annualized forest resource inventory
	100,000	Texas A&M University	Analytical support
	113,894	University of Florida	Quantifying changes in forest productivity
	311,683	University of Massachusetts	National woodland owner survey
Northern total	4,681,275		
Pacific Northwest	82,726	Aero Tech LLC	Data collection, transportation in Alaska

Table B-5. Grants and agreements entered into by FIA units, FY 2021, continued.

Unit	Amount	Recipient	Purpose
	2,183,097	Alaska Department of Natural Resources	Field data collection in Interior Alaska
Unit	**Amount**	**Recipient**	**Purpose**
	24,860	Alaska Pacific University	Using advanced remote sensing to estimate woody shrub biomass: pilot study in the Susitna-Copper inventory unit of Interior Alaska.
	12,616	Bureau of Land Management	Interior Alaska FIA Fuel Site in Lake Minchumina
	430,405	Coastal Helicopters, Inc.	Data collection, transportation in Alaska
	86,588	Contract services bundled for California	On-grid plot contract
	171,658	Contract services bundled for Oregon	Fire effects and recovery
	72,396	Contract services bundled for Washington	On-grid plot contract
	3,404	Firearms Training Services	Safety
	138,000	Micronesia Conservation Trust	Field data collection in Pacific Islands
	20,000	NASA Goddard Space Flight Center	Hyperspectral, LiDAR, Thermal, Aerial Photo remote sensing in Interior Alaska to extend field sampling
	50,000	NLCD national archive for LiDAR data	Improving tree canopy cover estimation and mapping (FIA contribution to NLCD) by capitalizing on expanding national archive of LiDAR data
	145,594	Oregon State University	Application and expansion of FIA monitoring data and protocols
	1,000	Parcel Quest	PS - Regional Surveyors BT-Parcel Quest License Renewal 992158
	64,000	Portland State University	Modeling economic drivers and restoration strategies on forest resilience
	49,864	University of Alaska	Analyzing soil samples to understand belowground composition in Interior Alaska
	145,325	University of Alaska, Anchorage	FIA Alaska native Science & Engineering Program Resource Assistants. Tree Growth estimation using tree-ring data
	35,522	University of California, Berkeley	Validating FVS predictions of forest biomass growth and mortality in California with inventory remeasurements
	45,000	University of Hawaii	Field data collection in Pacific Islands
	549,300	University of Montana	Timber Products Output Research
	77,500	University of Washington	Assessing forest carbon stocks using satellite Lidar. Development of a standardized attributed plot database to support the application of LiDAR and DAP to forest management
Pacific Northwest total	4,388,856		
Southern	535,012	Alabama Forestry Commission	Alabama Forest Inventory and Analysis
	456,887	Arkansas Forestry Commission	Arkansas Forest Inventory and Analysis
	115,000	Clemson University	Invasive Plant Fire Behavior Study
	466,604	Florida Forest Service	Florida Forest Inventory and Analysis
	646,564	Georgia Forestry Commission	Georgia Forest Inventory and Analysis

Table B-5. Grants and agreements entered into by FIA units, FY 2021, continued.

Unit	Amount	Recipient	Purpose
	367,602	Kentucky Division of Forestry	Kentucky Forest Inventory and Analysis
	432,425	Mississippi Forestry Commission	Mississippi Forest Inventory and Analysis
	508,236	North Carolina Forest Service	North Carolina Forest Inventory and Analysis
Unit	**Amount**	**Recipient**	**Purpose**
	245,511	North Carolina State University	Forest Health Monitoring and Assessment
	352,669	Oklahoma Department of Agriculture, Food & Forestry	Oklahoma Forest Inventory and Analysis
	100,000	Purdue University	Invasive Plant Vector Study
	387,683	South Carolina Forestry Commission	South Carolina Forest Inventory and Analysis
	424,464	Tennessee Division of Forestry	Tennessee Forest Inventory and Analysis
	798,964	Texas A&M Forest Service	Texas Forest Inventory and Analysis
	85,000	The University of Tennessee	Exploring Enhanced Methodology for FIA's Resource Use Monitoring
	80,804	The University of Tennessee	Exploring potential for market development of hardwood mass timber products
	20,000	The University of Tennessee	Assessing U.S. Roundwood Equivalent Factors
	59,995	The University of Tennessee	Analyzing and Enhancing Harvest Utilization Studies
	124,278	University of Florida	Storm Cloud - Rapid assessment of post-hurricane forest damage using cloud-based radar and optical remote sensing data
	61,973	University of Tennessee	Evaluating the sustainability of mixed-hardwood forest resources in the Eastern U.S.
	89,789	University of Tennessee	Evaluating Phodar digital surface models for operational forest inventory applications in the southeastern U.S.
	458,934	Virginia Department of Forestry	Virginia Forest Inventory and Analysis
	178,000	Virginia Tech	Multi-scale Estimation in FIA
Southern total	**6,996,394**		
Grand total	**22,913,623**		

ACES = Agriculture Conservation Experienced Services; BLM = U.S. Department of the Interior, Bureau of Land Management; CIO = Chief Information Office; DATIM = Design and Analysis Toolkit for Inventory and Monitoring; EFETAC = Eastern Forest Environmental Threat Assessment Center; ESRI = Environmental Systems Research Institute; FIA = Forest Inventory and Analysis; FY = fiscal year; G-LiHT = Goddard LiDAR, Hyperspectral and Thermal Imager; GTAC = Geospatial Technology and Applications Center, Forest Service; ICE = image-based change estimation; IITF = International Institute of Tropical Forestry; MIDAS = Mobile Integrated Data Acquisition System; NASA = National Aeronautics and Space Administration; NFS = National Forest System; NIMS = National Information Management System; NO = National Office; NWOS = National Woodland Owner Survey; ORISE = Oak Ridge Institute for Science and Education; RPA = Resources Planning Act; SE = Southeast; TPO = Timber Products Output; UNIMS = Universal National Information Management System; USDA = United States Department of Agriculture; USDOI = United States Department of the Interior.
Note: NFS cash contributions included in this table are also included in table B2, they are not additional.

Table B-6. Number and hours of significant consultations by FIA staff by customer group, FY 2021.

Customer group	Pacific Northwest		Rocky Mountain		Southern		Northern		National Office		Total			
	Number	Hours	Number	Hours	Number	Hours	Number	Hours	Number	Hours	Number	Percent	Hours	Percent
Academic	8	88	7	18	17	149	114	382	6	150	152	22%	787	9%
Government	41	2,445	31	1,533	47	480	223	1,361	6	150	348	50%	5,969	72%
Industry	-	-	1	3	17	124	44	154	5	90	67	10%	371	4%
NGO	6	26	2	21	8	126	57	114	1	120	74	11%	407	5%
NIPF	-	-			-	-	2	1	-	-	2	0%	1	0%
Media	1	4	1	15	1	3	15	24	1	60	19	3%	106	1%
Other	1	2	4	56	4	11	19	437	6	140	34	5%	646	8%
Total	57	2,565	46	1,646	94	893	474	2,471	25	710	696	100%	8,285	100%

FIA = Forest Inventory and Analysis; FY = fiscal year; NGO = nongovernmental organization; NIPF = nonindustrial private landowner.

Table B-7. FIA data access by online tools and spatial data center requests, FYs 2010–2021.

	Number of annual accesses												
Indicator	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total 2010–2021
Online tools													
DATA downloads	3,033	1,929	1,512	7,383	19,768	66,000	69,025	53,315	195,836	436,119	275,444	331,366	1,460,730
DATIM								37,000	1,605	5,129	4,755	3,768	52,257
EVALIDator	29,000	55,468	34,901	33,759	35,839	36,532	34,082	38,597	42,625	46,349	46,011	47,120	480,283
EVALIDator API							75,449	38,313	63,162	3,963,560	1,041,049	515,406	5,696,939
FIDO	70,943	72,946	52,099	57,567	57,974	47,263	33,293	11,898	4,500	-	-	-	408,483
National TPO Tool					69,600	18,544	37,000	1,092	2,652	2,771	2,400	1,400	135,459
NWOS	1,700	2,070	5,515	4,502	2,994	2,068	1,710	2,517	3,000	2,194	2,431	995	31,696
Online accesses total	104,676	132,413	94,027	103,211	186,175	170,407	250,559	182,732	313,380	4,456,122	1,372,090	900,055	8,265,847
Spatial data requests													
Academia	114	121	168	143	155	160	162	163	158	82	103	82	1,611
State	47	36	45	29	55	91	56	43	61	37	44	30	574
NFS	32	17	46	31	32	29	40	37	26	21	24	26	361
Other Federal	116	92	169	175	131	136	130	134	105	37	70	41	1,336
NGO	31	23	41	35	31	38	35	38	44	15	22	25	378
Industry	35	34	61	41	94	84	54	65	78	30	40	31	647
Other	48	91	75	67	88	66	55	59	31	20	21	22	643
Spatial data requests total	423	414	605	521	586	604	532	539	503	242	324	257	5,550

API = Application Program Interface; DATIM = Design and Analysis Toolkit for Inventory and Monitoring; FIA = Forest Inventory and Analysis; FIDO = Forest Inventory Database Online; FY = fiscal year; NFS = National Forest System; NGO = nongovernmental organization; NWOS = National Woodland Owners Survey.
Note 1: FIDO support was discontinued in FY 2019.
Note 2: Online data accesses jumped in FY 2019 due to FIA access to data through EVALIDator API for tool development.

Table B-8. Mill, fuelwood, and ownership surveys processed, and utilization sites visited, FYs 2000–2021.

		Number of annual survey questionnaires or sites											
Survey or site	Year initiated	2000–2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total 2000–2021
Timber products	1947	19,480	3,521	1,375	2,675	1,142	2,750	1,341	130	2,359	2,274	2,208	2,721	41,976
Fuelwood	1947	2,919	0	0	2,360	0	0	0	0	0	0	0	0	5,279
Ownership surveys	1978	17,281	7,960	4,028	5,262	0	0	0	5,254	6,407	1,713	3,135	3,105	54,145
Utilization sites	1947	569	58	162	189	105	216	162	39	219	132	118	97	2,066

FY = fiscal year.
Note 1: Ownership survey data included in fiscal years 2018 and 2019 corrects data reported in previous reports.
Note 2: FIA no longer conducts surveys to estimate fuelwood consumption. Industrial fuelwood estimates are part of the TPO mill surveys. Residential fuelwood estimates are calculated from the U.S. Department of Energy Residential Energy Consumption Survey, and the U.S. Census Bureau American Community Survey.

Table B-9. Forest health indicator, year of initiation, and number of plots sampled FYs 2000–2021.

Indicator	Year initiated	Total 2000–2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total 2000–2021
			Number of annual samples											
Crown condition	1991	10,205	-	1510	5,031	3,813	4,437	5,399	5,723	6,438	4,705	4,572	4,463	46,091
Lichens	1998	3,122	-	33	0	98	61	193	197	351	257	0	-	1,190
Soils	1999	6,481	2	595	565	439	487	456	716	426	791	394	836	5,707
Vegetation profile	2001	19,568	1,624	7,145	6,703	7,098	6,666	6,757	6,294	7,025	7,000	5,497	6,168	67,977
Ozone	1994	11,073	107	0	-	-	-	-	-	-	-	-	-	107
DWM	2001	23,881	1,414	6,263	8,271	8,635	8,186	8,459	9,234	9,277	8,188	7,203	7,280	82,410
Invasive species	2013	-			8,389	10,402	10,276	10,753	12,045	11,898	11,116	10,256	11,399	96,534
Mortality[a]	2001	87,970	15,858	20,275	13,859	17,308	16,825	14,606	17,083	16,825	16,116	16,942	16,810	182,507

FY = fiscal year; DWM = down woody material.
[a] Number of remeasured annual inventory plots from which tree mortality can be estimated.
Note: In 2013, all FIA units adopted the national invasive species protocol to collect data on nonnative invasive species. Although not included in this table, FIA data collection on nonnative invasive species, using regional protocols, goes back as early as 1999 in some States. This is the first year FIA reports on the number of plots sampling nonnative invasive species using the national protocol.

Table B-10. Status of FIA surveys in U.S. islands and territories in FY 2021.

Region and area	Land area in inventory (Acres)	Forest Area (Acres)	Percent forest	Number of major islands	Fiscal year of current inventory cycle end	Fiscal year of inventory available in database	Fiscal year of published report	Number of base field plots	Number of forest health (Phase 3) plots	Number of intensified plots	Available online data
Pacific (PNW)											
American Samoa	48,434	43,631	90%	4	2022	2012	2020	28		0	Yes
Guam	135,660	63,833	47%	1	2023	2013	2020	66		70	Yes
Palau	110,028	90,685	82%	10	2024	2014	2007	56		0	Yes
Commonwealth of the Northern Mariana Islands	75,546	51,009	68%	3	2025	2015	2012	37		0	Yes
Federated States of Micronesia	161,917	143,466	89%	4	2026	2016	2012	78		78	Yes
Marshall Islands	33,182	23,230	70%	10	2028	2018	2012	50		20	Yes
Hawaii	4,141,469	1,990,000	48%	8	2021	2015	in progress	554		82	Yes
Atlantic (SRS)											
Commonwealth of Puerto Rico	2,192,327	1,219,178	56%	4	2024	2019	2019	208	135	61	Yes
U.S. Virgin Islands	82,164	46,967	57%	3	2024	2014	2020	88	52*	25	Yes
Total	6,980,727	3,671,999	53%	47				1,165		336	

FIA = Forest Inventory and Analysis; PNW = Pacific Northwest Research Station; SRS = Southern Research Station.
Note 1: The 2019 inventory year for the U.S. Virgin Islands, scheduled to start collecting field data in FY 2020, was delayed due to COVID-19.
Note 2: Periodic inventories do not enter data in the FIA database until full cycle is completed. For interior Hawaii data check: https://www.fs.usda.gov/pnw/tools/pnw-fia-hawaii-inventory-database.

Table B-11. Land and forest area and FIA annualized implementation status by State and region, FY 2021.

Region and State	U.S. Census Bureau land area	Forest land area defined by 2017 RPA Assessment	Annual inventory entry date	State annualized as of 2019
	Thousand acres		*Year*	
Northern	**606,841**	**182,587**		**24**
Connecticut	3,099	1,808	2003	Yes
Delaware	1,247	361	2004	Yes
Illinois	35,532	4,980	2001	Yes
Indiana	22,929	4,876	1999	Yes
Iowa	35,749	2,923	1999	Yes
Kansas	52,326	2,527	2001	Yes
Maine	19,739	17,579	1999	Yes
Maryland	6,252	2,463	2004	Yes
Massachusetts	4,992	3,025	2003	Yes
Michigan	36,185	20,311	2000	Yes
Minnesota	50,961	17,413	1999	Yes
Missouri	43,995	15,409	1999	Yes
Nebraska	49,167	1,532	2001	Yes
New Hampshire	5,730	4,758	2002	Yes
New Jersey	4,707	1,990	2004	Yes
New York	30,161	18,887	2002	Yes
North Dakota	44,161	789	2001	Yes
Ohio	26,151	8,077	2001	Yes
Pennsylvania	28,635	16,898	2000	Yes
Rhode Island	662	370	2003	Yes
South Dakota	48,519	1,949	2001	Yes
Vermont	5,899	4,511	2003	Yes
West Virginia	15,384	12,077	2004	Yes
Wisconsin	34,661	17,074	2000	Yes
Southern	**533,031**	**245,513**		**13**
Alabama	32,413	23,127	2001	Yes
Arkansas	33,303	19,040	2000	Yes
Florida	34,447	17,253	2001	Yes
Georgia	36,809	24,635	1998	Yes
Kentucky	25,271	12,442	1999	Yes
Louisiana	27,650	14,984	2000	Yes
Mississippi	30,031	19,380	2007	Yes
North Carolina	31,115	18,829	2003	Yes
Oklahoma	43,901	11,911	2008	Yes
South Carolina	19,239	12,931	1998	Yes

Table B-11. Land and forest area and FIA annualized implementation status by State and region, FY 2021, continued.

Region and State	U.S. Census Bureau land area	Forest land area defined by 2017 RPA Assessment	Annual inventory entry date	State annualized as of 2019
Tennessee	26,390	13,967	1999	Yes
Texas	167,188	40,970	2000	Yes
Virginia	25,274	16,043	1998	Yes
Rocky Mountain	**547,691**	**123,844**		**8**
Arizona	72,700	10,934	2001	Yes
Colorado	66,331	20,063	2002	Yes
Idaho	52,892	21,386	2004	Yes
Montana	93,149	25,517	2003	Yes
Nevada	70,260	7,487	2010	Yes
New Mexico	77,631	16,619	2008	Yes
Utah	52,589	12,087	2000	Yes
Wyoming	62,140	9,751	2010	Yes
Pacific Coastal	**573,389**	**213,391**		**4**
Alaska, Coast	39,041	14,426	2004	Yes
Alaska, Interior	326,575	114,151	2016	Periodic
California	99,699	31,515	2001	Yes
Hawaii	4,110	1,471	2010	Periodic
Oregon	61,432	29,653	2001	Yes
Washington	42,532	22,174	2002	Yes
Total	**2,260,953**	**765,335**		**49**
Forest area performance measure, excluding Interior Alaska				100%
Forest area performance measure, including Interior Alaska				91%
State activity performance measure, includes all active States				100%

FIA = Forest Inventory and Analysis; FIADB = Forest Inventory and Analysis Database; FY = fiscal year; RPA = Resources Planning Act.

Table B-12. FIA summary statistics and performance measures, FYs 2012–2021.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Available funds directly invested (in thousand $)										
S&E funds directly invested in FIA										38,665
Operational funds										17,621
IT operational funds										1,500
Total apropriated funds directly invested in FIA	69,186	65,567	66,805	70,000	75,000	77,000	77,000	78000*	77,000	57,786
Other Federal operational funds[a]	528	2,668	3,077	743	304	85	2,377	3,617	3,223	8,035
Total Federal funds	69,714	68,235	69,882	69,882	75,304	77,085	79,666	81,617	80,223	65,821
Partner funds[b]	10,129	7,772	7,833	8,972	10,176	10,906	10,883	11,735	12,860	11,426
Total available funds	79,843	76,007	77,715	77,715	85,480	87,991	90,549	93,351	93,083	77,247
% Full Federal appropriated funding[c]	81%	76%	74%	78%	82%	83%	81%	80%	78%	68%
Program expenses and balances (in thousand $)										
Administration	2,735	2,854	3,036	2,703	2,759	3,632	3,532	3,714	3,090	3,098
Image processing	*519*	*589*	*597*	*635*	*761*	*680*	*833*	*981*		
Field support	*3,946*	*4,151*	*4,082*	*3,782*	*4,029*	*3,797*	*3,770*	*3,776*		
Data collection	*24,387*	*22,559*	*23,590*	*22,807*	*26,888*	*28,369*	*26,952*	*28,610*		
Combined field operations[d]	28,852	27,299	28,269	27,225	31,678	32,847	31,555	33,366	31,678	35,665
Information management[d]	6,740	5,933	6,737	7,680	7,962	7,599	8,807	7,920	7,872	7,457
Analysis	*6,570*	*6,695*	*7,058*	*6,907*	*6,800*	*6,534*	*6,575*	*6,453*		
Research[c]	*6,075*	*6,690*	*7,072*	*6,111*	*7,084*	*8,482*	*7,050*	*6,680*		
Combined analysis and research[d]	12,645	13,385	14,131	13,017	13,884	15,016	13,625	13,133	14,254	17,002
Miscellaneous/other	3,882	3,652	3,864	5,025	4,342	2,909	2,933	2,717	2,998	2,218
Total direct expense	54,854	53,124	56,037	55,651	60,625	62,002	60,452	60,850	59,894	65,440
Total indirect expenses[e]	14,180	14,704	13,461	14,708	14,652	15,083	16,587	19,076	19,437	652
Indirect rate	20.5%	22.4%	20.2%	21.0%	19.5%	19.6%	24%	23%	24%	2%
Fire transfer				449	181	-	-	-	-	-
Total EOY balance[f]	680	407	384	312	452	120	137	632	892	385
Total Federal expense	69,714	68,235	69,882	71,119	75,910	77,205	79,529	80,147	80,223	66,477
Other measures										
% States with annual activity	100	100	100	100	100	100	100	100	100	100
% Annualized States with FIADB 1-2 yrs old	94	94	96	96	96	96	94	86	88	87.5
Federal employees	372	366	366	338	352	341	339	382	379	334
Other employees	203	184	204	185	213	209	220	237	224	232
Total employees	575	550	570	523	565	550	559	618	602	566
P2 base forest plots	19,673	21,263	19,789	18,346	14,308	15,543	14,598	14,848	13,502	13,309
P2 base QA plots	4,417	5,465	2,312	3,083	1,529	2,199	2,171	1,839	1,730	1,233
Percent QA plots	9%	11%	5%	7%	11%	11%	15%	12%	13%	9%
All publications	272	238	234	236	371	206	211	204	239	248
Journal publications	90	90	87	122	122	92	122	112	101	97
Percent journal publications	33%	38%	37%	52%	33%	45%	58%	55%	42%	39%
Consultations, number	848	824	945	1,350	1,289	1,341	1,648	950	1,434	696
Consultations, hours	8,807	8,124	7,987	13,806	7,547	8,781	8,000	7,764	16,735	8,285
User/management meetings	15	12	14	13	12	9	14	19	16	10
Spatial data requests filled	605	605	586	604	532	586	503	242	324	257
Online accesses	94,027	103,211	186,175	170,407	250,559	182,732	310,758	4,456,122	1,372,090	900,055

EOY = end of year; FIA = Forest Inventory and Analysis; FIADB = Forest Inventory and Analysis Database; FY = fiscal year.
[a] Includes return of previous year carryover, return of fire transfers, and additional Forest Service research commitments.
[b] Includes partner contributions toward the base program and partner contributions that add value.
[c] Considering full program implementation funding to achieve 2007 Strategic Plan for FY 2007 through 2013, and Strategic Plan for FY 2014 through present for options A through C. Full funding was adjusted for inflation.

Table B-12. FIA summary statistics and performance measures, FYs 2012–2021, continued.

[d] Includes Federal grants and agreements.
[e] In FY 2021, indirect expenses and rate related to the salary and expenses of non-FIA employees tracked with FIA budget code.
[f] In FY 2021, EOY balance is for the appropriated operational funds. It does not include salary and expenses budgeted by the agency
* Includes $1 million supplemental appropriation for hurricane relief.
Note 1: Indirect expenses rate jumped in FY 2018 because of the Forest Service approach, adopted that year, to charge cost pools, which were considered an indirect expense rather than a direct expense in this report.
Note 2: Online data accesses jumped in FY 2019 due to FIA access to data through EVALIDator API for tool development.
Note 3: National Forest System (NFS) funding contributions are reported as part of "other Federal operational funds" and not as "partner contributions." Partner funding data in this table does not match table B4 where all NFS contributions (funding and in-kind contributions) were included.