



United States  
Department of  
Agriculture  
Forest Service

## Forest Service Research and Development

# R & D

## Fiscal Year 2011 Performance and Accountability Report





# Accountability Report

Fiscal Year 2011

## About This Report

The Government Performance and Results Act of 1993 requires all Federal agencies to engage in a strategic planning process that aligns resources with results and improves the accountability of all Government activities to the American people.

This process focuses on results and includes the development and implementation of a 5-year strategic plan. Annual reporting identifies specific, measurable targets for performance at the beginning of each fiscal year and a year-end assessment of the success of these endeavors.

This *Fiscal Year 2011 Performance and Accountability Report (PAR)* is the year-end progress report of the U.S. Department of Agriculture (USDA), Forest Service, Research and Development (R&D) Deputy Area. The data that Forest Service R&D used to measure performance are collected using standardized methodology that conforms to generally recognized principles for reporting.

This report outlines the Forest Service R&D organization, describes how it has applied the public's investments, and provides an accounting of budgets and accomplishments. It helps policymakers make informed decisions and presents an overview for all Americans interested in the workings of their Government and R&D's ability to manage for results in delivering its information, technology, and applications.

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## Message From the Deputy Chief

I am pleased to present the Forest Service Research and Development (R&D) *Fiscal Year 2011 Performance and Accountability Report (PAR)*. This report presents key budget and financial information and programmatic performance in measuring the success of the Research and Development (R&D) mission of the Forest Service, U.S. Department of Agriculture (USDA). The PAR provides transparency and accountability to the American people, highlights areas of demonstrated excellence, identifies areas that need improvement, and presents opportunities for redirecting research efforts to high-priority issues.



For example, this year we elevated the agroforestry program to build on significant science and technology advances we have made in the past 20 years due to Forest Service R&D and State and Private Forestry (S&PF) investments in the USDA National Agroforestry Center (NAC) and the work of NAC's national network of partners. As part of the new interagency agroforestry team, Forest Service R&D will play a key role in developing and delivering the science that helps landowners use agroforestry for both its economic and conservation benefits.

Funding for Forest Service R&D decreased by about 2 percent in fiscal year (FY) 2011 from FY 2010 funding. R&D's portion of the total Forest Service budget, however, continued to represent nearly 6 percent. I believe this reflects a commitment by the Forest Service to recognize our value to our constituents and the importance of science in achieving the overall goals of the agency. Today's Government managers know that leaner, more priority-focused programs are our new reality. We are challenged in this new time of austerity to deliver relevant results with fewer resources and to divert our attention from some research if the resources are not available or the return on investment isn't sufficient. The change we are undergoing requires extreme focus on the most critical research topics to deliver quality science and technology to the American taxpayer. Even in the face of resource constraints, Forest Service R&D scientists have the skills, public support, and commitment to research the multitude of problems and to provide land managers throughout the United States, and internationally, with the information and tools they need to ensure success in providing the resources and experiences that people desire.

Forest Service R&D supports the Forest Service mission of *sustaining the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations* through dedicated scientists and technical staff. We continue to focus on developing a diverse workforce, instilled with a culture of safety, whose work is recognized worldwide for contributions to basic scientific knowledge and cutting-edge applications.

A handwritten signature in blue ink that reads "Jimmy L. Reaves".

Jimmy L. Reaves  
Deputy Chief for Research and Development

## The R&D Mission

The Research and Development (R&D) mission of the Forest Service, U.S. Department of Agriculture (USDA), is to develop and deliver knowledge and innovative technology to improve the health and use of the Nation's forests and grasslands—both public and private. R&D provides this information to landowners, managers, policymakers, and the American people to help inform their decisions and actions.

Forest Service R&D scientists conduct research in the 50 States and all U.S. territories on both Federal and non-Federal lands. They integrate efforts on national, regional, and local research needs and scientific issues to address critical problems such as climate change, invasive species, and the need for alternative sources of energy in a coordinated and strategic manner. Forest Service R&D uses and contributes research to the international scientific community to inform policies and natural resource practices worldwide and works with scientists from around the globe to solve problems of common interest.

The ability to manage public lands for sustainable benefits and to promote sustainable management of natural resources on private land requires a continuum of both qualitative and quantitative information about the health, condition, productivity, and use of forests and grasslands. Forest Service R&D provides land and resource managers with the scientific, social, and economic tools they need for achieving the desired outcome to care for the land and serve people, now and in the future.

Forest Service researchers work independently and with a range of partners to provide land managers with information and technology to make management and land use decisions on issues such as invasive species, healthy watersheds, wildfires, climate change, and traditional and alternative forest products. The Forest Service R&D workforce includes scientists and technicians in the biological, physical, and social science fields, working in partnership with researchers from other agencies, academia, nonprofit groups, and industry.

## Organizational Structure

The R&D mission area has been a vital part of the Forest Service since the agency's inception in 1905. The organization consists of seven research stations, including the International Institute of Tropical Forestry and the Forest Products Laboratory, and 80 experimental forests and ranges. R&D interacts with national forests in nine regions and with the State and Private Forestry (S&PF) Deputy Area throughout the United States. Forest Service R&D is also allied with agencies in the USDA Research, Education, and Economics mission area that consist of the Agricultural Research Service (ARS); National Institute of Food and Agriculture;

National Agricultural Statistics Service; and ARS' National Agricultural Library. Forest Service R&D also partners with other Federal agencies, nongovernmental organizations, universities, and the private sector.

## Headquarters Staff

Forest Service R&D is organized into six staff groups that ensure scientific and programmatic consistency and synergy among the research stations and national headquarters, provide science-based leadership in agency policy decisionmaking, and provide strategic leadership and evaluation across broad program areas. This structure helps to ensure timely and effective coordination and cooperation with other deputy areas within the Forest Service; with USDA, other Federal agencies, the Office of Management and Budget, and Congress; and with key non-Federal clients and stakeholders. By disseminating relevant research information and new technologies, this structure also helps headquarters make science-based policy and management decisions, ensures the consistent application of standards and procedures, and builds support for continued investments in research programs, facilities, and employees.

The **Forest Management Sciences** staff provides research oversight and leadership in connection with wise natural resource policies and new options for protecting and managing forest and rangeland resources. A major focus is developing approaches to protect the health, diversity, and productivity of the Nation's forest and rangeland resources from natural and human-caused disturbances, such as climate change, fire, and invasive species.

The **Resource Use Sciences** staff provides research oversight and leadership in connection with improving the sustainable production and utilization of goods and services from natural resources and evaluating the potential of new and emerging goods and services. Three major foci are (1) new wood products and the performance of those products for a wide variety of uses, including the harvesting and processing of wood for emerging markets, such as bioenergy, along with improved performance of traditional products; (2) services, including outdoor recreation and ecosystem services; and (3) the human dimensions of resource use, including social sciences and cultural heritage influences on resource uses.

The **Environmental Sciences** staff provides research oversight and leadership in connection with wise natural resource policies and new options for protecting and managing the ecological components of forests and rangelands other than trees. A major focus is developing approaches to protect and manage watersheds for both water and aquatic habitats for fish and other creatures; soils to prevent erosion and maintain productivity; air quality; and terrestrial habitats for wildlife.

The **Quantitative Sciences** staff provides research oversight and leadership in connection with monitoring the conditions of forests and rangelands and

detecting changes in their health and productivity in time to adapt management activities to avoid detrimental outcomes. The major foci include (1) designing and conducting inventory, monitoring, and analysis activities of the Nation's forests and grasslands and related natural resources; (2) establishing and monitoring indicators of environmental sustainability; (3) assessing the status and condition of renewable resources, such as forests and rangelands, timber, water, fish and wildlife, and outdoor recreation; and (4) providing liaison and collaboration in the international research community on forest science and related policy issues.

The **Science Quality Services** staff provides leadership, development, and oversight of strategic planning and performance accountability; technology development and applications; agency patent and licensing activities; science education; and information management and technology for Forest Service R&D activities.

The **Policy Analysis** staff provides the Forest Service Chief and staff with timely, objective, and high-quality analyses of issues and events important to the productivity, health, and sustainability of the Nation's natural resources and agency policies, programs, and practices.

## Strategic Program Areas

Forest Service R&D organizes research under seven Strategic Program Areas (SPAs), which support an integrated approach to the study of broad, complex environmental and social issues. Within this structure, researchers address the Forest Service strategic goals and objectives at the watershed, landscape, regional, and national levels to focus research on the large-scale problems of national concern identified in the *USDA Forest Service Strategic Plan: FY 2007–2012*. SPAs provide consistent and stable, nationally strategic subdivisions of the national Forest Service research program for purposes of program development; management of review and oversight; communication to national audiences, including national interest organizations, the Administration, Congress, and the general public; budget formulation and presentation; and fostering integration and collaboration among research stations and between stations and external partners.

The **Wildland Fire and Fuels SPA** provides the knowledge and tools that managers use to reduce negative effects and enhance beneficial effects of fire and of fire and fuels management on society and the environment. The SPA has five major focus areas: (1) understanding and modeling fundamental fire processes, (2) interactions of fire with ecosystems and the environment, (3) social and economic aspects of fire, (4) evaluation of integrated management strategies and disturbance interactions at multiple scales, and (5) application of fire research to address management problems.

The **Invasive Species SPA** provides scientific information, methods, and technology to understand, reduce, minimize, or eliminate the introduction, establishment, spread, and effects of invasive species (and interactions with disturbance) and to restore ecosystems affected by invasive species or restore their functions. The SPA focuses on plants, animals, fish, insects, diseases, invertebrates, and other species that are not native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm.

The **Outdoor Recreation SPA** provides human and ecological sustainability through research directed at understanding and managing outdoor environments, activities, and experiences that connect people with the natural world. Research in this SPA is interdisciplinary and focuses on nature-based recreation and changing trends in American society; connections among recreation visitors, communities, and the environment; human benefits and consequences of recreation and nature contact; the effectiveness of recreation management and decisionmaking; and sustaining ecosystems affected by recreation.

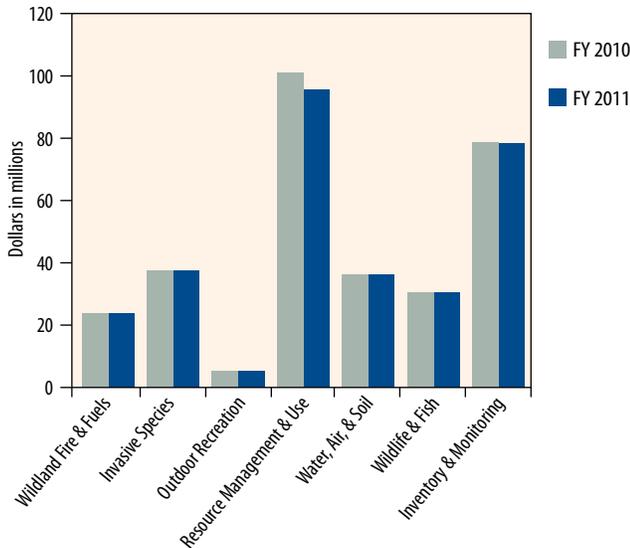
The **Water, Air, and Soil SPA** enables the sustainable management of these essential resources by providing clear air and safe drinking water, protecting lives and property from wildlife fire and smoke, and adapting to climate variability and change. The SPA features ecosystem services with a high level of integration among water, air, and soil research. It stresses the effects of climate variability and change on water budgets, and it focuses on carbon sequestration from an ecosystem perspective.

The **Inventory and Monitoring SPA** provides the resource data, analysis, and tools needed to effectively identify current status and trends of forests; management options and effects; and threats and effects of fire, invasive insects, disease, and other natural processes, enhancing use and value of the Nation's forests and grasslands. Assessing current and potential effects of changes in climate is dependent on monitoring forest ecosystems that are at the greatest risk to rapid changes in climate. Focus areas include the development and use of integrated interdisciplinary science, technologies, and remote sensing to increase the timeliness and spatial resolution of forest fragmentation caused by land use change; to describe the incidence of invasive insects, disease, and fire; to understand forest carbon pools; and to reduce the effects caused by extreme weather events.

The **Wildlife and Fish SPA** relies on interdisciplinary research to inform policy initiatives and management strategies affecting wildlife and fish habitat on private and public lands and the recovery of threatened or endangered species. Scientists in this SPA investigate the complex interactions among species; ecosystem dynamics and processes; land use and management; and emerging broad-scale threats, including global changes in climate, loss of open space, invasive species, and disease.

The **Resource Management and Use SPA** provides the scientific and technological base to sustainably manage and use forest and range resources and forest fiber-based products. Focus areas include plant sciences, soil sciences, social sciences, silviculture, genetics, productivity, forest and range ecology management, harvesting and operations, forest and biomass products and utilization, global change, economics, and urban forestry.

**Funding to Strategic Program Areas,  
2010–2011**



## Research Locations

Forest Service R&D strives to be recognized as a world leader in innovative science for sustaining global forest resources for future generations. R&D provides the information and solutions to sustain forests and grasslands and the values they provide for people. Our research benefits the owners and managers of working forests and farms, helps restore healthy forests, and protects communities. Forest Service R&D operates seven research stations, including the Forest Products Laboratory and the International Institute of Tropical Forestry in Puerto Rico. Forest Service R&D employs approximately 500 scientists and hundreds of technical and support personnel, who are located at 67 field sites throughout the United States, Puerto Rico, and the U.S.-affiliated territories and nations of the Pacific.

The **Northern Research Station (NRS)**, headquartered in Newtown Square, PA, has research and development programs across 20 States in the Midwest and Northeast (CT, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT, WI, and WV). The NRS was formed in 2006 through the consolidation of the former North Central and Northeastern Research Stations. The station’s research products and technologies provide the knowledge and tools to protect people and forest landscapes from the threat of

undesirable disturbances, improve the quality of life in urban areas through natural resources stewardship, maintain and enhance forest productivity and benefits, and increase production of clean water and air for a growing human population.

The **Southern Research Station (SRS)**, headquartered in Asheville, NC, conducts research programs across 13 States (AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, and VA). The SRS mission is to create the science and technology needed to sustain and enhance southern forest ecosystems and the benefits they provide to the public. The SRS realigned its organizational model from 28 research work units into 15 units grouped under 5 science areas that clearly define core strengths. These areas include threats to forest health; forest ecosystem restoration and management; forest values, uses, and policies; forest watershed science; and forest inventory and monitoring.

The **Rocky Mountain Research Station (RMRS)**, headquartered in Fort Collins, CO, conducts research across 12 States in the Interior West (AZ, CO, ID, KS, MT, ND, NE, NM, NV, SD, UT, and WY). Research at the RMRS is organized into seven science programs, plus a science application program that oversees two Research, Development, and Application (RD&A) units. The RMRS employs more than 400 professional, technical, and administrative personnel and 95 research scientists. These scientists and professionals, in collaboration with a variety of Federal, State, and university partners, develop high-quality scientific information responsive to land management and natural resources policy issues related to water supply, fire suppression and use, invasive species, wildlife and fish, climate change impacts, forest products use, human relationships to the land, and forest and grassland ecosystem restoration.

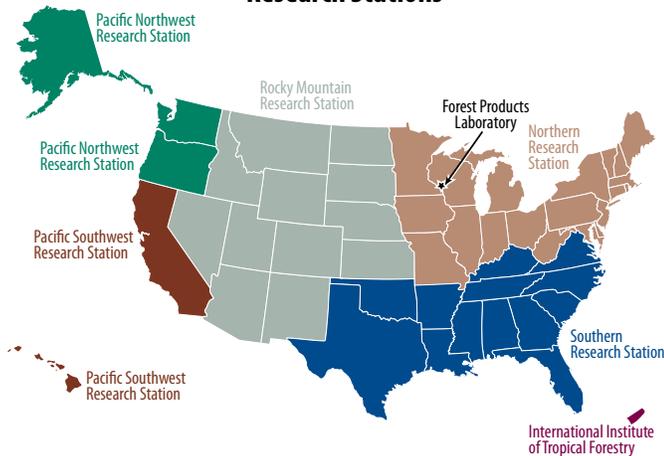
The **Pacific Northwest Research Station (PNW)**, headquartered in Portland, OR, maintains research and development programs in three States (AK, OR, and WA). PNW, which provides scientific information to land managers, policymakers, and citizens, employs about 500 people. Like the other stations, its mission is to generate and communicate scientific knowledge that helps people understand and make informed choices about people’s behaviors and attitudes, natural resources, and the environment.

The **Pacific Southwest Research Station (PSW)**, headquartered in Albany, CA, conducts research, development, and applications programs in CA, HI, and the U.S.-affiliated territories and nations of the Pacific. The PSW’s primary work occurs in California (the most populous State with the eighth largest economy in the world) and Hawaii (a strategic location in the Pacific Rim economies and tourism industry). The station develops and delivers science-based information, technologies, understanding, and applications to help people make well-informed decisions about natural resource management, conservation, and environmental protection.

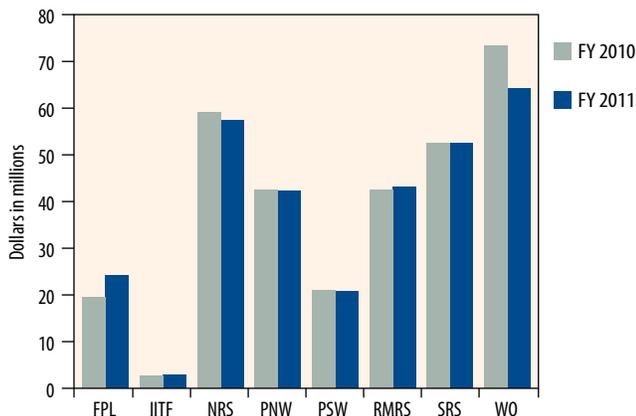
The **Forest Products Laboratory (FPL)**, located in Madison, WI, is concerned with the long-term health of the Nation's forests and how the Nation depends on sound conservation practices, including utilization. FPL uses science and technology to conserve and extend the Nation's forest resources and to develop innovative wood-related products. FPL's mission is to promote healthy forests and forest-based economies through the efficient, sustainable use of wood resources.

The **International Institute of Tropical Forestry (IITF)**, located in Rio Piedras, PR, has one work unit. The mission of this unit is to generate and disseminate scientific information in support of the sustainable use of tropical forests. The IITF accomplishes its mission by developing and disseminating knowledge of scientifically sound practices that contribute to the sustainable use of forest resources, conservation of primary and secondary forests, rehabilitation of degraded lands, and management of wildlife and watersheds. This work is conducted through an extensive network of collaborators at home and abroad.

### Research Stations



### Funding to Research Stations and Washington Office, 2010–2011



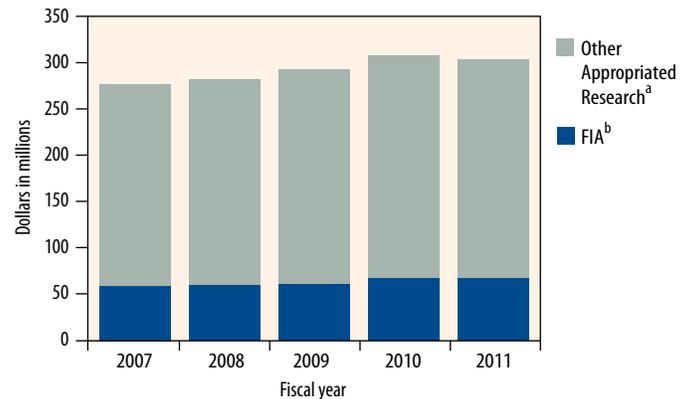
FPL = Forest Products Laboratory, IITF = International Institute of Tropical Forestry, NRS = Northern Research Station, PNW = Pacific Northwest Research Station, PSW = Pacific Southwest Research Station, RMRS = Rocky Mountain Research Station, SRS = Southern Research Station, and WO = Washington Office.

## Foundation Programs

Two *foundation programs* provide the infrastructure to sustain and expand Forest Service R&D's research temporally and spatially.

The **Forest Inventory and Analysis (FIA)** program, a congressionally mandated census of the resources of U.S. forests, is conducted in partnership with the State foresters and S&PF. The program, which operates out of NRS, PNW, RMRS, and SRS, is coordinated nationally from the Washington Office. The FIA program assesses and reports on the status and trends in tree species, size, and health; forest area and location; tree growth, mortality, and removal by harvest; wood production and utilization; and forest land ownership. The FIA assessments extend to the trust territories and Puerto Rico and include reports on changes in carbon budgets and forest health. R&D manages the program in cooperation with S&PF and NFS and implements the program in cooperation with a variety of partners, including State forestry agencies and private landowners who grant access to their lands for data collection.

### Forest Inventory and Analysis Portion of Research Appropriation



<sup>a</sup> Includes research and facilities maintenance.

<sup>b</sup> Research and Development, Forest Inventory and Analysis only; does not include Forest Resource Information and Analysis.

The **Experimental Forests and Rangelands (EFR)** program provides the venue for long-term research in which Forest Service R&D scientists can address regional- to continental-scale environmental change issues in rural and urban areas. The 80 experimental forests and ranges comprise lands dedicated to research that have been authorized by Congress and designated by the Chiefs of the Forest Service over the past 100 years. The EFR network, which has developed progressively since its inception in 1908, provides study sites for examining a wide variety of ecological questions that are specifically designed to address contemporary management challenges. Many of these sites are more than 50 years old and support research in all the major forest and rangeland vegetation types and geographical areas of the continental United States.

The EFRs are considered living laboratories, where Forest Service R&D can provide demonstrations of research project outcomes and results to cooperators and stakeholders. They represent some of the few places where ecological research can be maintained over the long term and perpetuate experimental studies far beyond the term of any individual scientist's career.

## Our People

In FY 2011, Forest Service R&D had 2,192 full-time employees (FTEs), including research scientists, biological and forestry technicians, statisticians, and administrative and technical support staff.

Over the past 5 years, the number of research scientists in Forest Service R&D has been fairly stable. In FY 2011, Forest Service R&D had approximately 537 full-time scientists, in line with 2010. R&D has been adopting a broader, more integrated approach to how we study the environment. Our researchers now have wider skill sets than the historically more specialized single-discipline scientists. Today's scientists can solve problems of national and regional scope across many landscapes. Forest Service R&D facilitates multidisciplinary, integrated programs and work units to focus on larger scale research rather than the more narrowly defined work units of the past.

### Research Scientists, Fiscal Years 2007–2011

Fiscal Year	2007	2008	2009	2010	2011
R&D FTEs	2,283	2,283	2,186	2,192	2,192
Research scientists	547	498	498	538	537

R&D = Research and Development. FTEs = Full-time employees.

The public's heightened concerns about climate change, alternative energy, clean and abundant water, and loss of open space from urban expansion have given the Forest Service R&D community a greater role in providing science for policy decisionmaking. Hiring programs, such as the Scientist Recruitment Initiative, have been successful in attracting entry-level scientists to Forest Service R&D who will be positioned to research the current environmental and social issues facing the Nation's forests and grasslands. Upon completion of their doctoral degrees, the students in the program will fill permanent scientist positions identified by program, research, workforce, and diversity needs.

## Collaboration

Forest Service R&D's enterprise consists of high-quality scientific research, applying findings to NFS lands and making these findings available to others for application to their lands. Forest Service R&D distributes information and technology to land managers and land use planners through a variety of mechanisms, including publications, videos, training, and demonstrations. R&D's ability to interact with users of its research and transfer technology is substantially enhanced through partnerships, particularly those with other research organizations, land management practitioners, State agencies, urban planners, private forest owners, private organizations, and horticultural and agricultural interests.

These partners of Forest Service R&D include Federal and State agencies, universities, industry, nongovernmental organizations, tribal governments, and foreign government research cooperators.

Forest Service R&D has a long history of supporting extramural research through grants and agreements (G&As) with colleges and universities; State, local, and tribal governments; nonprofit organizations; industry; and individuals. The number of G&As in FY 2011 was fairly level with FY 2010, but dollars invested was more than \$53 million, an increase over FY 2010 and a greater percentage of the R&D budget. This is due, in part, to a recognition by scientists of the added value of leveraging our resources through extramural collaboration.

### Number of Grants and Agreements and Percentage of Forest Service R&D Budget

Fiscal Year	2007	2008	2009	2010	2011
Number of G&As	729	541	749	735	732
Percent of R&D budget	14%	12%	15%	15%	16%

G&As = Grants and agreements. R&D = Research and Development.



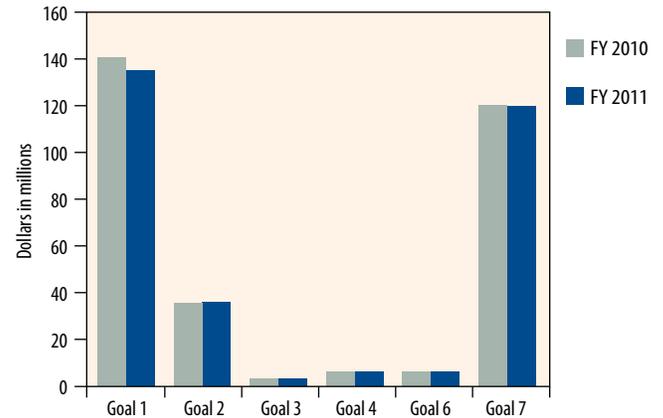
## Strategic Plan Overview

The *USDA Forest Service Strategic Plan: FY 2007–2012* provides the strategic direction that guides the agency in delivering its mission and identifies major current issues important to natural resource management. The direction and issues are addressed in seven strategic goals:

- Strategic Goal 1:** Restore, Sustain, and Enhance the Nation's Forests and Grasslands.
- Strategic Goal 2:** Provide and Sustain Benefits to the American People.
- Strategic Goal 3:** Conserve Open Space.
- Strategic Goal 4:** Sustain and Enhance Outdoor Recreation Opportunities.
- Strategic Goal 5:** Maintain Basic Management Capabilities of the Forest Service.
- Strategic Goal 6:** Engage Urban America With Forest Service Programs.
- Strategic Goal 7:** Provide Science-Based Applications and Tools for Sustainable Natural Resources Management.

Forest Service R&D targets its research and development activities and develops the means and strategies that contribute to achieving the outcomes of the Forest Service Strategic Plan.

**Research and Development Funding to Strategic Goals, Fiscal Years 2010–2011**



## Summary of Budget Changes for Fiscal Years 2007–2011 (dollars in millions)

Funding Sources	2007	2008	2009	2010	2011
Forest Service appropriation	4,698	5,039	4,959	5,315	5,489
Research appropriation (FRRE)	280.5	285.9	296.4	312.0	306.6
National Fire Plan (FRFR/FRF2)	22.8	23.5	23.9	24.0	23.9
Joint Fire Science Program (WFSU) <sup>a</sup>	7.9	7.9	8.0	8.0	8.0
<b>Total Research (FRFR)<sup>b</sup></b>	<b>311.2</b>	<b>317.3</b>	<b>328.3</b>	<b>344.0</b>	<b>338.5</b>
Forest Resource Information & Analysis (SPIA)	4.6	4.5	5.0	5.0	5.0
Facilities, Construction & Deferred Maintenance (CMFC/CMII)	22.0	21.2	24.6	13.4	10.0
<b>Grand Total Sources</b>	<b>337.8</b>	<b>343.0</b>	<b>357.9</b>	<b>362.4</b>	<b>353.5</b>
Funding Uses					
<b>Other than FIA research</b>	<b>248.6</b>	<b>253.5</b>	<b>264.1</b>	<b>273.2</b>	<b>268.1</b>
Forest Inventory and Analysis	59.4	60.4	60.8	66.9	66.8
Forest Resource Information and Analysis	4.6	4.5	5.0	5.0	5.0
<b>Total inventory and analysis</b>	<b>64.0</b>	<b>64.9</b>	<b>65.8</b>	<b>71.9</b>	<b>71.8</b>
<b>Facilities construction and maintenance<sup>c</sup></b>	<b>25.2</b>	<b>24.6</b>	<b>28.0</b>	<b>17.2</b>	<b>13.6</b>
<b>Grand Total Uses</b>	<b>337.8</b>	<b>343.0</b>	<b>357.9</b>	<b>362.4</b>	<b>353.5</b>

<sup>a</sup> Annually reprogrammed to FRRE.

<sup>b</sup> FY 2007–09 includes FIA; FY 2007–08 includes facilities maintenance.

<sup>c</sup> FY 2007–10 includes Facilities Maintenance Fund (CP09).

## Budget and Finance

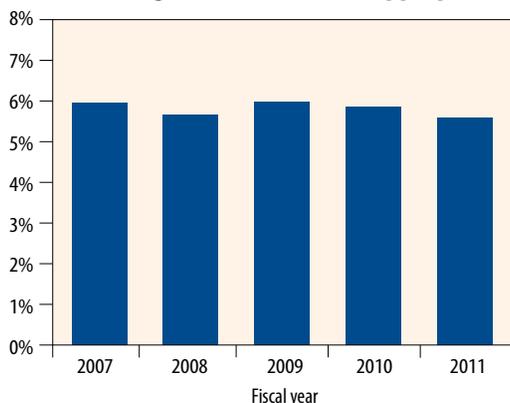
Forest Service R&D focuses its resources on the agency's mission, the priorities identified in the *USDA Forest Service Strategic Plan: FY 2007–2012*, direction from Congress, and Executive Branch priorities. The base Forest Service R&D mission area is formulated using input from the research stations, including FPL and IITF, which prioritize efforts needed to address the nature and magnitude of current and anticipated future resource problems and information requirements of resource managers.

Station directors communicate frequently with users of research products and technologies to ensure they consider local, State, and regional resource issues. The directors then request budget levels that best serve the science and technology needs of their clients, including other Forest Service deputy areas. These field requests are reviewed, coordinated with strategic priorities, and merged into a national research program. Funds are allocated to support the priorities and needs aggregated into the seven SPAs.

Forest Service R&D places a high priority on accountability and is committed to making the best use of taxpayers' dollars. Financial accounting is consolidated at the agency-level Agency Financial Report.

In FY 2011, Forest Service R&D was appropriated \$306.6 million, a decrease of just under 2 percent from FY 2010. This amount includes \$66.8 million for FIA and \$4.0 million for a facility maintenance fund. In addition, Forest Service R&D received \$23.9 million for the National Fire Plan and \$8 million for the Joint Fire Science Program. The total funding to R&D represents nearly 6 percent of the FY 2011 Forest Service appropriation.

**Research and Development Appropriation as Percentage of Forest Service Appropriation**



## Summary of Annual Performance for Strategic Goals

### Strategic Goal 1:

#### Restore, Sustain, and Enhance the Nation's Forests and Grasslands

The national forests and grasslands were established to protect the land, secure favorable water flows, and provide a sustainable supply of goods and services to the American people. The Forest Service provides land management assistance to the States and private forest landowners and to the national forests. In recent years, the increasing extent and frequency of uncharacteristically severe wildland fires and insect and disease outbreaks, along with the effects of climate change, have been of particular concern to the public, the Administration, Congress, and land management agencies.

In FY 2011, Forest Service R&D contributed to achieving Goal 1 by conducting research in fire, soil, water and air, fish and wildlife, invasive species, landscape ecology, global change, wilderness, and range. Performance for this goal is summarized by three major themes: fire, invasive species, and healthy watersheds. A key component of this research is long-range research conducted at experimental forests and rangelands and research natural areas.

#### Goal 1.—Resource Investments (dollars in thousands)

Strategic Program Area	FY 2010* (\$)	FY 2011 (\$)
Wildland Fire and Fuels	17,240	17,328
Invasive Species	24,139	24,139
Outdoor Recreation	1,231	1,231
Resource Management and Use	47,212	41,971
Water, Air, and Soil	24,078	24,078
Wildlife and Fish	19,033	19,033
Inventory and Monitoring	1,979	1,978
Forest Inventory and Analysis (FIA)	5,955	5,682
<b>Total Goal 1</b>	<b>140,867</b>	<b>135,350</b>

\* Funding levels to Strategic Program Areas are approximate and represent investments planned.

#### Selected Accomplishments: Wildland Fire

Measurements of fuel consumption, fluxes, and atmospheric circulations during fires are essential for evaluating and improving predictive models used by fire and land managers for prescribed burn planning and smoke management. When prescribed fires are conducted near urban centers or areas where air pollution is already a problem, Federal, State, or local air quality standards can be exceeded. Three large fire-fuel-atmosphere interaction (also known as Fireflux) experiments measured fuel loading and consumption; atmospheric turbulence; fluxes of energy, water vapor, and carbon dioxide; and smoke

transport at the landscape scale during operational prescribed fires in the New Jersey Pine Barrens. Results from the experiments indicate that most of the heat and water vapor released from consumed fuel is indeed captured by flux measurements, and that particulate matter (PM<sub>2.5</sub>) concentrations returned to below U.S. Environmental Protection Agency standards rapidly after flames passed.

As wildfires consume increasing areas of Western U.S. forests each year, private landowners are being encouraged to reduce wildfire risk on their property. They discovered that 75 percent of surveyed owners of ponderosa pine forests in eastern Oregon had treated some portion of their land between 2003 and 2008. Primary residents were almost eight times more likely to reduce fire risk on their property than absentee owners. Also, owners living near public lands were more likely to manage their land, providing the added benefit of buffering fire risk between public and private land. Owners indicated that they lacked sufficient resources to offset the costs of hazardous fuel reduction, and that they would benefit from cost-share funds and markets for logs and wood products generated through thinning.

Scientists from PSW developed a remote-sensing based model that produces heat flux estimates that are highly consistent with in situ fire plume measurements. Because carbon flux from the fires was strongly correlated with heat flux measurements, the rate of fuel consumption by the entire flaming front of a large fire can be estimated from fire temperatures estimated from remotely sensed, short- and mid-wave infrared. This model expected to have wide application for understanding the behavior and environmental effects of wildland fires.

The Rocky Mountain Center for Fire-Weather Intelligence delivers value-added fire-weather intelligence products that provide real-time critical support to fire- and air-quality managers across the country. The center offers more than 200,000 maps, graphs, and charts on current and future fire-weather conditions over the entire continental United States. All products are updated twice a day and delivered through the World Wide Web in real time at <http://FireWeather.info>.

Web-based applications allow the more than 1,300 registered users to plan prescribed burns, assess local and regional fire danger, predict smoke impact from ongoing fires, or develop short-term action plans for combating wildfires. The center's weather products also have been employed in the investigation of several fire-related accidents and fatalities, as well as in post-factum analysis of conditions that led to loss of property due to fire.

### **Selected Accomplishments: Invasive Species**

Termite colonies in laboratory and field tests were rapidly eliminated using a trap, treat, and release method with commercial termite toxicants and a patented termite bait developed at FPL. Characteristic changes occurred in

termite colonies that were on the verge of collapse after the dual treatment, including increased susceptibility to infestation with mites, bacteria, and fungi. Termite toxicants used in combination accelerated colony decline compared to termite toxicants used alone, especially with the trap, treat, and release method.

Black ash has great cultural and economic importance in the Northeastern and Midwestern United States, especially for Native Americans. Widespread destruction and removal of black ash following the discovery of an emerald ash borer infestation site is a painful prospect for tribes and basketmakers. Historically, black ash has sometimes been submerged for later use in basketmaking. In a recently completed study, a Forest Service entomologist working with a Forest Service geographer demonstrated that sinking black ash logs in running water for 2 to 3 months in the spring kills emerald ash borer larvae and preserves the wood qualities necessary for basketmaking. The scientists worked with a family of basketmakers from the Gun Lake Tribe throughout the research.

Scientists from SRS and Mississippi State University used advanced microscopy to examine the southern pine beetle, mycangia, and the specialized body structures where the insects carry fungi used to help kill trees. To get the images, researchers dissected small structures from beetles and used scanning electron microscopy to examine the mycangia. The images provided researchers new insight into the interactions between bark beetles and their associated fungi that can be used to devise new control strategies and identify new antibiotics and that is applicable to other bark beetle systems.

Damage and subsequent repair costs due to termite infestation nationwide is estimated to be about \$11 billion annually. Scientists from FPL helped purge the small town of Endeavor, WI, of its large termite population, ultimately saving its citizens tens of thousands of dollars. Using a novel communitywide approach, FPL collaborated with private businesses, local citizens, and State agencies to combat this tenacious pest. No termite activity has been detected since fall 2009. Scientists employed the most ecologically friendly methods for detection and treatment of termites, using the least amount of toxic chemicals possible. Eradication, it is hoped, will improve property values and provide other long-term benefits for the residents of this economically depressed rural community.

### **Selected Accomplishments: Healthy Watersheds**

Scientists at RMRS developed a statistically rigorous protocol that determines the extent of surface soil disturbance after management activities. This protocol has now been tested in every Forest Service region and has resulted in a common method for soil monitoring. During preharvest assessments, soil scientists will have the tools and data to help describe the degree and extent of soil disturbance and the impact this may have on long-term forest sustainability and health.

RMRS researchers developed biomass harvest best management practices that adapt management to the varying chemical and physical soil conditions inherent to western U.S. forests. The proposed soil chemical and physical property risk assessment process can be expanded to other regions across the Western United States where digital soil and geologic information is available. Such an approach would aid in identifying resilient soils for forest land managers considering biomass operations, policymakers contemplating expansion of biomass harvesting and investors deliberating where to locate bioenergy conversion facilities.

Forest Service scientists found that 10 years of different densities of white-tailed deer created contrasting forest tree communities with effects that ricocheted up the food chain even 20 to 30 years later. Higher deer densities during stand initiation resulted in significantly reduced diversity of tree species and density of canopy foliage, canopy insects, and birds, even 30 years later. These results show that even short-term variations in deer density may cause centuries-long disruptions to forest ecosystem structure and function. As numbers of predators decline and herbivores increase worldwide, similar effects may persist long after herbivore density becomes effectively managed.

Hurricane disturbance caused pronounced and persistent changes in the nontree species composition of a subtropical wet forest. A unique long-term Forest Service dataset tracked the response and recovery of tropical forest herb, shrub, and vine communities to multiple hurricanes over 21 years on the 13-hectare Bisley Experimental Watersheds in the Luquillo Experimental Forest, Puerto Rico. An analysis by Forest Service scientists found that hurricanes had altered nontree community species composition by promoting the dominance of rapidly spreading ferns and vines. These findings contrast sharply with other evidence showing that hurricane effects on the tree community is often negligible and are particularly significant because nontree species comprise the bulk of forest vascular plant diversity.

It has long been assumed that nutrients from dead salmon play an important role in the watershed, and there was some concern about the impact declining salmon runs might have on terrestrial ecosystems. Scientists at PNW and collaborators determined that younger soil closest to the stream had lower concentration of the nitrogen isotope <sup>15</sup>N compared to older soil found farther away from the stream. The <sup>15</sup>N isotope has historically been used to trace presumed salmon-derived nutrients in riparian systems. The model developed from this research will help improve estimates of the fate of salmon-derived nutrients in soils and vegetation.

## Strategic Goal 2:

### Provide and Sustain Benefits to the American People

This goal focuses on sustaining the productivity of the Nation's forests and grasslands to meet the needs of present and future generations. Forests and grasslands contain abundant natural resources and opportunities that help meet the demands and needs of the American people. Sustainable management of these resources ensures that the availability of goods and services continues into the future and that land productivity is maintained.

The Multiple-Use Sustained-Yield Act of 1960 directed that the national forests be administered for outdoor recreation, rangeland, timber, watershed, and wildlife and fish. National forest management provides a variety of use opportunities while maintaining wildlife diversity, supplies of wood products, energy sources and transmission infrastructure, wildlife and domestic livestock forage, water supplies, and other goods and services.

Forest Service research provides a solid scientific foundation for the sustainable management of forests and grasslands and improvements in the use and marketing of forest products and services. The FIA and Forest Health Monitoring programs continually gathered baseline information to assess the effectiveness of land management practices and to help guide the development of new research. A major emphasis of the research under Goal 2 was on developing new technologies for forest products and energy and on understanding global economic influences on the forest sector.

### Goal 2.—Resource Investments (dollars in thousands)

Strategic Program Area	FY 2010 (\$)	FY 2011 (\$)
Wildland Fire and Fuels	1,186	1,187
Invasive Species	3,398	3,398
Outdoor Recreation	716	716
Resource Management and Use	19,896	19,897
Water, Air, and Soil	3,991	3,990
Wildlife and Fish	1,792	1,792
Inventory and Monitoring	962	963
Forest Inventory and Analysis (FIA)	3,515	3,994
<b>Total Goal 2</b>	<b>35,456</b>	<b>35,937</b>

FY = fiscal year.

### Selected Accomplishments

The disposal of forest thinning residue is a concern when looking at sustainable forest management. FPL researchers investigated the technical possibility of utilizing aspen logging slash wood with diameters ranging from 50 to 76 millimeters for flakeboard production. The results indicated the modulus of elasticity, modulus of rupture, internal bonding, linear expansion, thickness swelling, and water adsorption of flakeboard made from aspen slash wood

flakes were all comparable to those properties of panels made from aspen commercial flakes and could be a valuable resource for commercially available structural panel products.

As part of the American chestnut restoration project, Forest Service scientists have planted thousands of blight-resistant American chestnut seedlings on reclaimed abandoned mined lands in southeastern Ohio. While evaluating various planting protocols, they tested inoculation with several species of ectomycorrhizal fungi, which play a vital role in tree nutrition. They found that a novel species of ectomycorrhizal fungus belonging to the genus *Scleroderma* was the most active and effective in the locations tested. This species appeared to be native to the reclaimed mined lands and was aggressive in forming beneficial symbiotic association with chestnut seedlings, even replacing the other species.

Thirty-nine talented high school students attended the Project SMART (Science and Mathematics Achievement through Research Training) Summer Institute on the campus of the University of New Hampshire (UNH) in July 2011. With funding support from the Northern Research Station's Civil Rights Diversity Committee Special Project Funds and More Kids in the Woods, the Forest Service was able to collaborate with UNH and Liberty Mutual Foundation to offer this exceptional experience to a diverse audience, including students from 11 different States, Greece, Turkey, and India. They spent 4 weeks researching various topics, including monitoring terrestrial and aquatic systems in the White Mountains and other forest management practices, climate change and its impact on forest productivity, and forest health.

Integrating research and education is a fundamental goal of institutions and agencies supporting science because society benefits from a more informed and scientifically literate population. The value of integrating traditional ecological knowledge in research has been demonstrated in several ecosystems, yet specific approaches and achievements of efforts integrating research and education are not widely published in environmental research journals. Scientists from IITF partnered with the University of Alaska and the University of Minnesota to integrate an interdisciplinary research project investigating the interactions of climate, vegetation, and permafrost in the study *Biocomplexity of Arctic Tundra Ecosystems* with a university field course, *Arctic Field Ecology*, and with indigenous Inuit students and elders. The integration allowed university students and Native community members to participate with the research team.

The U.S. forest industry is a multibillion-dollar business, providing jobs and economic value to local communities across the Nation. With increasing interest in bioenergy from forests, harvest and utilization data are critical to tracking the constant changes in the forest industry and wood utilization. In 2011, several FIA units formed a partnership with University of Montana Bureau of Business and Economic Research to bring national consistency to the Harvest

and Utilization program. Southern techniques for measuring felled trees and obtaining utilization data were passed on to the other partners as a national baseline through a national training effort.

### Strategic Goal 3:

#### Conserve Open Space

Open space provides many environmental, social, and economic benefits to rural and urban communities. Undeveloped forests and grasslands help protect water quality; conserve native wildlife; and provide renewable timber and nontimber products, recreational opportunities, and quality-of-life benefits. These green spaces enhance home values and generate jobs and economic vitality. Current population growth trends show a steady loss of these vital open spaces to developed uses.

The Forest Service helps communities develop sustainable urban and community forestry programs. In FY 2011, research activities provided the economic, social, and ecological information that communities use for urban forest management. Urban managers used this research information to develop strategies to help mitigate the effects of existing and new developments on open space, to understand the effects of fragmentation on animal and plant populations, and to generate revenue from ecosystem services.

#### Goal 3.—Resource Investments (dollars in thousands)

Strategic Program Area	FY 2010 (\$)	FY 2011 (\$)
Wildland Fire and Fuels	270	270
Invasive Species	774	774
Outdoor Recreation	165	166
Resource Management and Use	1,006	1,005
Water, Air, and Soil	504	505
Wildlife and Fish	610	611
Inventory and Monitoring	0	0
Forest Inventory and Analysis (FIA)	0	0
<b>Total Goal 3</b>	<b>3,329</b>	<b>3,330</b>

FY = fiscal year.

#### Selected Accomplishments

Tropical Montane Cloud Forests are important sources of water and remarkable hotspots of biodiversity. Scientists recognize that these special forests were being rapidly deforested and the scientific basis for managing them was lacking. Researchers from IITF developed the scientific understanding necessary to manage and conserve these unique forests and recently published their results in 72 papers. The United Nations and many international organizations have now formally recognized the importance of these forests, which has led to a decline in deforestation rates and establishment of numerous tropical montane cloud forest reserves.

In 2011, the Forest Service and the Southern Group of State Foresters unveiled the Southern Forest Futures Project, a multiyear research effort that among other things projects that the South may lose 23 million acres of forests over the next 50 years. The Futures Project forecasts the effects of urbanization, bioenergy use, climate change, land ownership changes, and invasive species over the next half century and discusses how those influences may affect water, wildlife, fire, and other issues to inform policy and management choices.

Forest Service scientists, in partnership with Forest Service International Programs and funded by the U.S. Agency for International Development, developed a concept community-based carbon monitoring of restoration plantings in forest reserves in Ghana. The premise of the pilot study is that local communities must be given incentives to protect and conserve forests. These incentives can augment help from government agencies that are often under-resourced in Africa. This work is helping to secure carbon payments for the restoration forests, in lieu of harvesting, under the REDD+ (Reduced Emissions from Deforestation and Degradation) or voluntary carbon payments.

The millions of miles of highways that criss-cross the Nation can be a recipe for ecological disaster for some wildlife communities. Roadways can carve up habitats, disrupt the natural migration of species, and result in collisions fatal for both animals and humans alike. A team of scientists from PNW, Washington State agencies, universities, tribes, and nonprofit organizations developed a set of geographic information system, or GIS, models, to identify places where highways pass through areas important for wildlife movement. The models allow scientists to identify places where wildlife crossing structures should be considered to promote highway safety and help maintain healthy wildlife populations. The team received the Federal Highway Administration's "2011 Environmental Excellence Award" for its statewide assessment of habitat connectivity in Washington State. For more information, visit <http://www.waconnected.org>.



## Strategic Goal 4: Sustain and Enhance Outdoor Recreation Opportunities

The public demand for high-quality outdoor recreational experiences places pressure on the ecological integrity of national forests and grasslands. The combination of increasing U.S. populations and declining public access to privately owned forest land creates demand for public lands to provide more recreational opportunities.

If public lands are to provide additional recreational benefits without unacceptable resource effects, we must emphasize effective management solutions that have a solid scientific foundation. Forest Service R&D studied the effects of changing demographics and peoples' perceptions of the value, importance, and opportunities created by healthy forests and rangelands. Our research helped communities understand the relationship between the quality of the recreation experience and the importance of ecological integrity to maintain recreational opportunities into the future.

### Goal 4.—Resource Investments (dollars in thousands)

Strategic Program Area	FY 2010 (\$)	FY 2011 (\$)
Wildland Fire and Fuels	233	234
Invasive Species	973	972
Outdoor Recreation	1,996	1,996
Resource Management and Use	1,018	1,018
Water, Air, and Soil	948	948
Wildlife and Fish	869	869
Inventory and Monitoring	0	0
Forest Inventory and Analysis (FIA)	0	0
<b>Total Goal 4</b>	<b>6,037</b>	<b>6,037</b>

FY = fiscal year.

### Selected Accomplishments

In a partnership with a professional dance company and a local environmental educator, a Forest Service scientist helped Baltimore children turn their observations of nature into movement as they learned about the environment. The scientist led discussions of local ecology in a neighborhood park in Baltimore, MD. The students and dancers created movements to express what they learned, which they combined into a "Moving Field Guide," a dance representing natural events, which included such events as bark sloughing off a tree trunk, wind blowing winged seeds to new homes, ducks migrating, and reactions to a skunk. These dances are shared through community performances and videos as encouragement to other children and parents to notice the intricacies of nature and find ways to make those observations personal and enduring.

PSW scientists, in collaboration with San Diego Audubon Society, gained a better understanding of the social and institutional factors affecting nature-based afterschool programs in San Diego. Investigators used interviews and content analysis to study the social and institutional factors that were linked to successful program outcomes. Results suggest that programs can be improved by improving coordination with partners with different goals and structures, building consensus on need for after-school nature programs, and providing a better explanation of benefits and outcomes across settings.

For more than 30 years, the Forest Service and the Recreation Research Unit in Athens, GA, have been recognized as leaders in partnering to address needs for information and technology and to support better recreation policy and management of public lands. This ongoing partnership has involved multiple Federal agencies, State associations, private associations, and universities. Projects have included the Federal Estate Visitors Survey, the Public Area Recreation Visitors Survey, the Customer Use Survey, the National Visitor Use Monitoring Survey, the National Recreation Survey, the National Survey on Recreation and the Environment, and, most recently, the National Kids Survey.

Major League Baseball has partnered with scientists from FPL to decrease the number of broken baseball bats. As a result of this research, there has been a 50-percent reduction in multiple-piece failure rates in baseball bats in the last three seasons. While broken bats have always been part of the game, multiple-piece failure is something relatively new. With recent changes in bat geometry, wood species used to manufacture bats, and inconsistencies in the grain of the wood itself, there had been an increase not only in cracked or broken bats, but also in bats dangerously shattering into multiple pieces on contact. Recommendations by FPL and TECO, an independent certification and testing agency for wood products, have led to increased safety of all on-field personnel and fans.

The California golden trout (CGT), *Oncorhynchus mykiss aguabonita*, one of the few native high-elevation fishes in the Sierra Nevada, are imperiled because of exotic trout, genetic introgression, and degraded habitat, and now face further stress from climate changes. Temperatures in degraded sections of meadows have been recorded at levels reportedly lethal for salmonids and may affect CGT in more subtle ways such as growth, condition, or long-term survival. Scientists at PSW are analyzing water temperatures in restored and degraded sections of meadows in the Golden Trout Wilderness. This research will provide essential information on which stream areas are most vulnerable to warming and will help managers make CGT habitat more resilient to future warming.

## Strategic Goal 5:

### Maintain Basic Management Capabilities of the Forest Service

Reliable information, good-quality facilities, and land protection are necessary to effectively manage natural resources in a perpetual state of change. Forest Service R&D must maintain investments in research laboratories, experimental forests and ranges, information systems, and a skilled workforce to support the research necessary to inform natural resource management decisions and activities.

Forest Service R&D contributed to Goal 5 by making strategic and careful investments in buildings and facilities and by taking the actions necessary to protect and prolong the life of valuable and sensitive laboratory equipment. We continued to manage our workforce needs through recruitment and retention programs and to develop a diverse workforce with the skills needed to address complex research problems and emerging issues.

### Facilities—Assessment and Allocation

Forest Service R&D maintains a fund for facility maintenance as directed by Congress (Title III, Administrative Provisions, Public Law 109-54). Funding is obtained from an annual assessment of program funds, providing an incentive to dispose of unneeded buildings and to refrain from any new construction.

In FY 2011, the facilities assessment ranged from \$1.48 to \$2.31 per square foot, distributed across approximately 2.3 million total gross square feet, based on the previous year's direct labor hourly charges for each program.

### Goal 5.—Resources Invested (dollars in thousands)

#### Fiscal Year 2011 Facilities Maintenance Assessment and Allocation for the Forest Service R&D Facilities

Unit Name	Total (gross sq. ft.)	Total Assessment/ Allocation (\$)
Forest Products Laboratory	401,546	596,000
International Institute of Tropical Forestry	26,459	61,000
Rocky Mountain Research Station	414,247	825,000
Northern Research Station	493,236	730,000
Pacific Northwest Research Station	279,908	558,000
Pacific Southwest Research Station	235,406	348,000
Southern Research Station	466,469	690,000
<b>Research Total</b>	<b>2,317,271</b>	<b>3,808,000</b>

R&D = research and development.

## Strategic Goal 6:

### Engage Urban America With Forest Service Programs

The Forest Service maintains an integrated program of natural resource stewardship designed to inform and educate urban residents on the value of well-managed public and private forested lands and to improve their quality of life. A vital part of the work with communities is in conservation education, urban greening efforts, and natural resources programs for youth. The Forest Service coordinates with Federal, State, and local partners to provide urban residents with the benefits they seek from local parks, nearby woodlands, and national forests.

Forest Service R&D scientists studied the effects of urbanization on public lands and provided the science needed to make decisions on how to best manage private lands and maintain working forests within urbanizing landscapes. This work included studying the effects of transportation expansion and fragmentation on streams, wildlife, and invasive species. Decision support tools provided include remote sensing, analysis, computer models, and expert systems to address issues such as wildland fire in the WUI.

#### Goal 6.—Resource Investments (dollars in thousands)

Strategic Program Area	FY 2010 (\$)	FY 2011 (\$)
Wildland Fire and Fuels	1,317	1,317
Invasive Species	1,407	1,406
Outdoor Recreation	462	462
Resource Management and Use	2,668	2,668
Water, Air, and Soil	282	282
Wildlife and Fish	0	52
Inventory and Monitoring	0	0
Forest Inventory and Analysis (FIA)	0	0
<b>Total Goal 6</b>	<b>6,136</b>	<b>6,187</b>

FY = fiscal year.

#### Selected Accomplishments

Traditional urban research involves tree inventories, census activities, water quality sampling, or socioeconomic studies, all conducted by separate scientists on separate locations and with separate questions. Forest Service researchers at IITF created a new coalition of more than 60 scientists, students, and collaborators with many specialties to study the city of San Juan, PR, socioecologically. The city was stratified by natural (geology, topography, etc.) and socioeconomic (e.g., income level, land cover, and population density) criteria. Natural scientists sampled biodiversity and social scientists studied people, households, and neighborhoods. The city model the scientists developed is an experience-based model that depicts both the natural and anthropogenic forces, components, and fluxes of the city.

An important part of urban tree planting campaigns is measuring and evaluating current urban forests so that realistic tree planting goals can be set. The term “urban tree canopy” is used to describe the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Although aerial and satellite images can now show amazing detail, there are substantial shortcomings to using reflected light in mapping the canopy in urban areas as trees can be totally obscured by building shadows. LiDAR—or light detection and ranging—a technology similar to radar can overcome these limitations. Researchers at NRS developed process protocols for using LiDAR to inventory and analyze the urban tree canopy. To date, the team has completed canopy assessments for more than 50 cities and towns that encompass more than 300 communities, mostly in the mid-Atlantic and Northeastern States.

In Los Angeles, the current urban forest cover is 21 percent and consists of about 11 million trees. Using research and models developed at PSW, a team of scientists estimated the value, over a 35-year period, from 1 million trees in Los Angeles as \$1.3 to \$2.0 billion. Average annual benefits were \$49 to \$60 per planted tree. For example, by storing carbon as biomass, 1 million new trees will reduce carbon dioxide in the air by about 1 million tons. This reduction is equivalent to removing 7,000 cars from streets and highways each year. “Million Trees LA” has planted more than 300,000 trees to date, and PSW’s tree canopy cover maps have helped the program target trees for residential neighborhoods and commercial areas with the least tree canopy cover. This and other PSW research quantifying the benefits and value of California’s urban forests was instrumental in the development and approval of Proposition 84. This bond measure is providing \$90 million for urban forestry and urban greening projects in California.

A team of Forest Service scientists developed a software tool used by a U.S. Department of Defense agency to assess the movement in Japanese rivers of radioactive contaminants released from Japan’s earthquake-damaged Fukushima Daiichi nuclear power plant. The Incident Command Tool for Protecting Drinking Water, or “ICWater,” allows incident commanders and water utility managers to rapidly assess risk to drinking water during toxic spill emergencies. Results of the analysis, performed for the Defense Threat Reduction Agency by the SAIC Corporation, were shared with emergency managers in Japan for use in assessing risk of waterborne radioactivity to the Japanese public in the aftermath of the accident.

In 2011, the Forest Service and its partners, The Davey Tree Expert Company, the National Arbor Day Foundation, the Society of Municipal Arborists, the International Society of Arboriculture, and Casey Trees released a new version of their free software, i-Tree v.4, which provides urban planners, forest managers, environmental advocates, and students a tool to measure the ecological and economic value of the trees in their neighborhoods and cities. A recent i-Tree study found that street trees in Minneapolis provided \$25 million in benefits, ranging from energy savings to increased property values.

Urban planners in Chattanooga, TN, were able to show that for every dollar invested in their urban forests, the city received \$12.18 in benefits. New York City used i-Tree to justify \$220 million for planting trees during the next decade.

**Strategic Goal 7:**  
**Provide Science-Based Applications and Tools for Sustainable Natural Resources Management**

The Forest Service provides science and technology solutions for clients’ and partners’ priority issues in ways they find effective and useful for sustainably managing forests and grasslands.

In FY 2011, Forest Service R&D conducted research to evaluate the effectiveness of organizations, both public and private, in managing natural resources. This research includes developing applications of organizational behavior, public administration, and social science to respond to changes in climate, improve inventory and monitoring activities, adapt to landscape changes, and better manage fire incidents and watershed conditions.

**Goal 7.—Resource Investments (dollars in thousands)**

Strategic Program Area	FY 2010 (\$)	FY 2011 (\$)
Wildland Fire and Fuels	3,359	3,359
Invasive Species	6,772	6,773
Outdoor Recreation	607	607
Resource Management and Use	28,962	28,963
Water, Air, and Soil	6,333	6,333
Wildlife and Fish	8,163	8,110
Inventory and Monitoring	8,522	8,522
Forest Inventory and Analysis (FIA)	57,469	57,129
<b>Total Goal 7</b>	<b>120,187</b>	<b>119,796</b>

FY = fiscal year.

**Selected Accomplishments**

Two industrial start-up companies are developing panel products that use technology developed at FPL from forest residuals, recycled fiber, and agricultural byproducts. One company is developing a line of furniture and structurally insulated panels, and the other company is focusing on furniture, office partitions, and architectural materials panels. All raw panels made at the FPL are naturally bonded and formaldehyde free. FPL is helping these companies with technology transfer issues so that they can be in production in the near future.

FIA plot data provide invaluable information about the distribution and health of our Nation’s forests to scientists and the public alike. Forest Service scientists found that winter satellite imagery with the vegetation change tracker (VCT) could generate more reliable estimates of forest lands in the

western Great Lakes area. These VCT data were consistent with those from FIA plots. The VCT is an automated forest mapping algorithm that exploits the Landsat archive to produce comprehensive maps of forest changes and is well-suited for filling in data gaps between FIA plots.

Technologies initially motivated by the Human Genome Project have been modified to bring affordable genomics to conservation genetics. Using this technology, Forest Service scientists sequenced entire mitochondrial genomes for 40 North American fisher and found subspecies and populations of the fisher reflect a population structure that has been in place for thousands of years and predates current management practices. This research is being used to aid management decisions about whether these populations warrant protection under the Endangered Species Act (ESA). Distinct population segments of fisher have recently been petitioned for listing under the ESA, and conclusions from this proposed listing are currently pending.

Forest Service scientists and collaborators modeled live, aboveground tree biomass by using FIA field data and applied the models to more than 20 years of Landsat satellite imagery to derive trajectories of aboveground forest biomass for study locations across the continental United States. Maps of biomass dynamics were integrated with maps depicting the location and timing of forest disturbance and regrowth to assess the biomass consequences of these processes over large areas and long timeframes. Policymakers and managers now have information to use in understanding how forest biomass has changed over the past 20 years to inform their decisions about how forest management affects biomass change today and in the future.

Researchers with the Eastern Forest Environmental Threat Assessment Center applied models they developed with partners to measure water supply stress in relation to carbon and biodiversity and to evaluate ecosystem services to several locations in Africa. These tools can be used by conservation agencies in any location worldwide to make sound decisions. The continual evolution of the model as it is applied internationally provides validation and improved application within the United States, and ultimately adds value to its use by land managers within the Forest Service.

Budgeting for wildfire suppression is increasingly difficult for the Forest Service and the U.S. Department of the Interior. Uncertainty about how much funding will be needed for future wildfire suppression presents an ongoing challenge to Federal land management agency policymakers and administrators. The FLAME Act of 2009, which provides funding for wildfire suppression, presents the challenge of accurately estimating fire suppression costs as far as 3 years out. SRS scientists developed regression models for forecasting Forest Service suppression spending at 1-, 2-, and 3-year lead times as part of an ongoing research effort to improve the accuracy and precision of fire cost forecasting. These forecasts continue to provide useful information for Fire and Aviation Management as they manage fire budgets in an environment of uncertainty.

## Measuring Forest Service R&D Performance

Science and technology are critically important for keeping the Nation's economy competitive and for addressing challenges in the environment. The White House Office of Science and Technology Policy identified three key indicators of research and development success: *relevance, quality, and performance* (M-03-15, June 5, 2003).

### Relevance

#### Customer Satisfaction Survey

In FY 2006, Forest Service R&D contracted with the Federal Consulting Group, now a part of the U.S. Department of the Interior, to design and conduct a survey every 3 years of the various people and groups who use our research information and products. The survey uses econometric models, developed collaboratively with Forest Service R&D staff and customized for our products and services. The results are presented as a score based on the American Customer Satisfaction Index methodology, which enables users to make comparisons with the scores of other Federal R&D agencies.

The model included three main components: relevant activities in each area that drive customer satisfaction, satisfaction itself, and desirable customer behaviors and outcomes. The FY 2009 survey scored 75, exceeding its target and scoring significantly better than the average for Federal agencies. It also identified ways to improve satisfaction by making products easier to use and by making information more accessible.

Results from this survey were incorporated into Forest Service R&D program area planning to ensure that the work we do is relevant to customers' needs. The survey will be repeated in FY 2012.



### Quality

#### Forest Service R&D Quality Assurance Reviews

Forest Service R&D places a high value on conducting sound science that customers and the scientific community view as being of the highest quality. To ensure that this work meets stringent standards for ensuring scientific integrity, Forest Service R&D routinely invites panels of internal and external reviewers to evaluate its performance. Such reviews include the following:

- Refereed reviews of publications.
- Statistical reviews and quality assurance and quality control procedures.
- Research grade evaluation process.
- Research performance accountability reviews.
- SPA reviews.

#### Peer Review of Strategic Program Areas

Peer review is a recognized and effective tool for evaluating research programs and designing future research. It provides managers with a basis on which they can (1) select, continue, modify, or redirect research program areas; (2) assess alignment of ongoing research activities with strategic planning documents; (3) assess research program area performance and productivity; (4) identify new opportunities or termination points for ongoing projects; and (5) provide important information to a research program area that is under particularly close external scrutiny.

Every National SPA peer review in the past 5 years has recommended a rating of satisfactory or excellent.

### Performance

#### Annual Outcome Measures

Forest Service R&D reports targets for the number of annual outcome measures in the Forest Service Budget Justification. In FY 2011, Forest Service R&D met or exceeded all of its targets.

## Trends in Forest Service R&D Performance Outcomes

Performance Measure	FY 2008	FY 2009	FY 2010	FY 2011
Customer satisfaction index score	72	75	75	75
Number of patent applications filed (3-year average)	6	6	6	13 <sup>1</sup>
Percent of R&D program areas that have been externally peer reviewed within the past 5 years	75%	100%	100%	100%
Percent of R&D program areas that achieved a rating of satisfactory or excellent during the past 5 years	100%	100%	100%	100%
Percent of Nation with accessible FIA <sup>2</sup> data	90%	92%	94%	94%
Quality fire science index—Wildland fire PART <sup>3</sup> performance measure calculated as the number of peer-reviewed fire science publications per scientist year on a 3-year rolling average	3.5	3.5	3.5	4.0
Fire output efficiency index—Wildland fire PART performance measure calculated as the total number of fire science products per scientist year on a 3-year rolling average	5.0	5.0	5.0	5.0
Number of invasive species tools developed, delivered, and used is an invasive species PART performance measure calculated as the number of invasive species tools on a 5-year rolling average	142	177	170	163
Cost per invasive species tool—Invasive species PART metric calculated as the cost of producing tools on a 5-year running average adjusted for budgets	\$426	\$198	\$208	\$218

<sup>1</sup> Note: A total of 13 patent applications were filed in FY 2011, 9 provisional and 4 utility applications.

<sup>2</sup> FIA=Forest Inventory and Analysis

<sup>3</sup> PART=Program Assessment Rating Tool

Forest Service R&D is also responsible to the USDA for a number of accomplishments reported in the USDA Performance and Accountability Report.

### Additional Accomplishments Reported to USDA

Accomplishment	FY 2008	FY 2009	FY 2010	FY 2011
New interagency agreements and contracts	40	57	38	32
Interagency agreements and contracts continued	12	12	12	12
Articles published in journals	1,903	2,294	1,884	3,083
Articles published in all other publications	1,487	921	993	1,178
Patents granted	6	3	2	3
Patent licenses executed	1	0	0	2

FY = fiscal year.

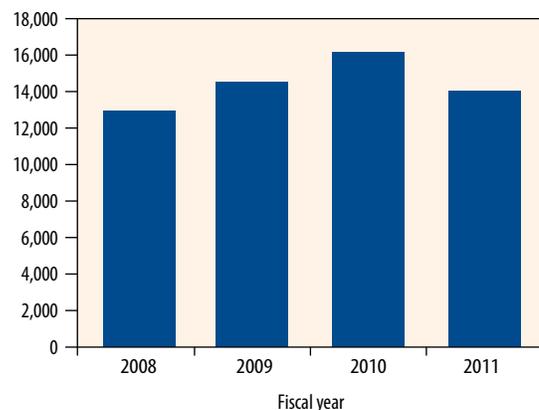
### Science Citations

Citation analysis is the analysis of data derived from references cited in footnotes or bibliographies of scholarly publications. The basic assumption behind citation analysis is that influential research or scientists are cited more often than others. In this sense, citations reflect the relative effect and utility of a work. Citation analysis can serve as a useful and powerful method of examining the intellectual effect of scientists and their research projects. It

can be used for research policymaking, monitoring scientific developments, and grant decisions.

Over the 10-year period from FY 2002 through FY 2011, Forest Service publications were cited in formally peer-reviewed publications almost 85,000 times, with more than 14,000 in FY 2011. The average number of Forest Service publications cited 20 or more times and 50 or more times were 1,152 and 286 respectively, as reported in Web of Science.

**Annual Citations  
Fiscal Years 2008–2011**



## National Accomplishments

Most of the Forest Service Research Program is targeted to local and regional issues, executed by scientists at field locations, and administered by research stations across the United States. Forest Service R&D also delivers products and services with a national scope and administered by Washington Office staffs located in the headquarters or embedded in the field. In FY 2011, these national programs reported the following significant results.

- The eResearch program made substantial improvements to R&D's information infrastructure in FY 2011. The Research Information Tracking System (RITS) expanded its user base from hundreds to thousands as it began managing information about the research expertise and interests of its employees. This improved information management was demonstrated through our collaboration with fellow research agencies in USDA to create the first Federal implementation of VIVO, an open source Web technology for enabling the discovery of researchers across institutions (<http://vivo.usda.gov>). RITS also began field testing new capabilities to track information on individual research studies.
- In FY 2011, Forest Service R&D published the *National Report on Sustainable Forests* that describes the state of forests in the United States and the national progress toward the goal of sustainable forest management (<http://www.fs.fed.us/research/sustain/>). The report is designed to provide information that will improve public dialog and decisionmaking aimed at achieving sustainability. The 64 indicators of forest sustainability used in the report reflect many of the environmental, social, and economic concerns of the American public regarding forests, and help establish a quantitative baseline for measuring progress. The current edition includes 130 pages of detailed information organized by indicator, as well as summary analyses and policy recommendations. More than 30 Forest Service scientists, senior staff, and outside collaborators contributed to this edition of the report. A previous edition of the report was released in 2003, and an update is anticipated in 2015.
- Forest Service R&D made the *Research Data Archive* (<http://www.fs.usda.gov/rds/archive>) available on the Internet and added an additional 50 research data sets in FY 2011. To improve long-term management of research data collected on EFRs, the archive provided metadata training for scientists and EFR data managers. The archive also entered into an agreement to provide a number of services to the Joint Fire Science Program (JFSP) (<http://www.firescience.gov>) including training Webinars for JFSP grant applicants, reviewing data management plans for grant proposals, providing metadata catalog services for all JFSP research projects, and serving as the recommended data repository for JFSP research projects.
- Since 2005, the International Union of Forest Research Organizations (IUFRO) Task Force on Traditional Forest Knowledge (<http://www.iufro.org/science/task-forces/>) has explored how knowledge and practices developed by indigenous and local communities have contributed to the sustainable management of forest ecosystems worldwide. These insights and management innovations have supported the economic, social, and cultural needs of traditional societies over countless generations. They demonstrate that indigenous community knowledge and formal scientific

knowledge can complement each other in the quest for sustainability in the modern world. The IUFRO Task Force, led by Forest Service scientists, organized six regional conferences in North America, Europe, Africa, and Asia and published a series of proceedings and peer-review journal issues and other products from the conferences, as well as a final synthesis report, "Traditional Forest-Related Knowledge: Sustaining Communities, Ecosystems, and Biocultural Diversity" (<http://www.springerlink.com/content/q80x5131k4136v44/>).

- The Global Bioenergy Partnership (GBEP) Task Force on Sustainability aims to optimize the indicators of biofuels sustainability to ensure they are science-based, technically sound, and act to promote bioenergy production and use. In FY 2011, the Forest Service R&D Forest Management Sciences staff provided review and technical comment to the U.S. State Department through the USDA Foreign Agricultural Service, which helped to inform the development of U.S. policy and positions on biofuels sustainability indicators. In May 2011, GBEP agreed on a set of science-based, voluntary, practical sustainability indicators to help countries assess and develop sustainable bioenergy production and use. It is the first global, government-level consensus on a set of voluntary, science-based indicators for assessing the sustainable production and use of bioenergy. Forest Service R&D played a key role in helping to formulate the U.S. position on biofuels sustainability indicators and has positively impacted U.S. domestic and international policy.
- Forest Service R&D provided considerable and significant scientific expertise to the forest components of the FY 2011 update to the 2005 Billion Ton Report, published by the U.S. Department of Energy (DOE). The Billion Ton Update provides: a spatial, county-by-county inventory of primary feedstocks, price and available quantities (e.g., supply curves) for the individual feedstocks, and a more rigorous treatment and modeling of resource sustainability. This report provides an indepth analysis on the technical feasibility of a billion ton annual supply of biomass capable of displacing 30 percent or more of the U.S. petroleum consumption. For more information, visit [http://www1.eere.energy.gov/biomass/pdfs/billion\\_ton\\_update.pdf](http://www1.eere.energy.gov/biomass/pdfs/billion_ton_update.pdf).
- FIA implemented annual forest sampling in all 50 States. FIA measured in excess of 42,000 field plots that represent 14 percent of the FIA national plot system. Current data defined as being less than 2 years old is publicly available for 46 States and coastal Alaska at <http://www.fia.fs.fed.us>.
- The USDA National Agroforestry Center, jointly sponsored by the Forest Service and the Natural Resources Conservation Service, works with partners to develop and deliver the science, tools, and training that help landowners and natural resource managers care for their land and maximize their profits. Agroforestry practices include riparian forest buffers along waterways; alley cropping that integrates crops, such as grains or vegetables, in alley ways with high-value trees and shrubs; forest farming where nontimber forest products, such as food, herbals, botanicals, and decorative products are grown under the protection of a managed forest canopy; and field, farmstead, and livestock windbreaks. To raise awareness and promote the science, practice, and benefits from agroforestry,

USDA Deputy Secretary Kathleen Merrigan unveiled the *USDA Agroforestry Strategic Framework* on June 6, 2011, during the 12th North American Agroforestry Conference, in Athens, GA. The framework lays the roadmap to influence the long-term health and sustainability of all lands for future generations.

- The *Natural Inquirer* is a science education journal for middle school science students and educators, with articles adapted from published Forest Service research papers. In FY 2011, Forest Service R&D—in cooperation with the Forest Service Conservation Education Staff, the Cradle of Forestry In America Interpretive Association, and other partners—published thousands of copies of the *Natural Inquirer* Climate Change edition and the Wildland Fire (second) edition. In partnership with PNW, the *Investigator*, an upper-elementary science journal, was published. This journal highlighted climate change research from PNW. Forest Service R&D distributed 77,081 copies of the *Natural Inquirer* to students and teachers nationwide and worldwide and an additional 10,714 copies of *Investigators*. The first World's Forest edition, published in partnership with the United Nations Food and Agriculture Organization, was translated into six languages, including Arabic, Chinese, French, Spanish, Russian, and Mongolian.

## Future Focus

Although FY 2011 was a productive year for Forest Service R&D, funding constraints will require a more priority-focused approach to research in the future. Concern about climate change and its effects on forests and rangelands have prompted legislators to ask for scientific solutions that help them adapt to these effects and to find ways forests and rangelands can help mitigate the effects. Less stable water supplies coupled with increased demand in urban areas means regional water shortages. Scientists have observed recent severe forest diebacks as a result of drought and an increased susceptibility of forests to insect and disease. They have also recorded an increase in large, destructive wildfires that threaten biodiversity, watershed stability, water supply, and human lives and property.

The 21st century is the first century in recent human history in which most people live in urban areas. The demands of conflicting interest groups continue to test the agency's ability to ensure the long-term sustainability of U.S. forests and rangelands through development and application of truly science-based management practices. The economic downturn of the past couple of years has left municipalities facing serious financial pressures. Cities and towns have had to cut back on many urban services, including urban forestry and other environmental programs. Forest Service R&D will be challenged

to offer innovative and cost-effective, science-based solutions that will help cash-constrained cities and towns maintain urban natural resource-based programs and help provide urban residents valuable benefits from nearby healthy rural forests. Solving all these problems will require sound science directed at social, economic, and natural resource issues.

## Priority Research Areas

As the world's preeminent natural resources science organization, the Forest Service R&D mission area seeks to increase national awareness of its valuable accomplishments in the field of forestry and natural resource management and make strategic investments in critical arenas of research. With decades of groundbreaking scientific research, the Forest Service is well positioned to achieve significant results from an investment in priority research areas (PRAs).

The PRAs rest on a science foundation structured around R&D's SPAs that reflect the scope of Forest Service research capabilities. The PRAs set priorities for the next 3 to 5 years. R&D will continue to build upon our core programs and our two foundation programs: Forest Inventory and Analysis and Experimental Forests and Rangelands.

PRAs include:

1. **Adaptation Research**—Research to improve the resiliency of forests, rangelands, and aquatic areas and to mitigate the adverse effects of climate change, including wildland fire, such as research addressing the effects and effectiveness of hazardous fuels treatments and biomass use.
2. **Biomass and Bioenergy**—Research to advance alternative energy sources and new markets that contribute to energy security and independence while reducing greenhouse gases.
3. **Urban Natural Resources Stewardship**—Research to improve the management, protection, and stewardship of urban natural resources to improve people's lives.
4. **Nanotechnology**—Research and technology to provide leading-edge innovations in the development of wood products.
5. **Water Management and Restoration**—Research to promote best management practices designed to protect and restore watersheds that enhance water quantity and quality.

The PRAs demonstrate R&D's commitment to remaining an interactive, vibrant, and visionary partner in solving today's critical problems with science and technology. This science and leadership service is a highly important investment for a world struggling with environmental change.





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