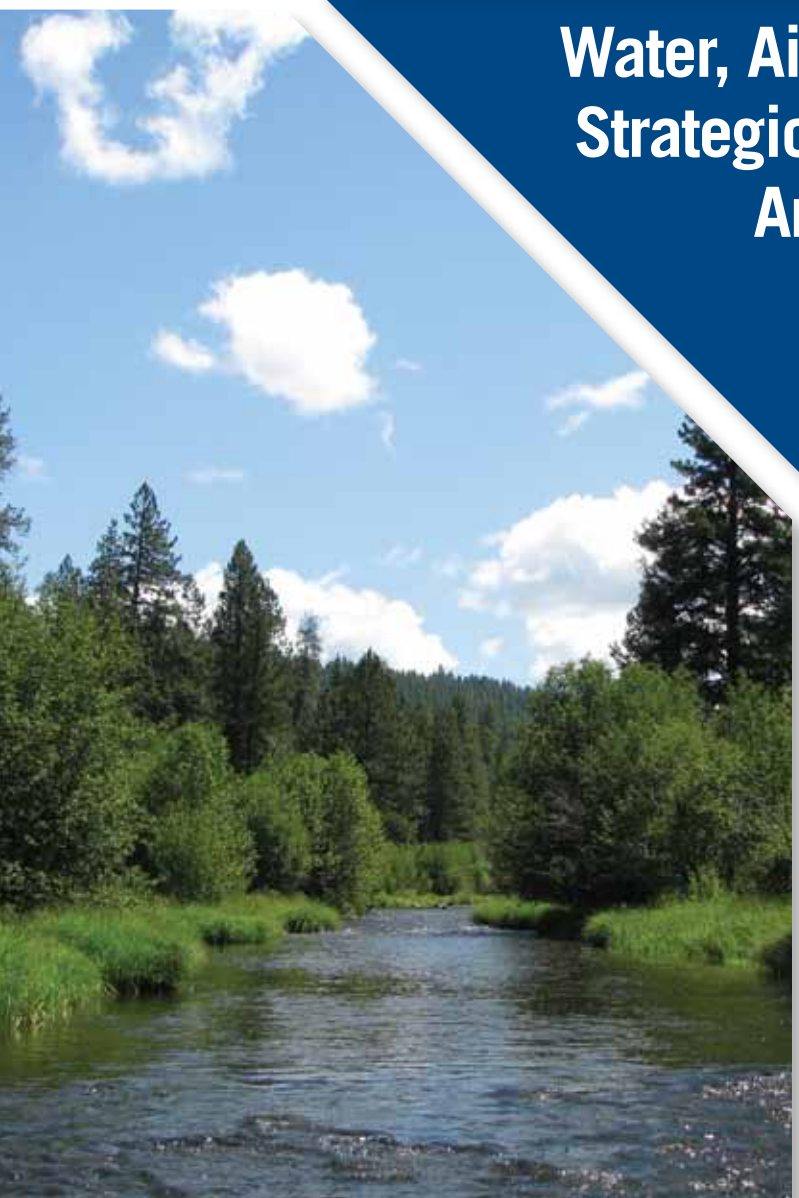
2011–2016 Strategic Plan for Research and Development

Water, Air, and Soil Strategic Program Area



Executive Summary

Research and Development (R&D) in the Forest Service, U.S. Department of Agriculture, provides the scientific basis and necessary tools to inform resource management decisions. These decisions often involve tradeoffs among conflicting uses of the Nation's water, air, and soil resources and societal values, as well as finding optimal solutions for these tradeoffs. With its strong multidisciplinary foundation and existing long-term data sets, the Forest Service is well positioned to build on its history of basic and applied research to better understand the coupling of changes in land use, climate, and pollution levels with our Nation's water, air, and soil resources. Moreover, its history of science-management partnerships promotes a sound scientific basis for making land-management decisions in wild, managed, rural, and urbanized lands.

This strategy identifies the following current and emerging issues related to the Forest Service R&D Water, Air, and Soil Research Strategic Program Area:

- The influence of climate change and variability on soil carbon and carbon sequestration.
- The effects of atmospherically dispersed pollutants, such as ozone, sulfur, nitrogen, and mercury on water, air, and soil resources.
- The economic and ecological tradeoffs between competing demands on water resources for in-place needs (e.g., supporting aquatic species), downstream or down-gradient uses, and human influences on those resources.
- The effects of management and environmental change on soil, including physical, chemical, and biological characteristics and how these changes relate to ecosystem sustainability.
- The temporal and geographical effects of climate change and human uses on the status and variability of water distribution, supply, and quality.
- How to use both climate and weather information, integrated with information about fuels, combustion, and emissions, to forecast smoke behavior related to wild and prescribed fire.

Planned Accomplishments by 2016

During the next 5 years, the Water, Air, and Soil Research Strategic Program Area in Forest Service R&D will accomplish the following:

- Study water, air, and soil conditions in a broader context that includes urban and rural landscapes as well as forested lands and rangelands.
- Provide managers with the tools necessary to sustainably manage terrestrial and aquatic resources within the context of changing climate conditions.
- Translate knowledge to land managers and the public about ecosystem processes with a high level of integration among water, air, and soil research and develop tools for managers and planners.
- Use the power of the networks, such as the Experimental Forests and Ranges and the Long-Term Soil Productivity Study, to provide high-quality, long-term data to assess changes in ecosystem processes and to address questions related to natural resource management in the context of climate change on wild, managed, rural, and urban lands.
- Build stronger collaborations both within the agency and with external partners.
- More effectively integrate the social sciences with water, air, and soil research.
- Use the power of long-term data sets to understand the effects of climate variability and change on the biogeochemical cycles of terrestrial, freshwater, and coastal ecosystems.

Water, Air, and Soil Strategic Program Area 2011–2016 Strategic Plan

Vision: Knowledge, tools, and technologies are efficiently and effectively integrated into forest, rangeland, and aquatic habitat management to restore, sustain, and enhance water, air, and soil resources for the benefit of ecosystem health and sustainability and for human health and welfare.

Mission: The Water, Air, and Soil Strategic Program Area of Forest Service Research and Development provides the science and technology to help land managers promote clean air, ample clean freshwater, and sustainably productive soil to meet the needs of a growing population; reduce air and water pollution; inform adaptive management strategies in response to climate change; and reduce and mitigate the impacts of extreme events, such as floods, droughts, landslides, and wildfires.

Ensuring access to safe drinking water, clean air, and productive soils is critical to human health and economic sustainability, domestically and globally. Protecting water supplies was a primary reason for creating the National Forest System (NFS). As an example, an estimated 80 percent of the freshwater in the United States originates in forests. In this century, many new challenges confront resource managers as human population increases the demand for food, fiber, energy, and water. With emphasis on management at the ecosystem level, the Forest and Rangeland Renewable Resources Planning Act of 1974 states that new knowledge derived from coordinated public and private research programs will be used to promote a sound technical and ecological basis for effective management, use, and protection of the Nation's renewable resources.

In its experimental forests, ranges, and watersheds, the Forest Service, U.S. Department of Agriculture (USDA), has research facilities that are geographically grounded and representative of a diverse group of biomes and ecological systems across multiple scales. This geographic coverage enables scientists to address local, regional, and national environmental and natural resource issues. Furthermore, developing networks with other research locations, including urban sites, and linking them with adjacent lands has broadened this integrated research program. Enhancing long-term monitoring networks and applying results to management actions through adaptive management experiments represents a powerful tool for addressing land management and climate change issues.

Background of Water, Air, and Soil Strategic Program Area

In 2004, Forest Service R&D developed a Logic Model and Business Plan for the Water and Air Strategic Program Area. Through a series of all-scientists meetings, development of the SPA activities continued in preparation for the 2008 Water, Air, and Soil Strategic Program Area (WAS SPA) National Program Review. Soil Research and the Experimental Forests and Ranges were added to the WAS SPA at this time. These activities, in addition to the National Program Review results, have provided the foundation for this WAS SPA Strategy.

This strategy is divided into four program goals, which provide science to (1) understand basic water, air, and soil processes; (2) understand the long-term effects of changes in climate, land and water use, and pollution on water, air, and soil processes; (3) understand the effects of extreme or catastrophic events on water, air, and soil processes; and (4) develop decision tools for natural resource managers, planners, and policymakers.

Research Goals

Goal I.

Develop the science necessary to understand how management actions on forests and rangelands affect water, air, and soil processes and, in turn, how these processes relate to water quantity and quality, air quality, and soil productivity.

Society demands clean air, access to adequate supplies of clean freshwater, and productive soils. These demands are increasing as the Nation's population and water use increase and as air and soil quality declines. Headwater and bottomland forests and rangelands, often located on national forests and grasslands, are primary sources of clean air and water. These lands not only influence water supply but also the quality of waters emerging from other land uses. In turn, the health of headwater, riparian, and bottomland forests and their soil resources is influenced by the quality and quantity of air and water that pass through them.

Crosscutting Issues—Ecosystems and Land Use Change

Land use and the resulting changes in landscape composition and structure profoundly affect the benefits derived from ecosystems. Social and economic considerations are among the important drivers of landscape change and thus ecosystem services, but the interactions between these drivers and the biophysical environment remain poorly understood.

To protect and enhance the Nation's supply of clean air, clean water, and productive soil resources, it is important to understand the ecological processes that underpin forest and rangeland capabilities to produce and sustain them. Moreover, it is important to understand and quantify how land management actions can affect these capabilities, both positively and negatively. Prescribed fire is an excellent example of a management activity with positive (fuel management, species habitat) and negative (air quality) effects.

Forest Service R&D works to improve land management practices through improved understanding of the effects of natural processes and human activities on interactions between aquatic and terrestrial ecosystems in wild, managed, rural, and urban areas. Long-term experimental watershed studies by Forest Service researchers and their collaborators have been critical to understanding how ecosystems function and what processes enhance or impair the quantity and quality of water that comes from forest, rangeland, or urbanized watersheds. Long-term management treatment studies have provided key information to increase productivity,

yet still maintain stewardship of the land. These studies have provided the scientific understanding and the technical basis for restoring degraded watersheds to a sustainable, productive condition.

Activity 1.1. *Conduct long-term, multiple-scale research on the interactions among vegetation, soils, atmospheric environment, and water quality and quantity in wild, managed, rural, and urban forest watersheds and rangelands.*

- Improve knowledge of the critical processes that regulate water, air, and soil quality.
- Identify forest and rangeland components most sensitive to natural or human-caused changes in vegetation, soils, and atmospheric environment.
- Develop a predictive understanding of watershed processes to assess current and future ecosystem health and resource sustainability.
- Improve understanding of nutrient and carbon fluxes.
- Improve knowledge of nutrient fluxes between terrestrial and aquatic ecosystems and the atmosphere.

Activity 1.2. *Conduct long-term, multiple-scale research to determine how land management activities influence water quantity and quality in wild, managed, urban, and rural forest and grassland ecosystems.*

- Improve knowledge of how land management activities influence water quantity and quality.
- Improve knowledge of how fuel management activities influence soil and air quality, in comparison to wildfire, over the long term.
- Develop and evaluate management activities to mitigate or improve water quantity and quality.

Crosscutting Issue—A World Below Our Feet

Up to two-thirds of the total amount of carbon stored in terrestrial ecosystems lies beneath the ground. Understanding the ecological processes in the belowground layer of an ecosystem is of great interest to scientists. Belowground systems are challenging to study because they are hard to observe without disturbing them. As a result, we know much less about belowground systems compared with aboveground systems. For example, the spatial heterogeneity associated with the physical and biological characteristics of soil, including carbon, are widely acknowledged. Yet, despite this recognition, the scale or extent of the spatial heterogeneity of soil carbon, how management and climate change affect it, and how these patterns are related to ecosystem processes below ground are poorly understood.

- Develop tools to optimize the tradeoffs and risks associated with the management of wild, managed, urban, and rural watersheds to provide for sustainable water supplies.
- Develop predictive models and other tools for quantifying watershed condition and trends resulting from land use change and management actions—including rehabilitation after wildland fire and other disturbance events.

Goal II.

Develop the science necessary to understand the effects of water, air, and soil pollution; climate variability and change; and land and water use change on wild, managed, rural, and urban forest and rangeland sustainability, and the benefits they provide to society.

Atmospheric pollution, deposition, and chemical contamination of soils and aquatic ecosystems pose direct and lasting threats to ecosystem sustainability. Global tropospheric ozone—which has doubled since preindustrial times and is expected to double again by 2020—depresses plant growth and exacerbates the susceptibility of forests to drought. Nitrogenous compounds associated with fossil fuel combustion and agricultural applications can significantly alter biogeochemical cycles, disrupt forest and rangeland productivity, and increase species mortality. Coal-burning power plants, major sources of atmospheric nitrogen and sulfate, also emit mercury, which is a critical environmental contaminant. In wetlands and poorly drained soils, sulfate deposition stimulates anaerobic bacteria, accelerating the production of methyl mercury, the biologically available form.

Land use change and the resulting changes in vegetation composition and structure profoundly affect the benefits derived from ecosystems. Social and economic considerations are among the most important drivers of landscape change, but the interactions between these factors and the biophysical environment remain poorly understood. Regional assessments, such as the Southern Forest Resource Assessment and The State of the Chesapeake Bay Forests, suggest that urbanization, especially in the form of low-density exurban development, represents a substantial threat to the extent, condition, and health of surrounding forests and surface waters.

Climate change is expected to affect a variety of human and ecological systems and cause changes in water supply for (1) human consumption and agricultural use; (2) in-stream flows that support aquatic ecosystems, recreational uses, hydropower, navigation, and wastewater assimilation; (3) wetland extent and productivity; and (4) the frequency and severity of floods and droughts. Quantifying the vulnerability of ecosystems to climate-change-induced alterations in water supply will help managers and urban planners plan and prepare for such changes.

Climate influences every aspect of resource management. Most management decisions, however, have been made with the implicit assumption that climate is static or changing slowly. But in fact, climate has changed throughout the centuries and could now be changing at an unprecedented rate. In addition, novel anthropogenic stressors such as pollution, landscape fragmentation, urbanization, invasive species, and altered fire regimes all interact with climate change and variability at local to global scales. A better understanding of these interactions is critical for developing science to sustain forest and aquatic ecosystems.

Activity 2.1. *Conduct long-term research on the effects of pollution on water, air, and soil resources to wild, managed, rural, and urban forest and rangeland ecosystems.*

- Improve the knowledge base of the relationships among water, air, and soil pollution and key attributes of forest and rangeland sustainability (e.g., nutrient fluxes, maintenance of critical habitats, biodiversity).

- Determine the critical loads, levels, and thresholds of water, air, and soil pollution that affect forest and rangeland ecosystems.
- Identify and classify airsheds, watersheds, and their components most sensitive to water, air, and soil pollution.
- Develop and evaluate the management options to prevent or mitigate the onsite and offsite effects of water, air, and soil pollution on wild, managed, rural, and urban forest and rangeland ecosystems.
- Improve the knowledge base that is required to enable compliance with water, air, and soil regulations (e.g., criteria pollutants, persistent organic pollutants, mercury).

Activity 2.2. *Conduct research on climate variability and change, and the effects on wild, managed, rural, and urban ecosystems mediated through changes to water, air, and soil.*

- Improve the knowledge base of the effects of climate variability and change on wild, managed, rural, and urban forest and rangeland ecosystems. Identify ecosystems most sensitive to climate variability and change.

Crosscutting Issue—Wildfire and a Changing Climate

Globally, wildland fires release about 1 billion tons of carbon annually to the atmosphere compared with about 6 billion tons released by burning fossil fuels. The magnitude and effects of climate change and its effect on fire regimes will vary by regions. If the frequency, extent, or severity of fire increases due to changing climate, then terrestrial carbon storage will decrease, and the carbon in the atmosphere—much of which has a negative effect on human health—will increase.

- Develop and evaluate the management options (e.g., carbon sequestration, in-stream flows, wetland mitigation) to prevent or mitigate the effects of climate variability and change on ecosystem sustainability.
- Improve the knowledge base of the human dimensions of climate variability and change, and potential effects on ecosystem sustainability.

Goal III.

Develop the science necessary to understand the influence of extreme events, such as fire, drought, hurricanes, landslides, and insect outbreaks; the effects they have on wild, managed, rural, and urban forest and rangeland sustainability; and the benefits they provide to society.

Disturbances such as fire, drought, insect and pathogen outbreaks, invasive species, hurricanes, windstorms, and ice storms are natural and integral processes in forest, shrub, rangeland, and aquatic ecosystems. These disturbances profoundly affect ecosystem dynamics. Ecosystems have evolved with disturbance, and in many instances, depend on disturbance for their maintenance. Human activities have greatly altered disturbance regimes by changing the frequency, size, intensity, seasonality, duration, and types of disturbance. The effects of these alterations are poorly understood, and, in some cases, abrupt and extreme changes in ecosystem structure and function seem likely.

With the increasing rate and variability of climate change, it is predicted that weather events such as hurricanes, storms triggering floods and landslides, ice storms, heat waves, and drought will occur with increasing intensity and frequency. How well ecosystems renew their structure and function after these weather events is an unanswered question of ecology, and the answer will likely depend on the overall resilience of the specific ecosystem.

Activity 3.1. *Conduct research on the timing, frequency, and magnitude of chronic and extreme events and their effects on water, air, and soil resources of wild, managed, rural, and urban forest, rangeland, and coastal ecosystems.*

- Improve the knowledge base of the causes, frequency, and magnitude of chronic and extreme events.
- Improve the knowledge base of the effects of chronic and extreme events on natural resources, property, and life through long-term research.
- Identify the forest and rangeland ecosystems that are most threatened by chronic and extreme events.

- Improve the cost-effectiveness of land management to maintain or restore ecosystems.

Activity 3.2. *Develop and evaluate management options to prevent or mitigate the effects of extreme events on water, air, and soil of wild, managed, rural, and urban forest, and rangeland ecosystems.*

- Develop a predictive and risk-based understanding of structural failures in watersheds including the mechanisms of landslides, erosion, and flooding.
- Develop and test management options to prevent or mitigate the effects of extreme events on natural resources, property, infrastructure, and human lives.

Activity 3.3. *Conduct research on the effects of fire on water, air, and soil resources of forest and rangeland watersheds and develop management options to restore or rehabilitate fire-damaged ecosystems.*

- Improve the knowledge base of the effects of fire on vegetation, air, soil, water resources, and aquatic habitats.

Crosscutting Issue—Urban Ecosystems

Water and air quality problems are disproportionately tied to urban areas. In addition to focusing on critical processes on NFS lands that are key sources of high-quality freshwater and clean air, Forest Service researchers are addressing the critical need to better understand water quality and quantity in rural, urban, and urbanizing landscapes.

- Develop new or improve existing cost-effective management options to restore and rehabilitate fire-damaged ecosystems, where desirable.
- Develop cost/benefit and ecological analyses of restoring and rehabilitating damaged ecosystems.
- Develop the ability to predict and compare changes in atmospheric chemistry and composition and smoke behavior due to wildland and prescribed fire.

Goal IV.

Develop and provide the knowledge base and tools to inform land managers, the general citizenship, and children about forests and rangelands in ways that protect, improve, and sustain watersheds.

Partnerships are the most effective way to deliver empirical and applied knowledge and tools on forest, rangeland, and urban and coastal landscapes to land managers. Verification of models should be conducted in partnership with the community of users to continually improve the assumptions and model design. Researchers and managers working in concert produce the most effective application of adaptive management plans for continuous improvement and delineation of Forest Service research focus and technology development.

Educational programs carry the knowledge beyond the communities of experts and specialists to create a future citizenship that is able to make informed decisions about global environmental issues and the steps that are necessary to meet the world's needs using sustainable natural resources. Using Federal lands as living laboratories brings the student and citizen to the outdoors to assist in understanding the forest-to-faucet story.

Activity 4.1 *Develop tools and technologies necessary to manage the water, air, and soil resources that affect managed transitional lands and wilderness areas.*

- Develop and evaluate new technologies to improve or increase the efficiency and effectiveness of resource management activities on public and private lands, and wildland-urban interface and urban landscapes.
- Develop new tools and approaches to understand the human dimensions of water, air and soil management on public and private wild, managed, rural, and urban lands.
- Develop new tools and monitoring approaches to increase the understanding of the effect pollution has on water, air, and soil resources on federally designated wilderness areas.

Activity 4.2 *Conduct knowledge-delivery activities to provide predictive and decision-support services for natural resource management.*

- Conduct workshops and webinars to educate users about new science and tools for water, air, and soil management.

- Integrate new water, air, and soil decision-support tools into current science-based management planning, prediction, and forecasting.
- Coordinate with land managers to validate predictive models and other tools that quantify watershed conditions and trends due to management actions, including rehabilitation after disturbance events.
- Test advanced modeling tools, such as models of fire and smoke, cumulative effects of pollution (e.g., critical pollution loads), sediment regimes, and nutrient fluxes, by coordinating with managers.
- Increase the incorporation of data and knowledge from long-term studies to improve management actions on the ground.

Activity 4.3 *Combine user feedback, collaboration, and coordinated approaches to provide relevant and timely tools and knowledge delivery products.*

- Develop, participate in, and maintain consortia (through local and regional partnerships) for water, air, and soil research.
- Develop expert systems and systematic approaches to transfer technology of water, air, and soil research to user communities.
- Institute a collaborative life-cycle management system for water, air, and soil applied research and technology development.
- Develop new technology and knowledge for remote sensing of natural resource status and trends and human influences.

Activity 4.4 *Partner with educational specialists and organizations to develop or provide educational material for all educational levels and the public.*

- Coordinate and collaborate within USDA and with other agencies to develop teacher guides and study plans on topics and issues affecting water, air, and soil resources.
- Develop partnerships with nongovernmental organizations (NGOs) to plan and produce local and national community events and materials to highlight information about water, air, and soil resources.
- Develop and distribute media packages to explain the Forest Service water, air, and soil research program and the value to the public of long-term and interdisciplinary research.
- Provide information and make researchers available to higher levels of education to teach the scientific process and encourage students to move into science careers.

Research in the Long Term—Forest Service Experimental Forests and Ranges

Experimental Forests and Ranges (EFRs) serve as living laboratories, providing windows in time. This network of more than 80 sites is the oldest, most extensive system of research sites dedicated to resolving the Nation's natural resource problems through research, partnerships, and public education. Today, a network of experimental research sites is more relevant than ever before to answer complex natural resource questions of regional and global scale. Because EFRs constitute a national network of permanent outdoor laboratories, they are also uniquely positioned to respond to emerging issues on large spatial and temporal scales—such as land use change, global climate change, and extreme ecological events.

Partners, Collaborators, Users, and Customers

A core strength of Forest Service R&D is building internal and external strategic alliances. Many working alliances already exist within the organization, and their importance will increase due to the realities of constant or declining resources.

Internal partners include the Washington and regional staffs of the NFS for water, air, and soil issues; the Stream Team; and State and Private Forestry.

External partners include other Federal agencies, such as USDA's Natural Resources Conservation Service, Agricultural Research Service, Economic Research Service, and National Institute of Food and Agriculture; U.S. Department of the Interior; U.S. Department of Commerce, National Oceanic and Atmospheric Administration; U.S. National Aeronautics and Space Administration; National Science Foundation; U.S. Environmental Protection Agency; and U.S. Department of Defense. External partners also include public and private landowners; State departments of agriculture and natural resources; Consortium of Universities for the Advancement of Hydrologic Sciences, Inc.; private R&D organizations; NGOs; local and tribal governments; private industry; and international governments and organizations.

Crosswalk With Interagency and Interagency Goals

USDA Strategic Plan 2010–2015.

Goal 2: Ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources.

- *Objective 2.1*—Restore and conserve the Nation's forests, farms, ranches, and grasslands (WAS Goals 1, 2, and 3).
- *Objective 2.2*—Lead efforts to mitigate and adapt to climate change (WAS Goal 3).
- *Objective 2.3*—Protect and enhance America's water resources (WAS Goal 1).
- *Objective 2.4*—Reduce risk from catastrophic wildfire and restore fire to its appropriate place on the landscape (WAS Goal 3).

USDA Forest Service Strategic Plan, FY 2007–2012

- *Goal 1:* Restore, sustain, and enhance the Nation's forests and grasslands (WAS Goals 1, 2, and 3).
- *Goal 2:* Provide and sustain benefits to the American people (WAS Goals 1, 2, 3, and 4).
- *Goal 3:* Conserve open space.
- *Goal 4:* Sustain and enhance outdoor recreation opportunities (WAS Goal 1).
- *Goal 5:* Maintain basic management capabilities of the Forest Service.
- *Goal 6:* Engage urban America with Forest Service programs (WAS Goals 1, 2, 3, and 4).
- *Goal 7:* Provide science-based applications and tools for sustainable natural resources management (WAS Goal 4).

Integration Opportunities With Other Forest Service R&D Strategic Program Areas

Resource Management Use SPA—Forests and rangelands provide many beneficial services to people, and many of these services are tied to water, air, and soil resources. Forest Service researchers are developing management and planning tools to measure the value of ecosystem health and its effect on human health

Invasive Species SPA—Invasive species are a growing threat to ecosystem health due to persistent introductions by human activities and habitat alterations due, in part, to climate change. Invasive species have the potential to affect water quality and quantity, soil erosion, and disrupt self-sustaining plant communities. Through integrated research on invasive species and ecosystem structure and processes, methods to prevent, control, and mitigate the influence of invasive species and to rehabilitate affected ecosystems are being developed.

Fire SPA—Wildland fire and prescribed burns can have both detrimental and positive effects on water, air, and soil resources. Forest Service researchers are working with land managers to maximize the positive effects of prescribe burns, such as reducing fuel loads, while minimizing negative effects, such as smoke on air quality and visibility.

Recreation SPA—Recreational activities can have a major effect on watershed health through soil compaction on trails and in campgrounds, sediment from roads on water quality, and increased air pollution through increased vehicles on public lands. In turn, water quality and quantity can have a strong effect on quality of the recreational experience. The Forest Service conducts research on the environmental effect of recreation activities and the social values, which direct the intensity and location of recreation on NFS land. Through increased knowledge, the Forest Service develops technologies and management plans that mitigate or redirect recreational activities.

Fish and Wildlife SPA—The structure and productivity of terrestrial, aquatic, and riparian habitats that support fish and wildlife populations are dependent on the biophysical environment (water, air, and soil). Forest Service researchers are working to understand how hydrologic, geomorphologic, and geochemical processes influence ecosystem structure and function and the relationship between ecosystem processes and species, populations, and communities.

Inventory and Monitoring SPA—The Forest Service monitors forest cover and land use change, forest productivity inclusive of forest biomass, carbon, and forest health through several programs, including the Forest Inventory and Analysis (FIA) Program. These data are often used in water, air, and soil research to assess the long-term effects that atmospheric pollutants and climate change have on forest ecosystems.

Inventory and Monitoring SPA—Overarching Research Activities

Key components

Providing basic and applied science to better understand how ecosystem processes and management actions influence forest and rangeland air quality, water quality, and water quantity.

- Support network of experimental forests and ranges sites
- All-lands approach

Providing science to understand water, air, and soil pollution; climate variability; and land use change.

- Research on pollution effects
- Research on climate change

Providing science and tools to understand extreme events.

- Research on extreme events
- Research management options
- Research on fire

Developing and providing tools.

- Develop tools
- Deliver knowledge
- Adapt tools based on user feedback

Authorities

The Organic Administration Act of 1897 initiated the practice of forest management on the national forests and set up a direct goal to improve, protect, and enhance water supplies; reduce flooding; and secure a favorable condition of water flow.

The Clean Water Act of 1948's objective is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The Forest Service has developed the Best Management Practices, as mandated in the Act, as precautionary measures to protect water resources.

The Clean Air Act of 1955 initiates and accelerates a national research and development program to achieve the prevention and control of air pollution. Reduction of air pollution from Federal properties and facilities also falls under this act, which includes particulates and visibility condition of smoke from fires. It also directs protection of Class I Wilderness areas and requires public lands to follow the National Ambient Air Quality Standards.

The Forest and Rangeland Renewable Resources Research Act of 1978 is the USDA's primary authority to conduct research activities, including research that relates to vegetation management and protection; wildlife, fish, water, and air sciences; resource valuation and use; and inventory and monitoring. The act contains expansive authority to conduct research and technology development on, and with applications for, all U.S. lands related to the protection, conservation, and sustainable use of natural resources. The act also authorizes competitive grants to conduct research and authorizes cooperative agreements with university, industry, and other partners, as needed, to complement national program needs.

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