The national forests were created in part for “securing favorable conditions of water flows,” the importance of which has grown as populations have grown. The highlands and northern forest lands provide the source of our nation’s water sources.
Hubbard Brook Experimental Forest

The longest running, most comprehensive ecosystem study in the world is on the Hubbard Brook Experimental Forest. Established in 1959 to control New Hampshire’s White Mountain National Forest, the Hubbard Brook Experimental Forest is a “research treasure” where NSF scientists and their numerous cooperators can study the effects of forests and forest management on the hydrological cycle, erosion, and water quality in a typical New England granite-based northern hardwood forest type (beech-maple-oak). The Hubbard Brook watershed was chosen for its special characteristics suited to small watershed studies. Its central brook is fed by a network of smaller streams flowing over shallow soils on water tight New Hampshire granite bedrock. Nine stream gauges (see page 9) were installed, the first in 1965. In 1983, Robert Parce, the lead USFS scientist, and his colleagues Herbert Bormann and Gene Likens (then at Dartmouth College) began using the small-watershed technique for early cooperative work. The work they began has, during the past 50 years, allowed us to develop an understanding of restorine forests in small watersheds and ecosystems in addition. Hubbard Brook scientists were first to report, and ultimately for 18 different chemical parameters and have produced year-round monitoring. The samples are typically analyzed at the Hubbard Brook EF headquarters, from five decades of some of the 40,000+ bottles of water samples in storage at the Hubbard Brook Experimental Forest. For example, they were the first to report, and ultimately understood the importance of the Forest Service’s network of experimental forests cannot be underestimated. Because the experimental forests in the United States are a Department of Agriculture government forestry research organization, they are sometimes thought of as laboratories that can be used to test the effects of climate change or other factors. Hubbard Brook scientists have been able to take measurements and analyze the data over decades, and some of the NSF experimental forests have 50-year-long hydrological studies. Scientists from all of these sites use their work to individually study, and together examine, the changes that are occurring in the major causes of changing climate. The Hubbard Brook research has had a profound impact on the study of riparian ecosystems—not only how they function today, but how they are likely to react over time to both disturbance and attempts at restoration.

In the 1950’s, 1960’s and 1970’s, the Hubbard Brook EF was the site of many early studies of the effects of acid rain and other pollutants on forest ecosystems. In addition, Hubbard Brook scientists were first to report, and ultimately for 18 different chemical parameters and have produced year-round monitoring. The samples are typically analyzed at the Hubbard Brook EF headquarters, from five decades of some of the 40,000+ bottles of water samples in storage at the Hubbard Brook Experimental Forest. For example, they were the first to report, and ultimately understood the importance of the Forest Service’s network of experimental forests cannot be underestimated. Because the experimental forests in the United States are a Department of Agriculture government forestry research organization, they are sometimes thought of as laboratories that can be used to test the effects of climate change or other factors. Hubbard Brook scientists have been able to take measurements and analyze the data over decades, and some of the NSF experimental forests have 50-year-long hydrological studies. Scientists from all of these sites use their work to individually study, and together examine, the changes that are occurring in the major causes of changing climate. The Hubbard Brook research has had a profound impact on the study of riparian ecosystems—not only how they function today, but how they are likely to react over time to both disturbance and attempts at restoration.
In the 20-year-old, wide-scaled, whole-ecosystem studies, research began using the small-watershed technique for early cooperative work. The work they began there in the 1950s and 1960s laid the foundation for the understanding of nutrient cycling in forests and stream ecosystems. In addition, Hubbard Brook scientists have, during the past 56 years, advanced our fundamental understanding of nutrient cycling in forests and stream ecosystems. In 1999, with NSF funding, NSF scientists applied 56 tons of calcium (the amount estimated to have been leached by acid precipitation) as crushed calcium silicate rock back onto the watersheds. Data from this work will be used to improve our understanding of the possible impact of calcium depletion due to acid precipitation, provide increased knowledge of the role of calcium in ecosystem processes, and develop models that can be used on a larger, regional landscapes.

Marcell Experimental Forest

The Marcell EF in northern Minnesota was established on the Chippewa National Forest in 1968 to study biogeochemistry and hydrology in boreal ecosystems that were bounded in their watersheds. Peatlands occur across the United States but are more common in boreal forests of the northeastern United States and Canada. Boreal forests are typically low-relief postglacial landscapes where organic matter has accumulated under waterlogged conditions that inhibit normal decomposition. The soils are thus rich in organic matter and store vast amounts of carbon. Peatlands occupy about 340 million acres in North America, mostly in Canada and Alaska and about 23 million acres in the continental United States, mostly in the northern Great Lakes region. Peatlands such as those in the Marcell EF are classified as either bogs or fens according to their hydrology and chemistry. Fens have water contribution from groundwater, upland runoff, and precipitation; whereas bogs have contributions only from the latter two. The chemistry of bogs is driven by the production of acids by bogs species whereas fen chemistry is driven by the inputs of nutrients—nitrate, neutral-gas groundwater.

The Marcell EF has six watersheds equipped with measuring instruments, each consisting of a mineral soil upland surrounding an organic-soil peatland. Weather, precipitation, streamflow, groundwater levels, and water chemistry are routinely measured, and most records now date back nearly 50 years. Watershed studies evaluated various forest management options: upland fertilization, and conversion of aspen uplands to conifer forests using cattle grazing to control aspen regrowth. Based on our field results, computer models have been developed to simulate streamflow responses to timber harvests. These results were instrumental in evaluating best management practices and establishing harvest rate guidelines for forests throughout the region. Pioneering studies at the Marcell EF evaluated the sources and sinks of both carbon and mercury in the experimental watersheds. Ongoing work focuses on understanding the importance of localized hotspots that affect nutrients, carbon, and mercury availability at the watershed scale.

The ability to think several generations ahead is a valuable characteristic of our experimental forests—not only how they function today, but how they will likely react over time in both disturbance and attempts at restoration.

Sandy Terry, retired Forest Service Research Hydrologist, Marcell Experimental Forest

WHAT MAKES THESE EXPERIMENTAL FORESTS SO VALUABLE?

Steve Sebestyen, right, at Marcell EF

The importance of the Forest Service’s network of experimental forests cannot be emphasized enough. Because the experimental forest system is managed by the government forest research organization, they operate without the financial pressure to generate income. Scientists have been able to take measurements and understand the data over decades, because some of the HBEF experimental forests have 50-year-old hydrology systems. Scientists estimate that over the last century, large-scale efforts in the United States have led to a 30% decrease in watershed delivery (the amount of water that flows into the air, water, or soil) in major forest fire areas in the United States.

Let clean waters flow.

Barack Obama, Inaugural Address

Some of the 40,000+ bottles of water samples in storage at the Hubbard Brook EF headquarters, from five decades of biogeochemical research. The bottles were taken from one of five locations in the Hubbard Brook Experimental Forest. The samples are kept liquid nitrogen. With the ability to access and use this vast data set, the Hubbard Brook Experimental Forest serves as a unique research tool.

October 31, 2008
In the 1950’s-1960’s, many ecologists recognized the importance of causal factors on the declines of forest species. Scientists at the Hubbard Brook Experimental Forest (HB) in New Hampshire, USA, began documenting the growth, composition, and productivity of a small watershed in the White Mountain National Forest. This work began as a cooperative effort between the U.S. Forest Service and the U.S. Geological Survey in 1951. The purpose of this study was to understand the conditions and processes that influence the nutrient cycling and productivity of this small watershed.

Some of the early studies at HB focused on the impact of forest management on water chemistry and nutrient cycling. Scientists at HB began to collect water samples from the forested areas and analyzed the nutrients present in the water. They found that the nutrient concentrations in the water were influenced by the type of forest management practices used. For example, clearcutting the forest resulted in a significant increase in nutrient concentrations, whereas the use of selective logging resulted in a decrease. These findings were important in understanding the impacts of forest management on water quality.

In the 1970’s, HB began to collect data on the effects of acid precipitation on forest health. Scientists began to collect water samples from the forested areas and analyzed the pH and nutrient concentrations in the water. They found that acid precipitation was causing a decrease in the pH of the water, which in turn was affecting the growth and productivity of the forest.

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Hubbard Brook Experimental Forest

The Hubbard Brook Experimental Forest is a National Science Foundation (NSF) Research Natural Area located in the White Mountains of New Hampshire, USA. The forest is approximately 1600 acres in size and is surrounded by a large, forested area. The forest is composed of a variety of tree species, including spruce, fir, and aspen. The forest is home to a variety of wildlife, including deer, elk, and black bears.

The research at HB is focused on understanding the relationships between the forest and the water. Scientists at HB began to collect water samples from the forested areas and analyzed the nutrients present in the water. They found that the nutrient concentrations in the water were influenced by the type of forest management practices used. For example, clearcutting the forest resulted in a significant increase in nutrient concentrations, whereas the use of selective logging resulted in a decrease. These findings were important in understanding the impacts of forest management on water quality.

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The ability to think of new strategies and experiments depends on the ability to think of new ways to conduct research. Scientists at HB began to collect water samples from the forested areas and analyzed the nutrients present in the water. They found that the nutrient concentrations in the water were influenced by the type of forest management practices used. For example, clearcutting the forest resulted in a significant increase in nutrient concentrations, whereas the use of selective logging resulted in a decrease. These findings were important in understanding the impacts of forest management on water quality.

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Keeping Our Water Safe and Abundant: Hydrology Research on Experimental Forests

Water is vital to life and health at both the personal and societal levels. Just as humans cannot thrive without clean and adequate water, no region, country, or city can exist without clean, reliable, and adequate water can function well. Although civilizations have built infrastructures to supply and transport water, the ultimate source of the water is always the natural world. Surface water and ground water both depend on lands where precipitation falls into watersheds or is pumped from springs or wells. In most of the northeastern and midwestern United States, this source is the highlands and northern forest lands. Providing clean water is considered the most vital of the ecosystem services provided by our forest and wetlands. Forested watersheds in the United States provide drinking water to more than 180 million people.

U.S. FOREST SERVICE PROTECTS OUR NATION’S WATER SOURCES

Protecting our water source was a primary purpose for which the U.S. Forest Service (USFS) was established in 1910. The USFS commitment to our nation’s water quality is nurtured—protecting the 193 million acres of National Forest System lands that provide water to 66 million people, and studying the fundamental science of watershed hydrology for most of the major forest types of the United States. Much of the agency’s long-term watershed research happens on specially designated lands (often within the National Forest System) that are set aside solely for scientific study. The Northern Research Station (NRS) has three experimental forests (EFs) that have specialized in watershed processes for more than half a century. The Hubbard Brook EF in New Hampshire, the Fernow EF in West Virginia, and the Marcell EF in Minnesota are places where NRS scientists study the basics of the hydrological cycle in the major forest and wetland types and determine the effects of forest management on water resources.

NRS Research Review is published quarterly by the Communications and Science Delivery Group of the Northern Research Station (NRS), USDA Forest Service. As part of the nation’s largest forestry research organization, NRS serves 20 states in the Northeast and Midwest and beyond, providing the latest research on current problems and issues affecting forests and the people who depend on them.

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