



# Hubbard Brook Experimental Forest

**NORTHERN RESEARCH STATION  
EXPERIMENTAL FOREST NETWORK**

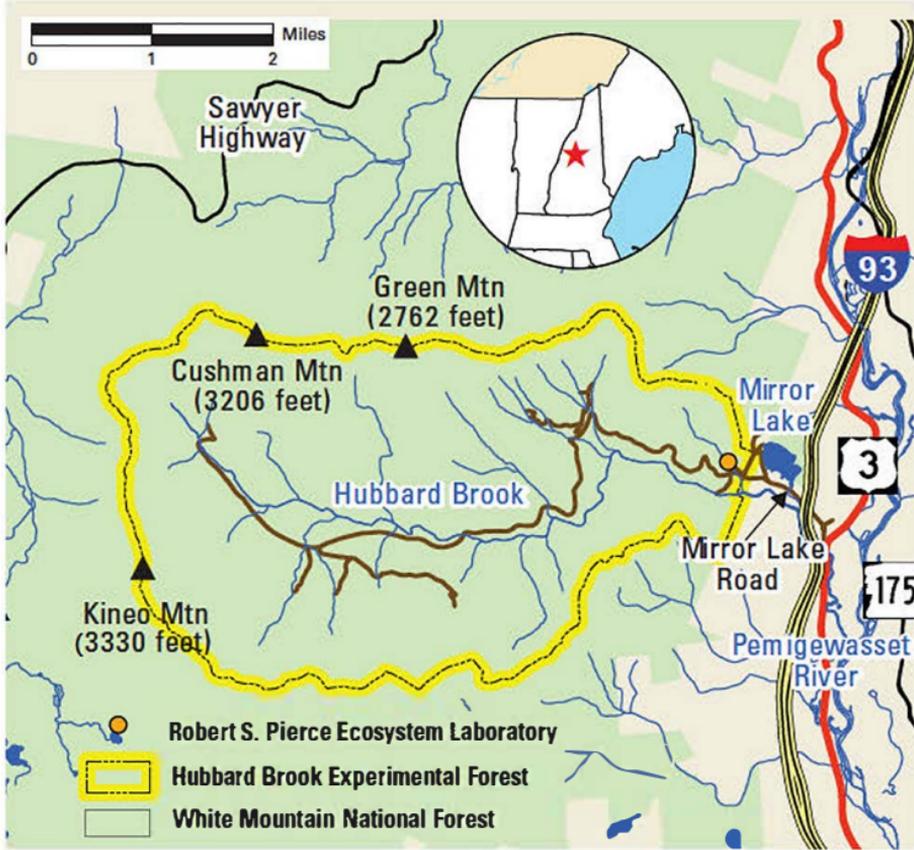
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# Hubbard Brook Experimental Forest

The Hubbard Brook Experimental Forest (HBEF) is world renowned for its research on hydrology and forest ecosystem dynamics. Located within the White Mountain National Forest in central New Hampshire, the site was established in 1955 as a center for hydrologic research in New England. Abundant small watersheds serve as a natural laboratory for research on water yield and quality in response to natural and human disturbances. The U.S. Forest Service manages HBEF for long-term ecosystem research and operates a field station, the Robert S. Pierce Ecosystem Laboratory. A 1963 collaborative agreement was established with neighboring universities to use the small watershed approach to study element flux and cycling. This relationship grew into the Hubbard Brook Ecosystem Study, a collaboration of researchers from multiple institutions committed to the study of the northern hardwood forest. In 1988 the HBEF was designated a Long Term Ecological Research site.

Map by U.S. Forest Service.





V-notch weir and flume at the base of Watershed 8 continuously measure stream discharge. Photo by Don Buso, Cary Institute, Millbrook, NY; used with permission.

## Features

The HBEF is a 7,900-acre bowl-shaped valley with mountainous terrain, ranging from 733 to 3,313 feet above sea level. The experimental watersheds range in size from 29 to 191 acres. These headwater watersheds are all steep, face either to the north or south and have distinct topographic divides.

- The vegetation is part of the extensive northern hardwood ecosystem and is dominated by uneven aged, second growth northern hardwoods. The principal tree species at HBEF are sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), American beech (*Fagus americana*), red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*).**
- The climate is humid continental with short, cool summers and long, cold winters and is further characterized by changeability of weather, a large range in daily and annual temperature and even distribution of precipitation throughout the year.**
- Mean annual temperature is 42° F and mean annual precipitation is 53 inches.**
- Bedrock comprises highly metamorphosed sedimentary rocks of the Rangeley formation and granitic rocks of the Kinsman pluton. Soils are mostly well-drained spodosols developed in acidic glacial till with loamy sand to sandy loam textures.**
- Abundant streams drain small watersheds suitable for gaging.**

## Research

The small watershed ecosystem approach has been used to study changes in streamflow, nutrient cycling, soil processes, and forest growth and composition over time to develop a better understanding of northern hardwood ecosystems response to disturbances. The watersheds are equipped with a network of precipitation and stream gaging stations and weather instruments and soil and vegetation monitoring sites that provide the framework for ecological research. Experimental manipulations at the watershed scale have been conducted to inform forest management practices, the role of biological uptake on nutrient cycles, the mitigation of air pollution, and to validate ecosystem models. Ongoing studies of the breeding bird populations at the HBEF examine the relationship between breeding behavior and vegetation structure.

## Science Delivery

Hubbard Brook research is used by scientists, forest practitioners, land owners, policy makers, educators, students, and the public. Research results are communicated through traditional venues of publications, presentations, and guided tours. Booklets on related topics such as acid rain, nitrogen and mercury deposition and carbon cycling have been produced to translate HBEF science for the public. The HBEF website provides research highlights, access to high quality long-term datasets, and real time data delivery of key environmental variables. Over 2,000 publications have been produced and hundreds of students have received training in the fundamentals of ecosystem science.



Male black throated blue warbler feeding chicks on a bird monitoring plot. Photo by Nick Rodenhouse, Wellesley College; used with permission. Aerial photo of Watershed 5 the summer after the 1984 whole tree harvest to study the impacts of logging on the forest ecosystem. U.S. Forest Service, Hubbard Brook archives.

# Outcomes

Research conducted at the HBEF has provided guidelines for the management of the northern hardwood forest, input to important environmental policy legislation such as the Clean Air Act, and a basis for understanding the structure and function of a northern hardwood forest ecosystem. Current environmental concerns such as clean water, air pollution, biodiversity, changing climate and ecosystem services are addressed by Hubbard Brook research. Long-term research studies have documented and resulted in the following accomplishments:

**Pioneered the small watershed approach to study nutrient transport.**

**Small watershed cutting experiments showed conspicuous losses of water and nutrients such as nitrogen, calcium, and potassium, which can be mitigated by best management practices.**

**Acid rain first identified at the HBEF in the early 1970s and Hubbard Brook research influenced national acid rain policy.**

**Long-term data demonstrated that declines in emissions of lead and sulfur corresponded with decreases in the concentrations of these elements in precipitation, soils and surface waters.**

**Uninterrupted long-term hydrometeorological databases have documented significant changes in the climate and hydrology of the site.**

**Long-term bird studies of the abundance and demography of forest bird populations, coupled with experimental tests, determined that populations are limited and regulated by breeding ground conditions such as food availability and competition.**

# Facilities

The Robert S. Pierce Laboratory provides year round office space, laboratories, conference facilities and living quarters. A maintenance building provides space for vehicles, tools and field supplies with additional sample processing and storage space. The sample archives building provides storage for samples gathered during research such as soil, water and plant tissue.

## **U.S. Forest Service Experimental Forest and Range Network**

Forest Service Research and Development (R&D) works at the forefront of science to improve the health and use of our nation's forests and grasslands. Research has been part of the Forest Service mission since the agency's inception. Today, Forest Service researchers work in a range of biological, physical, and social science fields; their research covers all 50 states, U.S. territories, and commonwealths. The Northern Research Station is one of six in R&D, and includes 20 states in the north-central and northeastern U.S., comprising both the most densely populated and most heavily forested portions of the country.

The Experimental Forest and Range (EFR) network contributes importantly to R&D's research infrastructure and is increasingly viewed as one of its most valued assets. There are currently 22 official experimental forests in the Northern Research Station, and 80 EFRs nationwide. Taken together, these sites provide a record of forests and forest change that dates back more than 100 years. Though initially focused on local and regional topics, EFRs are becoming increasingly networked to address issues of national and international concern such as climate change, carbon sequestration, air and water quality, and invasive plants and animals.

## **Partners**

Forest Service partners have included U.S. Geologic Survey, National Atmospheric Deposition Program, National Science Research Center, Cornell University, Yale University, Syracuse University, Dartmouth College, The Cary Institute for Ecosystem Studies, and many other national and international universities.

## **For more information about Hubbard Brook Experimental Forest**

### **Websites:**

<http://www.nrs.fs.fed.us/ef/locations/nh/hubbard-brook/>

<http://www.hubbardbrook.org/>

### **Contacts:**

Hubbard Brook Experimental Forest  
(603) 726-8902

Scientist in Charge,  
Northern Research Station,  
Forest Service  
271 Mast Road  
Durham, NH 03824  
(603) 868-7637

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Weather station associated with Watershed 9. Electronic real-time and traditional weather instruments provide continuous data to estimate how water and nutrients move through northeastern forests. Photo by Amey Bailey, U.S. Forest Service.