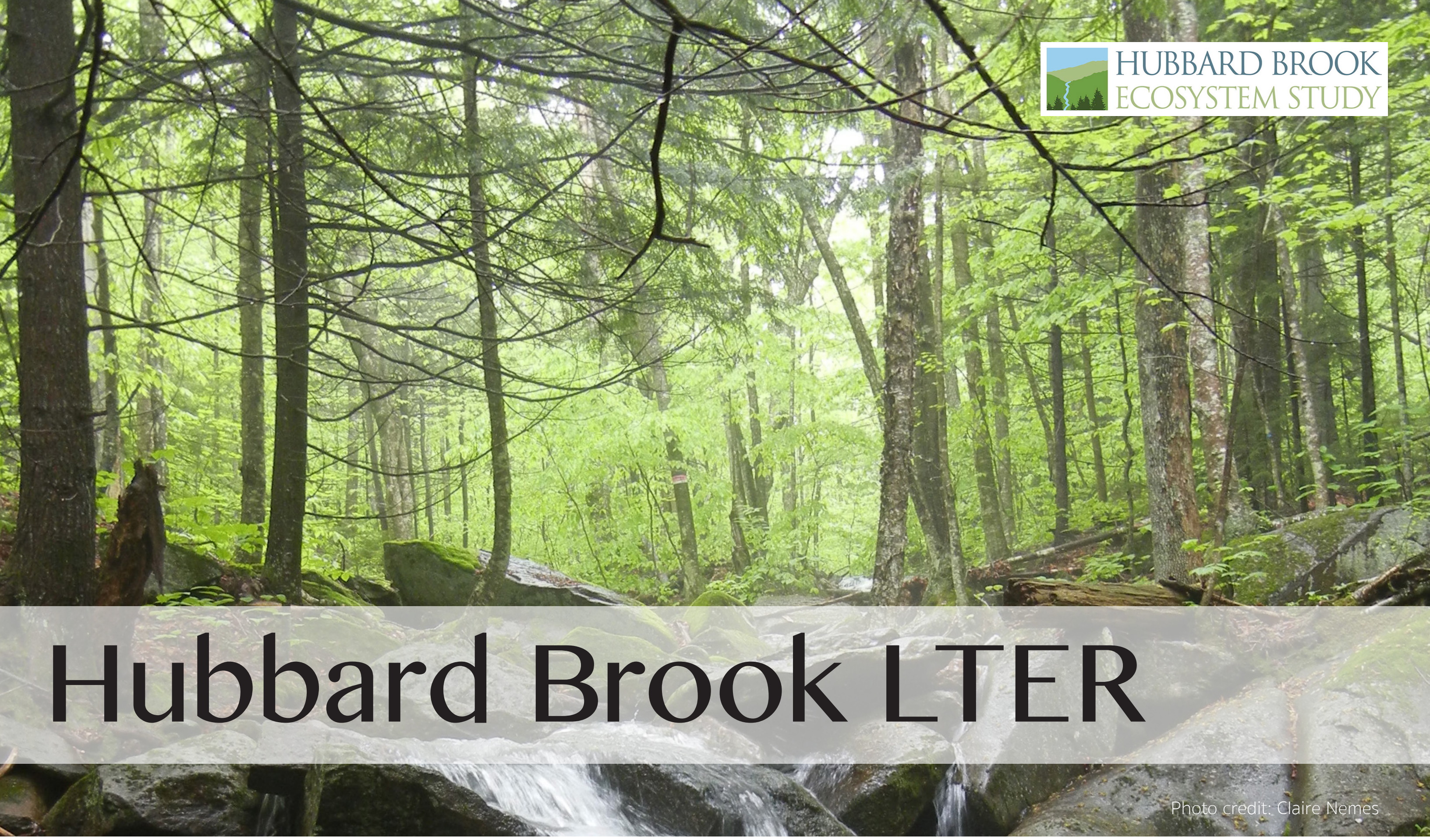


Hubbard Brook LTER

The mission of Hubbard Brook (HBR) LTER is to improve understanding of the response of Northern Forest ecosystems to natural and anthropogenic disturbances. Research takes place primarily at the Hubbard Brook Experimental Forest in the White Mountains of New Hampshire. Hubbard Brook research is organized around three drivers of disturbance: 1) changing atmospheric chemistry, 2) changing climate, and 3) changing biota, which includes changes in forest structure and plant and animal species composition.

Long term measurements and experiments have led to seminal research on trends, impacts, and recovery from acid rain and other forms of atmospheric deposition, ecological impacts of forest harvesting practices, long term vegetation dynamics in forests, and songbird population trends. Future research will emphasize the interactions between current disturbances and the legacies of past disturbance.

Between 2008-2018:

36 investigators

23 institutions represented

154 graduate students

Forest

Principal Investigator:

Gary Lovett

Cary Institute of Ecosystem Studies

Est. 1988

Funding Cycle:

LTER VI

NSF Program:

Biological Sciences / Division of Environmental Biology

Key Findings

Patterns of streamwater nitrogen loss from the watershed are not consistent with expectations. A mismatch between theory and data has led HBR LTER researchers to re-examine the role of denitrification, the role of mineral soil in nitrogen dynamics during succession, and the role of climate change in “tightening” the nitrogen cycle. [Products 1, 2]

Songbird populations have declined dramatically since measurements began in 1968, but show signs of stabilizing in recent years. Songbird declines are primarily due to the loss of neotropical migrant species, particularly species that nest and forage in mid-successional habitats. These species have become less common as the forest has matured [3].

Calcium is critical to forests exposed to acid rain. De-acidification of an entire watershed through calcium silicate application led to improved tree growth, health, and reproduction; increased decomposition and loss of soil organic matter; decreased root growth; and increased loss of nitrogen in streamwater starting ~10 years after application. Lack of calcium may be inhibiting the regeneration of sugar maple in harvested watersheds. [4, 5]

Climate change affects forest productivity. Climate change has extended the growing season and altered conditions during seasonal transitions. It has also had significant effects on the fluxes of whole-system carbon and nitrogen. [6, 7]

Partnerships

U.S. Forest Service | Hubbard Brook Research Foundation (HBRF) | National Atmospheric Deposition Program (NADP) (member) | U.S. EPA Clean Air Status & Trends Network (CASTnet) (member) | DroughtNet (member)

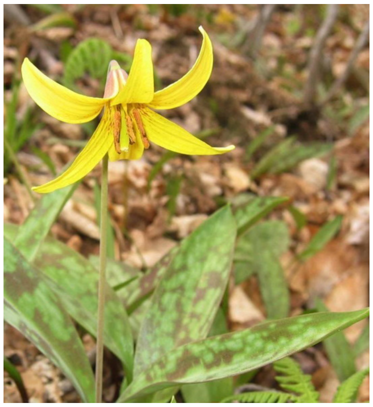
Photo credits: Pamela Templer (top); U.S. LTER (center), Joe Klementovich (bottom)

Synthesis

Quantifying uncertainty in ecosystem studies. Researchers at HBR LTER have led LTER-wide collaborations to characterize and share sources of uncertainty related to data on soils, biomass, atmospheric deposition, stream water export, and ecosystem budgets. Overall, the goal was to improve data quality and usefulness for modeling.

Photo credits: Jane Sokolow (top); HBR LTER (above); Scott Schwenk (right)

Forest pests. Hubbard Brook, Harvard Forest LTER, and others summarized existing knowledge on the ecological and economic impacts of imported forest pests in the U.S., and evaluated policy options for reducing future importation of new pests.



Soil methane uptake. Joint studies from HBR LTER, Baltimore Ecosystem Study LTER, and other international sites demonstrated decreased soil methane uptake over time. This finding may help explain why atmospheric levels of this potent greenhouse gas have been increasing globally [8].

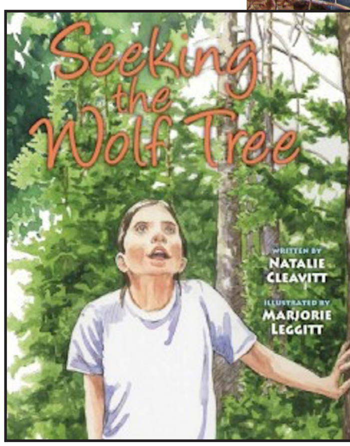
Data Accessibility

Hubbard Brook hydrologic records began in 1955, watershed chemical inputs and outputs began in 1963, and continuous songbird population recording began in 1968. The information management system at HBR LTER maintains an accessible catalog of Hubbard Brook data with an emphasis on high quality and maintains a physical sample archive.

The HBR Information Manager established a workflow from field/lab data collections to the Environmental Data Initiative (EDI) data repository, where data are open access. The majority of the 1,000 annual dowloads come from outside the HBR LTER. These data also support K-12 curricula and synthesis activities between LTER sites and beyond.

Broader Impacts

Hubbard Brook Roundtables connect HBR LTER scientists with decision-makers. Roundtables at HBR LTER are facilitated dialogues between scientists and decision-makers. Topics have included climate change impacts on forests, the maple industry, snowmobiling, wood fuel, public engagement with science, forests in a climate economy, biodiversity, and preventing forest pest importation.



Engaging teachers and the next generation of ecosystem thinkers. Each year approximately 6,000 students and teachers participate in HBR LTER education programs, which include K-12 classroom resources, guided and virtual tours of the Hubbard Brook Experimental Forest, and continued education for teachers, such as training workshops and summer field research experience. In addition, the HBR Research Experience for Undergraduates (REU) offers hands on science training for up to ten undergraduate students per summer.

Linking scientific information with public policy. Hubbard Brook Research Foundation established the "Science Links" series of reports and is a founding member of the Science Policy Exchange, a consortium dedicated to the sound use of science in federal policy. Products include a fact sheet about climate change, a summary for community leaders on reducing carbon emissions, synthesis and outreach on the health and environmental co-benefits of reducing carbon dioxide emissions, and the ecological and economic impacts of invasive forest pests.

Photo credit: Kevin McGuire (top)

Top Products

1. Yanai, RD et al. 2013. From missing source to missing sink: Long-term changes in the nitrogen budget of a northern hardwood forest. **Environmental Science & Technology.** doi: 10.1021/es4025723
2. Lovett, GM et al. 2018. Nutrient retention during ecosystem succession: a revised conceptual model. **Frontiers in Ecology and the Environment.** doi: 10.1002/fee.1949
3. Holmes, RT. 2011. Avian population and community processes in forest ecosystems: Long-term research in the Hubbard Brook Experimental Forest. **Forest Ecology & Management.** doi: 10.1016/j.foreco.2010.06.021
4. Battles, JJ et al. 2014. Restoring soil calcium reverses forest decline. **Environmental Science & Technology Letters.** doi: 10.1021/ez400033d
5. Rosi-Marshall, EJ et al. 2016. Acid rain mitigation experiment shifts a forested watershed from a net sink to a net source of nitrogen. **PNAS.** doi: 10.1073/pnas.1607287113
6. Groffman, PM et al. 2012. Long-term integrated studies show complex and surprising effects of climate change in the northern hardwood forest. **BioScience.** doi: 10.1525/bio.2012.62.12.7
7. Keenan, TF et al. 2014. Net carbon uptake has increased through warming-induced changes in temperate forest phenology. **Nature Climate Change.** doi: 10.1038/NCLIMATE2253
8. Ni, X and PM Groffman. 2018. Declines in methane uptake in forest soils. **PNAS.** doi: 10.1073/pnas.1807377115
9. Campbell, JL et al. 2011. Streamflow responses to past and projected future changes in climate at the Hubbard Brook Experimental Forest, New Hampshire, United States. **Water Resources Research.** doi: 10.1029/2010wr009438
10. McGuire, KJ et al. 2014. Network analysis reveals multiscale controls on streamwater chemistry. **PNAS.** doi: 10.1073/pnas.1404820111