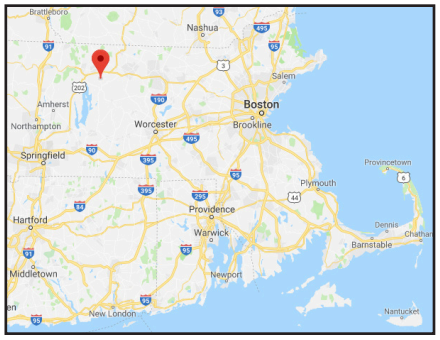
Harvard Forest LTER

The Harvard Forest (HFR) LTER program is based at the Harvard Forest, Harvard University's 2,000 ha outdoor classroom and laboratory in central Massachusetts. Harvard Forest research is dedicated to understanding how New England's temperate forests function and are affected by natural and human forces. In its first 30 years, the program has transformed scientific understanding of how forest ecosystems respond to disturbances, such as land use and hurricanes, and to chronic stressors, such as air pollution and climate change. The program has demonstrated the persistent ecological legacies of past conditions and their central role in shaping future forests. Through the combination of deep historical studies, sustained measurements and experiments, and modeling, HFR LTER has developed a mechanistic understanding of ecosystem function and is poised to predict the impacts of global change on temperate forest ecosystems from site to regional scales.



Between 2008-2018:

43 investigators

15 institutions represented

51 graduate students

Forest

Principal Investigator:

Jonathan Thompson

Harvard University

Est. 1988

Funding Cycle:

LTER VI

NSF Program:

Biological Sciences / Division of Environmental Biology

Key Findings

Carbon uptake exceeds expectations. Contradictory to theoretical models, forest carbon uptake has accelerated over recent decades in maturing forests, a legacy of 19th century land use, and to a lesser degree, modern increases in atmospheric CO_2, nitrogen deposition, temperature, and precipitation. This and many other insights into forest ecosystem function have resulted from sustained measurements of biosphere-atmosphere exchanges at HFR's Environmental Monitoring Site (EMS) eddy flux tower, which provides the world's longest record of CO_2 fluxes in a forest ecosystem. It is also the founding prototype for the AmeriFlux network and National Ecological Observation Network (NEON). [Products 1-3]

Microbes respond to global change. Decades of experimental soil warming and nitrogen enrichment have induced adaptive responses in microbial communities, abruptly shifting soil carbon dynamics. The experiments have revealed phased responses to warming, oscillating between multi year periods of significant soil carbon loss and phases of no carbon loss. [4,5]

Hemlock is a foundation species. Three decades of research on abrupt declines in pre-European hemlock populations, long term regional measurements of hemlock decline from the invasive insect hemlock woolly adelgid, and the long term Hemlock Removal Experiment confirm that hemlocks are a foundation species. They control forest structure, composition, and microclimate, with cascading trophic effects extending from mammals to microbes. As invasive insects proliferate across North America, HFR LTER is developing a generalizable understanding of population, community, and ecosystem level responses. [6,7]

Spring is arriving earlier. Over the last 30 years, spring phenology has advanced across eastern North America, increasing photosynthesis and net ecosystem carbon storage, with a small negative feedback to climate change. Beginning in 1990 as a biannual pen-and-paper record of bud break and leaf fall, HFR LTER launched the PhenoCam Network in 2008, a continental scale observatory of digital imagery tracking phenology at fine spatial and temporal scales [8].

Synthesis

Science for society takes a village. As a founder of the Science Policy Exchange, HFR LTER often co-designs studies with public and private partners to use long term data to solve real world problems. Products range from policy and management recommendations for rare species management, land protection goals, and responses to natural and human disturbances to simulations of land use and climate change scenarios that quantify consequences for critical ecosystem services and help guide land planning and conservation. [9, 10]

Partnerships

NEON | AmeriFlux | Smithsonian/ForestGEO | PhenoCam Network | Harvard University

AMERIFLUX

ForestGEO
GLOBAL EARTH OBSERVATORY NETWORK

neon
National Ecological Observatory Network

Data Accessibility

The Harvard Forest data archive contains data collected over the last 30 years from all studies at or pertaining to Harvard Forest, regardless of the source of funding, as well as selected data, photography, and cartography since 1907 from the Harvard Forest Archives. New datasets and updates are posted simultaneously to the Harvard Forest (HF) data archive (where they are cross indexed with the online HF bibliography) and to the Environmental Data Initiative (EDI) repository.

Broader Impacts

Wildlands, Woodlands, Farmlands and Communities. With the Highstead Foundation and many public and private partners, HFR LTER is advancing a regional conservation effort by providing science based tools and training for more than 300 partner agencies and organizations in New England.

Local, long term classroom data. The Schoolyard Ecology Program leverages LTER funding by a factor of four and engages more than 50 teachers and 3,700 students annually in a science literacy program rooted in field data collection. Investigators at HFR LTER lead workshops to help classrooms explore, compare, and graph their field data using an online system designed by the HFR Information Manager. More than 240 classrooms have submitted data and several datasets now span more than a decade. All teacher created lesson plans, plus a "data nugget" exploring a signature HFR dataset, are publicly available online.

Team science for diverse undergrads. Harvard Forest's world class summer research program draws 20-30 Research Experience for Undergraduates (REU) students annually (>40% from traditionally underrepresented groups) to work on mentored, team based projects. Assessment shows that most program alumni go on to study or work in environmental fields and that benefits are greatest for students from traditionally underrepresented groups and those who lack prior research experience.

Landscape Scenarios. Stakeholders from every New England state contribute to and use results and tools from LTER based landscape scenarios research, which examines ecological consequences of alternative scenarios of climate and land use change.

LTER based partnerships. Collaborations with artists, writers, and designers through leveraged funding has resulted in many books, exhibits, public events, and conference and classroom presentations.

Top Products

1. Finzi, AC et al. 2019. The Harvard Forest carbon budget: patterns, processes and responses to global change. **Ecological Monographs.** (in review)
2. Wehr, R et al. 2016. Seasonality of temperate forest photosynthesis and daytime respiration. **Nature.** doi: 10.1038/nature17966
3. Urbanski, SP et al. 2007. Factors controlling CO2 exchange on time scales from hourly to decadal at the Harvard Forest. **Journal of Geophysical Research - Biogeosciences.** doi: 10.1029/2006JG000293
4. Melillo, JM et al. 2017. Long-term pattern and magnitude of soil carbon feedback to the climate system in a warming world. **Science.** doi: 10.1126/science.aan2874
5. Frey, SD et al. 2013. The temperature response of soil microbial efficiency and its feedback to climate. **Nature Climate Change.** doi: 10.1038/NCLIMATE1796
6. Foster, DR et al. 2014. Hemlock: A Forest Giant on the Edge. **Yale University Press.**
7. Ellison, AM et al. 2010. Experimentally testing the role of foundation species in forests: The Harvard Forest Hemlock Removal Experiment. **Methods in Ecology and Evolution.** doi: 10.1111/j.2041-210X.2010.00025.x
8. 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
9. Lovett, GM et al. 2016. Nonnative forest insects and pathogens in the United States: Impacts and policy options. **Ecological Applications.** doi: 10.1890/15-1176
10. Thompson, JR et al. 2014. Changes to the Land: Four Scenarios for the Future of the Massachusetts Landscape. Harvard Forest, **Harvard University.**

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