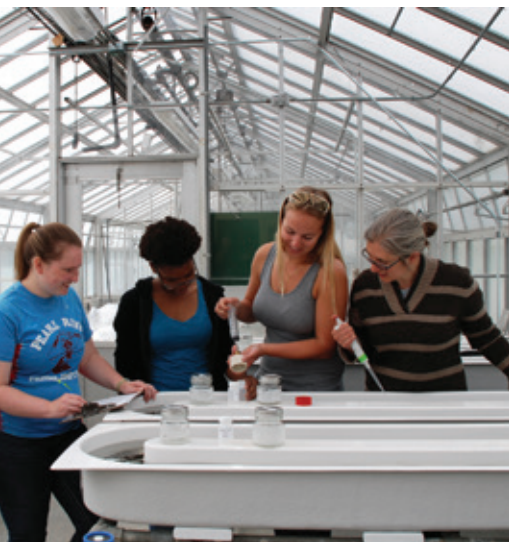




# Cary Institute of Ecosystem Studies



The science  
behind  
environmental  
solutions

Annual Report

2014

[www.caryinstitute.org](http://www.caryinstitute.org)

# INTRODUCTION FROM OUR PRESIDENT

Dr. Joshua R. Ginsberg



## Welcome

Dear Friends,

In September, I arrived in Millbrook as the new President of the Cary Institute of Ecosystem Studies. It is an honor to work closely with some of our nation's finest environmental scientists. Their work on topics like disease ecology, forest and freshwater health, climate change, urban ecology, and invasive species informs current management practices, and will shape the world we leave to future generations.

Our research program has deep regional roots, with long-term studies on the Hudson River's recovery, Lyme disease, and the Catskill watershed. But Cary Institute scientists also lead collaborative studies in the White Mountains of New Hampshire and in urban Baltimore, Maryland. And they are engaged globally in places like Kenya's Mara River and the coastal fog forests in Chile, and on topics like Ebola and sustainable development in China.

This annual report spotlights four of the Cary Institute's long-term field sites; two of them are part of the National Science Foundation's Long-Term Ecological Research Network. Many research studies that began at these sites have evolved to incorporate other locations. To date, our scientists are active at more than 70 sites spanning five continents.

We are locally grown, with a national presence and an international reach. We are fortunate, as well, to have a research team committed to connecting their findings broadly, from informing resource managers to infusing ecological science into the K-12 curriculum.

I look forward to building on the remarkable reputation of the Cary Institute. The future holds great things.



Dr. Joshua R. Ginsberg  
President

*Stay abreast of Cary Institute happenings, from events to breaking science, by signing up for our e-newsletter ([www.caryinstitute.org](http://www.caryinstitute.org)) or following us on Facebook and Twitter.*

# HUDSON RIVER, NEW YORK

## Guiding the Restoration and Recovery of an Iconic River



The Hudson River has changed dramatically in the 400 years since Henry Hudson's journey. From habitat loss and pollution to overharvest and species invasions, human demands have exacted a heavy toll on the Hudson.

Can we protect shoreline habitat, to ensure the river remains a nursery for fish and waterfowl? Can we prevent the next destructive invasive species? Will the river continue to provide safe drinking water? These are some of the questions that Cary Institute research is helping to address.

By treating the Hudson River as an integrated system, with field sites from Troy to the New York Harbor, our scientists have revealed the impact of invasive species, the recovery of native fish, and the status of globally rare wetlands. Over the past three decades, their long-term studies have helped make the Hudson River one of the best-understood rivers in the world.

Our field research extends into the Hudson River's watershed. This includes ongoing studies of road salt and pharmaceutical pollution in the tributaries that feed the Hudson. Over-dependence on rock salt has compromised stream life and led to chronic elevations of sodium

and chloride in ground water. At the same time, streams are experiencing rising pharmaceutical inputs, with negative impacts on water quality.

Cary Institute research on the Hudson has resulted in more than 120 scientific papers, extensive media coverage, curriculum materials, the well-received book *The Hudson Primer: The Ecology of an Iconic River*, and interpretive efforts, including an award-winning collaboration with the American Museum of Natural History and an interactive display on the Walkway Over the Hudson River. Most importantly, our work informs sound river stewardship.

We play a leadership role in the Hudson River Environmental Conditions Observing System, a monitoring effort that provides data essential to permitting, pollution cleanup, fisheries management, and safe navigation. Our scientists are part of the Sustainable Shorelines initiative, focusing on creating shore zones that support water quality and biodiversity while safeguarding property from sea level rise and extreme weather. And we are informing the Hudson River Comprehensive Restoration Plan, a partnership that includes state agencies, the U.S. Army Corps of Engineers, and The Nature Conservancy.

After more than 20 years of service, our research vessel needed replacement. Funding for the new boat, named *Ned Ames*, was made possible by the Hudson River Foundation and individual donors. We look forward to many more years on the river, keeping a careful eye on its recovery.

Our experts advise the NY State Department of Environmental Conservation, the NY State Energy Research and Development Authority, and the NY State Assembly. In addition, knowledge gained from the Cary Institute's work on the Hudson is helping to understand and manage large rivers around the world.





## BALTIMORE, MARYLAND

### Improving Water and Urban Lives: Lessons from a Coastal City

Can ecological principles inform sustainable cities that are healthier for both residents and the environment? After leading the Baltimore Ecosystem Study for the past seventeen years – working collaboratively with economists, engineers, sociologists, educators, and urban planners – Cary Institute scientists would answer a resounding ‘yes.’

While some field sites are covered in trees, others are dominated by buildings. This may seem counterintuitive until one considers that most of the world’s population lives in urban areas. Cities concentrate people and resources. At the same time, they are often saddled with failing wastewater infrastructure, aging industrial zones, and environmental justice disparities.

Baltimore’s location makes work done there especially relevant. By 2020, U.S. coastal cities are expected to add another 10 million residents. Globally, 11 of the world’s 15 largest cities lie along coasts or on estuaries. These areas are vulnerable to sea level rise and extreme weather, and their runoff has a tremendous impact on valuable fisheries.

The Baltimore Ecosystem Study is one of just two urban sites in the National Science Foundation’s Long-Term Ecological Research Network. Many projects focus on the role of the urban watershed. Like most cities, Baltimore’s waterways have been channeled, diverted, and buried for centuries. Concrete, rooftops, and roadways dominate the landscape, and the runoff flowing into streams carries contaminants and trash.

Cary Institute-led studies are investigating how restoring urban streams and green spaces can mitigate aging sewer systems. So far, results are

positive. Urban gardens and restored waterways improve the lives of urban residents, and they retain nitrogen, safeguarding the Chesapeake Bay from this harmful pollutant. Excess nitrogen has long been linked to algal blooms, fish kills, and the loss of blue crab fisheries.

Environmental justice is at the heart of many Baltimore Ecosystem Study projects. Our scientists are monitoring the presence of illicit and prescription drugs in urban streams, and revealing the relationship between urban decay and incidence of West Nile virus. Special attention is given to community engagement through partnerships with organizations like the Parks & People Foundation.

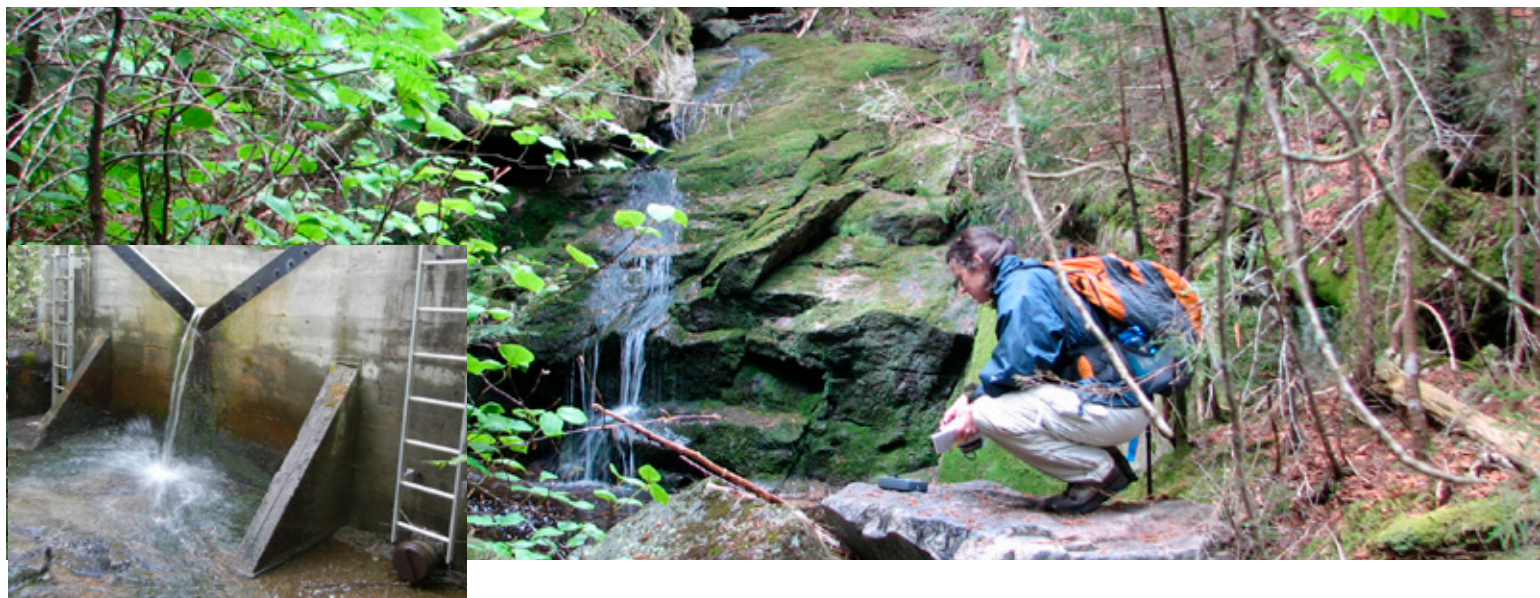
By uniting the natural and the social sciences, the Baltimore Ecosystem Study is unraveling how the urban environment functions, bringing us closer to understanding this growing ecosystem type. From discovering urban parks can be sanctuaries for migrating birds, to revealing that urban dwellers care deeply about the environment, lessons learned in Baltimore are informing sustainable cities worldwide.

Our urban ecology experts advise the Chesapeake Bay Program, the City of Baltimore, and the Maryland Department of Natural Resources. Work in Baltimore has inspired collaboration with the Research Center for Eco-Environmental Sciences in Beijing, China.



# HUBBARD BROOK, NEW HAMPSHIRE

## Revealing How Pollution, Logging, and Climate Change Shape Forests



In 1955, the U.S. Forest Service set aside 7,400 acres in New Hampshire's White Mountains to research how forestry influenced water quality in New England. A bowl-shaped valley made the Hubbard Brook Experimental Forest ideal for exploring how nearby lakes and streams responded to deforestation.

Environmental scientists were attracted to the site, among them the Cary Institute's founding president, Dr. Gene E. Likens, who was then a Dartmouth College professor. In 1963, he helped initiate a long-term project called the Hubbard Brook Ecosystem Study. A cornerstone of the study is the forest's six gauged watersheds; separated by mountain ridges they allow for watershed-scale manipulations and comparisons.

Fifty years after its founding, the Hubbard Brook Ecosystem Study has emerged as one of the world's most comprehensive studies of how land use, air pollution, and climate change influence the way that forests process water. Findings include the discovery of acid rain in North America, validation of the watershed approach as a tool for understanding forest ecosystems, documentation of the decline of songbird populations, and confirmation that clear-cutting disrupts water quality and element cycles.

Continuous, long-term studies are rare in ecology, but essential to sound stewardship. In 1998, the National Science Foundation recognized the Hubbard Brook Ecosystem Study's role in informing forest management by making the site part of their Long-Term Ecological Research (LTER) Network.



Its long history of groundbreaking research provides critical insight into human-accelerated environmental change.

Since the Cary Institute's formation, our scientists have played a leadership role at Hubbard Brook. Ongoing studies include forest response to invasive pests, the fate of nitrogen in mature forests, the

processing of mercury pollution, the relationship between algal blooms and excess nutrients, and the effect that reduced snow cover has on tree growth and soil productivity. There is a deep commitment to connecting our findings with policy audiences.

To bridge the science-policy divide, in 2012 the Cary Institute helped launch the Science Policy Exchange. A consortium of six world-class research institutions and four LTER sites, the Exchange is dedicated to bringing science to bear on environmental policy, conservation, and natural resource management in the Northeast. The Cary Institute's first project, due out in 2015, will focus on the ecological and economic impacts of invasive insects and diseases afflicting our forests and policy options for preventing future invasions.

Cary Institute scientists engaged in the Hubbard Brook Ecosystem Study advise the U.S. Forest Service, Congress, and the Environmental Protection Agency, as well as other state and federal agencies. Work at the site was instrumental in informing the Clean Air Act Amendments of 1990. The watershed approach that is a hallmark of the study has been replicated at sites throughout the world.

# CARY INSTITUTE CAMPUS

## Long-Term Studies on Forest Pests, Tick-borne Disease, and Freshwater Health

The Cary Institute has been allowed to flourish, in part, because Mary Flagler Cary loved trees. During the 1920s and 30s, Mrs. Cary acquired much of the organization's 2,000-acre campus in her pursuit of ideal specimens. Upon her passing in 1967, her trust was instructed to leave her land to a charitable organization, "engaged in the conservation, maintenance, and preservation of natural resources."

Initially, the land was an outpost of the New York Botanical Garden dedicated to woody plants. But in the 1980s, a panel of advisors determined that the Cary Arboretum was uniquely suited to advance the discipline of ecosystem science. Some three decades since the Cary Institute's founding, studies done on our grounds now inform forest management.

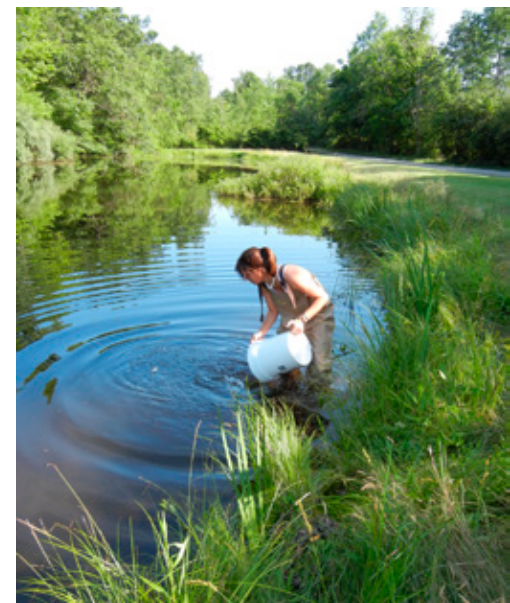
Long-term monitoring in our forests has shed light on the impact invasive pests and pathogens have on forest productivity, with recent studies focusing on the hemlock woolly adelgid and beech bark disease. Our grounds have also helped reveal how white-tail deer shape seedling survival, sensitive understory vegetation, and the fate of future canopy trees. The Cary Institute's successful deer management program has been replicated at other sites.

For more than 20 years, our forests and fields have also been a laboratory for studies on the ecology of tick-borne disease. We now know that Lyme disease risk is tied to the size of mouse populations, not deer. Forests with a diversity of mammals, including predators, harbor fewer infected ticks than fragmented lands with low diversity. This is because non-mouse hosts are less efficient at transferring Lyme disease to ticks. New work is exploring a Lyme disease vaccine for mice, with the goal of minimizing human risk.

Since 1983, our campus has operated a state-of-the-art environmental monitoring station. Trends in variables like temperature, precipitation, ozone, and carbon dioxide provide a window into our changing climate, and inform studies conducted on our grounds. We also host stations for the National Oceanic and Atmospheric Administration, the National Atmospheric Deposition Program, and the New York State Department of Conservation, among others.

Our robust data on air quality and precipitation is complemented by a stream monitoring program. Since 1985, we have been collecting water samples at two sites on Wappinger Creek, a tributary of the Hudson River. We have the longest running dataset on stream water chemistry in our region. It has allowed us to understand changes in the environment feeding the stream, and supports investigations on the impact of both road salt and pharmaceutical pollution.

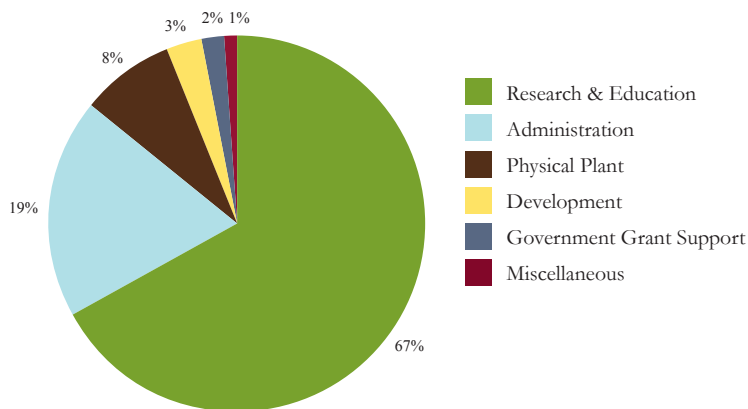
Our campus freshwater studies have been complemented by an Artificial Stream Facility, which allows for controlled studies of pollutants. One of the nation's only indoor stream labs, it was constructed in a former greenhouse.



# TOGETHER WE CAN MAKE A DIFFERENCE

## Our Funding

### Statement of Activities



Uses of \$10.4 million in operating support

### Investing in the Science Needed for a Sustainable Society

Donations from foundations and individuals provide us with flexibility essential to tackling new and sometimes controversial environmental problems, such as the impact that pharmaceutical pollution is having on freshwater ecosystems and drinking water supplies.

Our donors also play a vital role in connecting the Cary Institute's findings with citizens and decision makers. Our Friday Night at Cary public lectures and Science and Management Forums would not be possible without our supporters.

Learn how you can help us provide the science behind environmental solutions by visiting: [www.caryinstitute.org/make-difference](http://www.caryinstitute.org/make-difference).

## EDUCATION AND OUTREACH ARE INTEGRAL TO THE CARY INSTITUTE'S MISSION



Our scientists have appointments at colleges and universities, including Yale, Princeton, Cornell, Columbia, Rutgers, and Bard, where they supervise students and offer courses. For the past 27 years, we've mentored budding ecologists through the National Science Foundation's Research Experiences for Undergraduates program. At the graduate level, we teach a Fundamentals of Ecosystem Ecology course that attracts students from across the county and abroad.

K-12 students and their teachers are the focus of our Education Program. Our educators craft innovative curricula, develop schoolyard ecology programs, host onsite field trips, and engage students and their teachers in environmental monitoring projects. Each year, more than 100 students participate in the Cary Institute's Summer Ecology Camp. We also offer teacher training opportunities that focus on incorporating ecological science into classroom lessons.

We engage public audiences in environmental thinking through our Friday Night at Cary lecture series and our Science and Management Forums. Videos of past events are available online. Outdoor nature programs and our interpretive trail system provide additional avenues for ecological exploration. Our scientists also advise policy makers, government agencies, planning boards, conservation advisory councils, and land managers.

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