

TRACKING INFECTIOUS DISEASE

by Lori M. Quillen

Imagine a world where a computer program could pinpoint the next infectious disease outbreak, guiding response efforts and saving lives. Cary Institute disease ecologist Dr. Barbara Han is bringing this vision closer to reality.

Most emerging infectious diseases are spread to humans by animals, with more than a billion people suffering annually. Prevention hinges on knowing which animals carry disease, where they come in contact with people, and how this interface is shaped by urbanization, poverty, agriculture, political unrest, and climate instability. To date, most infectious diseases are dealt with reactively, with the medical community scrambling to contain outbreaks.

In the age of big data, Han is harnessing computing power to develop targeted disease surveillance tools. Thanks to the efforts of field biologists, data repositories house robust information on the ecology, behavior, physiology, and distribution of the world's wildlife. Using machine learning, a form of artificial intelligence, Han is mining these data to identify characteristics common among disease 'reservoirs.' These animals harbor pathogens that make other species, including humans, sick.

Rodents have been long maligned for their role in spreading disease, from Hantavirus to the plague. Fittingly, they were the first group that Han investigated. With University of Georgia colleagues, she developed an algorithm-based sorting model that assessed 2,227 rodent species for more than 50 characteristics. Not only did it predict known rodent reservoirs with 90% accuracy, it flagged 58 new potential reservoirs and 159 new hyper-reservoirs – animals that can carry multiple pathogens.

The riskiest rodents live fast, die young, and have large geographic ranges in areas with low biodiversity. Past work has shown animals that mature quickly and reproduce early and often tend to invest less in immune response. Fast-lived rodent species may be more tolerant of pathogens, hence better reservoirs. And since they thrive in diverse habitats, including those fragmented by development, they are more likely to come into contact with people.

Results, published in the *Proceedings of the National Academy of Sciences*, provide a watch list of high-risk rodents. They also highlight areas vulnerable to rodent-borne disease outbreaks, including North America, South America's Atlantic coast,

"In the age of big data, Han is harnessing computing power to develop targeted disease surveillance tools."

Europe, Russia, and parts of Central and East Asia. Two potential reservoir species flagged by the model were confirmed before the paper went to press. In the U.S., red-backed voles carry the tapeworms that cause echinococcosis, while in Asia Minor, Gunther's voles harbor the leishmaniasis protozoan.

Machine learning is an exciting tool because it can model risk using incomplete datasets. While scientists have catalogued 1.9 billion of Earth's animal inhabitants, only a fraction have been carefully monitored, with efforts skewed toward wealthy nations. The disease-sleuthing model Han is refining will help bolster surveillance in less affluent regions. Ultimately, turning predictions into prevention will require collaboration with experts on the ground.

Han and colleagues are currently using machine learning to explore potential reservoirs of Ebola and other filoviruses that infect humans and other great apes. Stay tuned for a new paper.

HIGHLIGHTS

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ECOFOCUS

Ecofocus is published by the Cary Institute of Ecosystem Studies. Our scientists are leading efforts to understand human impacts on air and water quality, climate change, invasive species, and the ecological dimensions of infectious disease. As an independent, not-for-profit organization, the Cary Institute produces unbiased research that leads to more effective management and policy decisions.

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FROM OUR PRESIDENT



“What is remarkable is the high regard, and deep affection our alumni have for the Cary Institute.”

Dear Friends:

Summer was a bustling and productive time at the Cary Institute. Rick Ostfeld's field crew continued their mammal and tick surveys – work essential to understanding the ecology of tick-borne disease. Visiting scientist Ken Schmidt and his team spent their 18th season investigating the ecology and behavior of veeries. Cornell graduate students attended a two-week "biogeochemistry bootcamp." And we hosted our 27th cohort of Research Experiences for Undergraduates (REU) students, where eleven undergrads spent the summer learning the ins and outs of being an ecologist under the mentorship of a Cary scientist.

Spring and summer were also a great time for our staff. Stuart Findlay was honored with the Environmental Law Institute's prestigious National Wetlands Award for Research (see page 4), and three of our scientists were elected Fellows of the Ecological Society of America (see page 4) and honored at ESA's centennial meeting, which was held in Baltimore this August. We made good use of the venue, showcasing our 20-year investment in the Baltimore Ecosystem Study—one of only two National Science Foundation funded Long Term Ecological Research Programs (LTER) that focuses on urban ecology.

The conjunction of the words urban and ecology may seem awkward. But with over 50% of the world's population living in cities, the importance of understanding the ecology of urban environments is critical to making city life sustainable, efficient, and inviting. Urban ecology was central to this year's ESA meeting. This was highlighted in a review of the meeting in the journal *Nature*, which profiled Steward Pickett, as well as in a film produced for the opening of the centennial meeting. Take a peek at www.caryinstitute.org/urban-esa.

In Baltimore, we hosted our first alumni get together. Over 140 staff, post docs, undergraduates, grad students, and visiting researchers – past and present – came together to celebrate the Cary Institute and its founder Gene Likens. Our network is national and extends globally. What is remarkable is the high regard, and deep affection our alumni have for the Cary Institute. The question I was most asked was "when are we going to do this again?"

Sincerely,

Dr. Joshua R. Ginsberg, Ph.D.

RESEARCH UPDATE

ON WIKIPEDIA, BE WARY OF ENTRIES ON CONTROVERSIAL SCIENCE

by Lori M. Quillen

wikipedia & controversial SCIENCE

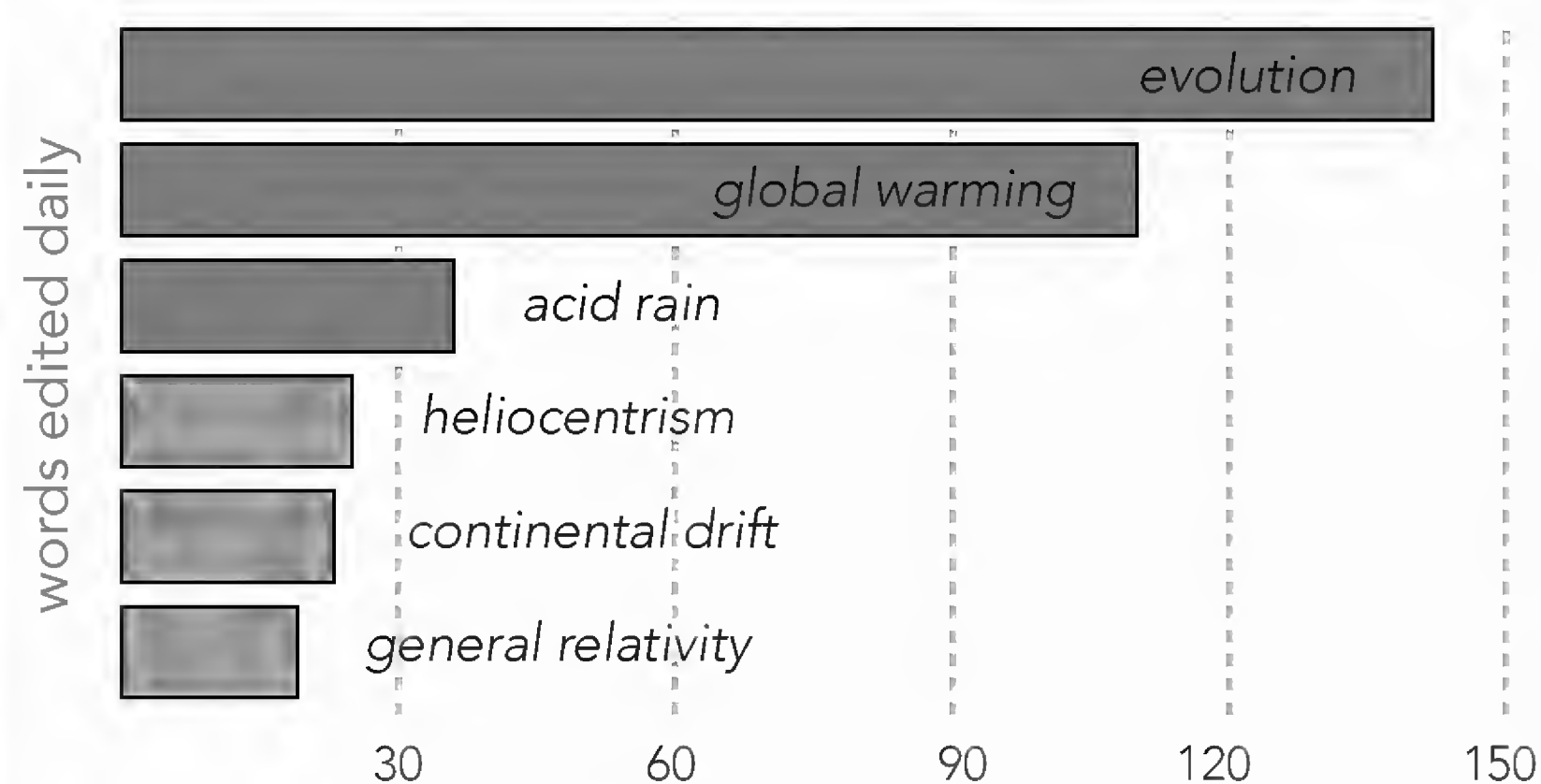
80%

of U.S. students use for research

wikipedia
FACTS6th most visited site in America
4.9^M articles in English

science topics

controversial vs uncontroversial



suggestions

- 1 identify entries subject to 'edit wars'
- 2 quantify reputation of individual editors
- 3 ensure students and other users understand limitations and appropriate uses

Users should be aware that content in Wikipedia can be extremely dynamic; two students could obtain, within seconds, diametrically different information on a controversial scientific topic.

Wikipedia reigns. It's the world's most popular online encyclopedia, the sixth most visited website in America, and a source most students rely on. But, according to a recent paper by Dr. Gene E. Likens, Cary Institute President Emeritus, Wikipedia entries on politically controversial science can be unreliable.

Likens co-discovered acid rain in North America and counts among his accolades a National Medal of Science. Since 2003, he has monitored Wikipedia's acid rain entry. He explains, "In the scientific community, acid rain isn't controversial. Its mechanics have been understood for decades. Yet, Wikipedia's acid rain entry receives near-daily edits, some of which result in serious errors."

To see how Wikipedia's acid rain entry compared to other science entries, Likens partnered with Dr. Adam M. Wilson, a geographer at the University of Buffalo. They analyzed Wikipedia edit histories for three politically controversial topics (acid rain, evolution, and global warming), and four non-controversial topics (the standard model in physics, heliocentrism, general relativity, and continental drift).

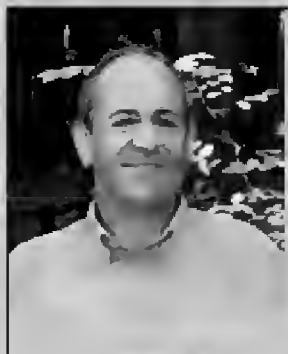
Using nearly a decade of data, they teased out daily edit rates and the mean size of edits. While the acid rain article was edited less than the evolution and global warming articles, its edit rate was higher than the non-controversial topics. Across the board, politically controversial science topics were subject to larger and more frequent edits.

Likens notes, "Students, educators, and citizens should understand Wikipedia's limitations when researching politically-charged science. The rate of change observed makes it difficult for experts to monitor accuracy and make corrections." Adding, "On entries subject to edit-wars, one can obtain – within seconds – different information on the same topic."

Likens and Wilson suggest that Wikipedia identify entries known to have significant controversy and quantify the reputation of individual editors. In the meantime, users should cast a critical eye on Wikipedia source material, which is found at the bottom of each entry.

SPOTLIGHTS

STAFF NOTES AND DISTINCTIONS



Peter Groffman, Steward Pickett, and Kathleen Weathers were elected as Ecological Society of America Fellows for their 'outstanding contributions to the field of ecology,' and recognized at the Society's centennial meeting in August.



Mary Alisa Borre has joined Scientist Kathleen Weathers as Senior Research Specialist.



Pasha Feinberg has joined Scientist Barbara Han as Assistant Research Specialist.



Michelle Forster has joined Scientist Alan Berkowitz as Ecology Education Program Specialist.



Amanda Johnson has joined our Grants Program as Grants Specialist.



Alexander Reisinger has joined Scientist Emma Rosi-Marshall as Post Doctoral Associate.



Toni Taylor has joined the Accounting Office as Staff Accountant and Payroll Specialist.

The Cary Institute of Ecosystem Studies is an Equal Opportunity/Affirmative Action Employer; minorities/females/vets/disabled are encouraged to apply.

Please visit our website at www.caryinstitute/who-we-are/jobs for employment opportunities.

BALTIMORE SCHOOL OF URBAN ECOLOGY

In 1997, Cary Institute Distinguished Senior Scientist Steward T. A. Pickett formed the Baltimore Ecosystem Study (BES), one of only two National Science Foundation Long Term Ecological Research sites in an urban setting. Under his direction, BES has grown into an interdisciplinary team of more than 150 researchers and collaborators advancing an understanding of how to achieve sustainable, resilient cities.

Discover lessons learned from two decades of pioneering social and ecological studies in the newly published *The Baltimore School of Ecology*, offered by Yale University Press. Pickett and coauthors explore how a more nuanced view of people, green space, water, and development can help address urban environmental and social inequities.

Insights are vital at a time when the world's population is concentrated in metropolitan areas, and society grapples with climate change, emerging infectious diseases, human migrations, and water supply issues.

The Baltimore School of Urban Ecology Space, Scale, and Time for the Study of Cities

J. Morgan Grove,
Mary Cadjenesso,
Steward Pickett,
Gary Mathis, and
William R. Burch Jr.



UWIN NETWORK

Alan Berkowitz will lead education activities for the Urban Water Innovation Network (UWIN), a consortium of 14 institutions recently awarded \$12 million dollars by the National Science Foundation to address threats to urban water systems. Led by Colorado State, partners include the Cary Institute, Princeton University, University of California – Berkeley, University of Maryland – Baltimore County, Arizona State, and Oregon State.

Six regional hubs will provide scalable blueprints for managing water regionally, nationally, and globally. Among UWIN's priorities: providing the science needed to inform effective urban water conservation, flood mitigation, drought management, and pollution control. Berkowitz will develop UWIN's Research Experiences for Undergraduates Program as well as citizen science programs for residents and schools.

WETLANDS AWARD



Stuart E.G. Findlay has received the Environmental Law Institute's prestigious National Wetlands Award in recognition of his contributions to freshwater ecology and restoration. These include more than 25 years of research on the Hudson River, a leadership role in the Hudson River Environmental Conditions Observing System, and over 100 peer-reviewed publications. Findlay serves on advisory committees for the NY Department of Environmental Conservation, the National Oceanic and Atmospheric Administration's Research Reserve, and the U.S. Environmental Protection Agency.

WHERE WE WORK

REMOTE ECOSYSTEMS VULNERABLE TO POLLUTION

by Lori M. Quillen

The Grand Canyon reach of the Colorado River meanders through one of the most remote ecosystems in the United States. It would be easy to assume steep canyon walls and uninhabited shores resulted in pristine waters. But research by Cary Institute's Dr. Emma Rosi-Marshall and colleagues has found that this isolated part of the Colorado harbors toxic levels of mercury and selenium.

As part of a food web study, Rosi-Marshall and collaborators from the U.S. Geological Survey, Montana State University, and Idaho State University surveyed aquatic life at six sites along a 250-mile stretch of river downstream of Glen Canyon Dam. Sampled invertebrates and minnows had mercury and selenium concentrations in excess of toxicity thresholds for fish, wildlife, and people. Mercury levels in fish were consistently higher than other U.S. rivers, even those draining more agricultural, industrial, and urban landscapes.

Animals exposed to excess mercury and selenium can suffer from impaired



Emma Rosi-Marshall

reproductive success, growth, and survival. The Grand Canyon reach of the Colorado River supports the largest population of endangered humpback chub, a fish whose diet relies on aquatic invertebrates. It is also an important foraging ground for a variety of fish-eating birds, such as the kingfisher.

Mercury in the Grand Canyon's food web largely originates from air pollution. Coal-burning power plants are the largest human-caused source

of mercury emissions, which can travel hundreds of miles before being deposited. Irrigation of selenium-rich soils in the upper Colorado River basin leads to an accumulation of this contaminant downstream.

The study adds to the growing body of evidence that seemingly remote ecosystems are vulnerable to long-range pollution generated by human activities.



Baltimore Ecosystem Study



Pamela Freeman

THE HUDSON AND BES DATA JAMS

This spring, Cary Institute educators hosted two Data Jams, one in New York's Hudson Valley and the other in Baltimore, Maryland. Both competitions, now in their second year, challenge middle and high school students to interpret ecological data and creatively communicate their findings to general audiences.

Two hundred and forty students participated in the Hudson Data Jam, more than doubling enrollment from 2014. Projects explored everything from invasive species to biogeochemistry using video, art, and song. A team of 80 scientists and educators judged submissions, with winners honored at a ceremony at Marist College. The event was made possible, in part, by a \$10,000 grant from the Malcolm Gordon Charitable Fund, which is managed by

the Open Space Institute.

Baltimore Data Jam participants gained their inspiration from urban watershed data collected as part of the Baltimore Ecosystem Study (BES). Winners were invited to present their projects at the signing of the Greater Baltimore Wilderness Accord, where they had the opportunity to meet Baltimore City Mayor Stephanie Rawlings-Blake as well as Congressional and Federal Agency representatives.

Planning is already underway for the 2016 Data Jams. Preliminary assessments done by Cary Institute educators show that participation improves students' scientific knowledge, data literacy skills, and motivation for learning about ecology and their local ecosystems.

(Top: Baltimore students met Congressional leaders, the Mayor, and the Deputy Director of the National Fish and Wildlife Service)

(Bottom: Hudson Data Jam participant John Maxwell Weigand)

SUPPORTERS' CORNER



We are very grateful to supporters who made the 5th *Fall Luncheon on the Grounds* on September 20, 2015, a resounding success.

On a spectacular fall day, friends of the Cary Institute gathered together to enjoy good food and good company in a little-known field tucked away on the Institute's 2,000-acre campus. During lunch, freshwater ecologist Dave Strayer described his work partnering with colleagues and agencies to better protect the Hudson River's shoreline habitats. Guests were treated to his new handbook *Managing Shore Zones for Ecological Benefits*, which provides insight into practical ways of protecting shore zones—anywhere water meets land to increase the benefits of these important ecosystems. Meanwhile, a dozen intrepid EcoKids explored the Fern Glen and Wappinger Creek, sharing fascinating facts about plants and animals they encountered along the way.

Thanks again to all who help support and celebrate the Cary Institute's world class research and education programs.



Trustee Soohyung Kim and Carolina Gunnarsson Kim

Pamela Freeman



Friends gather to celebrate the *Fall Luncheon on the Grounds* in a remote research field

Pamela Freeman



Left to right: Doug and Torrie Larson, Tracy Kimmel, and Jim Florack

Pamela Freeman



Left to right: Susan MacEachron, Byron Tucker, and Board Chair Irene Banning

Pamela Freeman



Margot Slade matches leaves and plants found in the Fern Glen to a color swatch

Pamela Freeman



EcoKids explore a pristine stretch of the Wappinger Creek

Pamela Freeman



Naturalist Kali Bird enthralled EcoKids with fun flora and fauna facts

Pamela Freeman

CALENDAR

Upcoming Public Programs

Our Public Programs are a great way to expand your ecological understanding while learning about issues facing the environment. Lectures are held in our auditorium, located at 2801 Sharon Tpk., (Rte. 44) in Millbrook, NY. Seating is first come, first served. Aldo Leopold Society members may reserve seats. Registration is required for outdoor events. For more information call (845) 677-7600 x 121 or email freemanp@caryinstitute.org.

Friday, November 20 at 7:00 p.m.

The Ecological Homogenization of Urban America

Cities and suburbs in very different parts of America share familiar patterns of roads, neighborhoods, commercial areas, landscaping, and water features. Urban ecologist Dr. Peter Groffman will explain how these similarities can help us understand land use change from local to continental scales.

Friday, December 11 at 7:00 p.m.

Warlords of Ivory

This gripping National Geographic documentary explores the global ivory trade, how poaching funds terrorism, and what is needed to protect Africa's elephants. Q&A panel with experts to follow the film.



Friday, January 22 at 7:00 p.m.

Healing America's Streams and Rivers

Dr. Margaret Palmer, Director of the National Socio-Environmental Synthesis Center, will discuss the realities of restoring our nation's flowing fresh waters.

Scientific Seminar Series

Free and open to the public, our scientific seminars are held on Thursdays at 11 a.m., from September through May, in the Cary Institute's auditorium.

November 12: Dispelling the Controversy Surrounding the Dilution Effect. Dr. Jason Rohr, University of South Florida

November 19: Unpacking Imperviousness: Spatial and Temporal Links Between Urbanization and Ecological Responses in Maryland Streams. Dr. Matt Baker, University of Maryland Baltimore County

December 3: The Battle for Suburbia: Invasive Species and Deer. Dr. Janet Morrison, The College of New Jersey

For a complete listing of upcoming events, programs, and videos of past public lectures visit our website at www.caryinstitute.org/events.

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Visit us online at www.caryinstitute.org

LOCAL ARTISTS INSPIRE CARY INSTITUTE CAMPERS



Pamela Freeman



Pamela Freeman



Pamela Freeman

This summer, the Cary Institute offered a special two-week camp exploring the interface between ecology and art. Cary educators teamed with George Kaye of Ecographs and Laurie Seeman of Strawtown Studio to add a new dimension to stream studies. Campers learned how pharmaceuticals and other

pollutants impact Wappinger Creek. Then they created pigments and tints from streambed materials. Using aquatic plants as brushes, they made water colors conveying ecological lessons learned. Work was presented to the community at the Millbrook Farmer's Market.