ECOfOCUS
CARY INSTITUTE OF ECOSYSTEM STUDIES
Science for environmental solutions *Spring 2021*

Sarah Batterman

Restoring tropical forests is critical to mitigating climate change.

TROPICAL FORESTS **FIGHT CLIMATE CHANGE**

Tropical forests are our climate allies. By storing carbon dioxide in their trees and soils, tropical forests trap harmful greenhouse gases that contribute to climate change.

Sarah Batterman, an ecologist at Cary Institute, studies tropical forests in Central and South America. She is working to understand the role of different tree species in tropical forests, how soil nutrients affect tree growth and carbon storage, and how we can restore healthy tropical forests while promoting biodiversity.

Tropical forests hold 70% of the carbon stored in forests globally. They are also highly threatened due to deforestation, agriculture, development, mining, and logging. These activities turn a critical carbon sink into a carbon source.

Batterman explains, "As trees grow, they take up carbon dioxide and store it in their wood. This traps carbon emissions that would otherwise fuel climate change. But when forests are converted to farms and pastures, and trees are burned or chipped, stored carbon is released back into the atmosphere. Globally, due to fossil fuel emissions and deforestation, we are releasing far more carbon than forests can absorb."

A focal area of Batterman's research is investigating the role of nitrogen-fixing trees in tropical forests, and how they could help increase the tropical carbon sink in regrowing forests, including areas undergoing active reforestation.

"Nitrogen fixers have special abilities that allow them to access nutrients that promote plant growth throughout the forest community," Batterman says. "This important service will be even more critical in the future; tropical forests are expected to become increasingly nutrient-starved as rising atmospheric carbon dioxide levels stimulate tree growth which will require more nutrients than the soils can provide."

Just as people need a mix of nutrients – fats, protein, fiber – to stay healthy, plants also need a variety of nutrients to thrive. Nitrogen and phosphorus are among the most important.

Nitrogen-fixing trees have nodules on their roots that house bacteria. The trees feed the bacteria carbon, and in exchange, the bacteria convert nitrogen in the atmosphere into a form that the tree can use for food. This process, called nitrogen fixation, allows nitrogen-fixing trees to self-fertilize, speeding growth while increasing carbon storage.

New research shows that nitrogen fixers are also able to 'unlock' phosphorus – an essential plant nutrient that is scarce in tropical soils – by altering soil chemistry around their roots. Fixers make the soil more acidic, which speeds weathering and releases vital nutrients. By increasing nutrient availability, fixers fertilize the soil, enhance plant growth and carbon storage, and support a diversity of species.

Batterman emphasizes, "Promoting biodiversity is an important goal in reforestation efforts. When a deforested area is replanted with one crop, like a palm plantation, these monocultures do not provide the diversity of habitat needed to support a variety of plants and wildlife. Letting forests regrow naturally is the best way to support biodiversity and ensure future resilience. Active reforestation efforts should take care to plant a mix of tree species, including nitrogen fixers."

"Restoring tropical forests is a critical step to mitigate climate change impacts," Batterman concludes. "By protecting existing forests, allowing degraded forests to grow back, avoiding monocultures, and supporting active reforestation strategies – we can protect the global carbon sink."

HIGHLIGHTS

ECOfOCUS

Ecofocus is published by Cary Institute of Ecosystem Studies, an independent nonprofit center for environmental research. Since 1983, our scientists have been investigating the complex interactions that govern the natural world and the impacts of climate change on these systems. Our findings lead to more effective management and policy actions and increased environmental literacy. Staff are global experts in the ecology of: cities, disease, forests, and freshwater.

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FROM OUR PRESIDENT

Dear Friends:

Spring is a time of renewal. This year, we are all feeling hope, both from the blooming wildflowers and the advent of vaccines and a vision of a future with less social distancing. Celebrate this renewal and visit Cary's trails and grounds to enjoy the longer, warming days: take a hike, have a picnic, or perhaps settle in for some bird watching in the lowlands.

Renewal seems to be a theme at Cary Institute. We are halfway through a major reinvention of our headquarters, renamed the Ecosystem Science Building. The Campaign for Cary has raised or secured $12.2 million to support these renovations, and I host monthly virtual updates – email forbesc@caryinstitute.org if you'd like to join us.

Some scientific highlights: Steward Pickett was recently elected to the National Academy of Sciences, one of the highest honors that a scientist can attain. He joins Cary's Gene Likens, Bill Schlesinger, and Jon Cole. Tom Lovejoy, a longtime Cary Institute Trustee, and Cary Adjunct Scientist Juan Armesto, were also honored with the distinction this year. Steward also received the Ecological Society of America's (ESA) Eminent Ecologist Award, and Juan received ESA's Robert H. Whittaker Award for an international ecologist. All so very well deserved.

Newsflash: Charlie Canham was quoted extensively in *Bloomberg* on the growing debate over the social and environmental impacts of carbon offset programs, and Rick Ostfeld and Felicia Keesing (Bard Professor and Cary Adjunct Scientist) published an important paper on why conserving biodiversity is critical to preventing the next pandemic.

And there is no end in sight… because we are in this for the long term, please consider joining me as a member of the Mary Flagler Cary Legacy Society so you can provide critical support to the Institute through estate planning. If you are interested in joining, contact Catherine (forbesc@caryinstitute.org).

Stay healthy and optimistic, and believe in the power of science!


John Halpern

Joshua R. Ginsberg, PhD

CAMPAIGN **FOR CARY**

The **Campaign for Cary** is underway. We launched this initiative to generate critical support for our reimagined headquarters. These modern facilities will allow us to live our mission, convene and collaborate, work efficiently, and think deeply.

We need your help. Our scientists are tackling environmental issues that you care about – freshwater and forest health, prevention of emerging diseases, and the sustainability of cities. With your gift to the Campaign for Cary, you can be the catalyst for science-based solutions.

To give: caryinstitute.org/campaign-cary-gift

Courtney Tsahalis

Want to stay up-to-date on the latest Cary happenings?
Subscribe to our **e-newsletter** at caryinstitute.org.

ASK THE SCIENTIST

MOSQUITO RESEARCH TO **MITIGATE RISK**


Surprise Photography

Shannon LaDeau is a disease ecologist at Cary Institute. For over a decade, she has explored mosquito ecology, to better understand how environmental and social factors influence mosquito-borne disease risk for people. Here, LaDeau discusses her latest mosquito research, with fieldwork centered in Baltimore, Maryland.

How did mosquitoes come to be a problem in cities?
Climate change and invasive species have made the problem worse. The invasive tiger mosquito (*Aedes albopictus*) has eggs that can survive out of water for months. It arrived at US ports hidden in tires imported from Southeast Asia. In addition to changing climate, urban heat islands make it easier for mosquitoes to survive winter and multiply rapidly.

Do different mosquito species transmit different diseases?
Mosquito feeding preferences vary among species, and the animals they choose to bite carry distinct pathogen loads. For example, West Nile virus circulates in birds and is transmitted to people by *Culex* mosquitoes. West Nile won't be a risk to people unless there are *Culex* mosquitoes that bite birds. Zika, on the other hand, is spread primarily by *Aedes* mosquitoes. Mosquitoes will only become infected with Zika – with potential to transmit – if they bite an infected person.

In Baltimore, we are identifying which mosquito species live where, what animals they bite, and how this shapes residents' risk of contracting a mosquito-borne disease.

Where do you find high mosquito numbers?
Mosquitoes need water to breed and many don't fly far. City blocks with more 'water habitat' have more mosquitoes. This can include everything from bottle caps to abandoned tires – anything that can collect and contain water. More juvenile mosquitoes means there will be more adults looking for blood meals.

We find higher mosquito numbers in neighborhoods where legacies of racialized disinvestment in infrastructure coincide with high residential abandonment, unmanaged vegetation, and illegal garbage dumping.

What is the status of mosquito species diversity in Baltimore?
Looking at differences in mosquito populations from rural to urban settings, we are finding that mosquito diversity is lower in more developed areas. Unfortunately, the species that thrive in cities tend to be those that prefer to bite people.

How is changing climate affecting mosquitoes, and what does this mean for disease risk?
Urban landscapes 'blur' the natural rhythms – like water availability and frost-thaw cycles – that control mosquito numbers. Paired with shorter winters, mosquitoes enjoy a longer growing season in cities. This allows populations to get really large. Longer seasons mean there is more time for pathogens to build up in the community – meaning greater risk of infection among mosquitoes and everything they bite.

What solutions might reduce mosquito-borne disease risk for city residents?
Residents can help reduce mosquito habitat by removing sources of standing water, like bird baths and non-draining potted plants. However, this is only effective in neighborhoods where all yards can be actively managed. Vacant land and abandoned buildings are mosquito breeding hotspots; city investment in managing these spaces is critical. Mosquitoes fly, after all, so people living in an impeccably managed home next to an abandoned one will likely encounter biting neighbors.

At the same time, replacing abandoned buildings with new development or green space can cause problems, so it's important to consider unintended outcomes. By blending research on mosquito ecology with social and demographic factors, we are aiming to develop strategies to reduce mosquito risk while keeping residents' needs and voices at the fore.

What are you looking at next?
A new project is exploring the effects of plants on mosquito population growth. Juvenile mosquitoes feed on plant matter, which differs dramatically between vacant and highly managed land. We know that adult mosquitoes are bigger on city blocks with more abandoned land. We want to know whether the type of plants feeding young mosquitoes impacts body size – which is connected to fitness, reproductive ability, and disease transmission. Bigger mosquitoes pose a higher risk to people.


CDC

Asian tiger mosquito (*Aedes aegypti*)

BE A GOOD LAKE STEWARD & **HELP SPREAD THE WORD**

Summer is fast approaching – time to ready the rods, rafts, oars, and swimsuits. If you live near a lake or enjoy spending time on the water, you can help protect your favorite place to cast a line or take a dip every time you visit.

Here are a few tips to keep lakes and resident wildlife healthy, brought to you by Dane Whittaker, a member of Cary scientist Chris Solomon's FishScapes research team and a graduate student in the School of Sustainability at Arizona State University – in collaboration with an advisory team of volunteers, researchers, and educators from Wisconsin.

Alex Ross

Healthy lakes are in our hands. (Camp Lake, WI.)

Give wildlife space. Stay at least 200 ft away from wildlife, nests, and marked breeding areas. Close encounters can disrupt activities like resting, breeding, and finding food.

Keep the shoreline natural. Leave logs and submerged vegetation in place. Keep shoreline vegetation intact. Driftwood, downed trees, and plants provide habitat for fish and wildlife, hold soil in place, and filter pollutants and excess nutrients that fuel algae.

Observe no-wake zones. Slow to no-wake within 200 ft of the shoreline and wildlife. Wakes can cause erosion, disturb animals, and damage vegetation.

Prevent the spread of invasive species. Before leaving the water access, clean, drain, and dry all gear. Invasive species can overtake native plants and animals, creating ecosystem imbalances.

Lake associations and advocates are welcome to download these tips on an infographic, to share or print as a magnet. Visit **caryinstitute.org/lake-tips-infographic** to access the file, which includes instructions on ordering magnets to distribute to community residents and renters.

To learn more about FishScapes research, visit: **caryinstitute.org/fishscapes**

BIODIVERSITY IS **GOOD FOR OUR HEALTH**

Preventing future pandemics starts with protecting nature. A new paper co-authored by Bard College professor and Cary Adjunct Scientist Felicia Keesing and Cary disease ecologist Rick Ostfeld discusses the mounting evidence that biodiversity is good for our health.

Keesing explains, "There's a persistent myth that wild areas with lots of animal species are hotspots for disease. More biodiversity must equal more dangerous pathogens. But this turns out to be wrong. Biodiversity isn't a threat to us; it's actually protecting us from the species most likely to make us sick."

Zoonotic diseases like COVID-19, SARS, and Ebola are caused by pathogens that jump from vertebrate animals to people. Animals differ in their ability to transmit disease.

Our activities, including development and climate change, degrade wildlife habitat. When habitat quality declines, long-lived, larger-bodied species tend to disappear first. This leaves smaller-bodied species – which live fast, die young, and reproduce early – to proliferate. The latter are most likely to make us sick.

Ostfeld says, "Species that thrive in disturbed landscapes are often more efficient at harboring pathogens and transmitting them to people. In less-disturbed landscapes with more animal diversity, these risky species are less abundant and biodiversity has a protective effect. The next emerging pathogen is far more likely to come from a rat than a rhino."

To predict and prevent future disease spillover, research efforts should focus on animal traits, with close attention to characteristics associated with efficient disease transmission. Areas where these species overlap with people should be targeted for surveillance.

Keesing concludes, "As we rebuild our communities after COVID-19, one of our best strategies to prevent future pandemics is to protect, preserve, and restore biodiversity."

Read more here: **caryinstitute.org/biodiversity-for-health**

Ali Rajabali via Flickr

When biodiversity declines, risky species (like mice) proliferate.

USE YOUR VOICE: **TREE-SMART TRADE**

Join us in the fight to protect our trees from harmful forest pests.

Trees keep people and the planet healthy. They filter air pollution, reduce flooding, cool neighborhoods, provide wildlife habitat, and trap carbon. Unfortunately, our trees are in trouble due to imported insect pests and pathogens.

Colin McDonald

Imported forest pests are threatening US trees – and the many services that they provide.

Forest pests make their way into the US via solid wood shipping materials and live plants destined for the nursery trade. Insects like the emerald ash borer and Asian long-horned beetle are already decimating forests, street trees, and parks in every state across the US. Lax trade policies are largely to blame. And we're paying for it. Removing and replanting lost trees cost homeowners and municipalities billions of dollars annually.

Cary's Gary Lovett is an advocate for Tree-SMART Trade, a set of policy recommendations designed to prevent the importation of new forest pests. You can help bring attention to this issue – plus ways to fix it – by signing our petition calling for federal action to clean up the pathways by which harmful insects and diseases enter the country.

Sign our petition calling on Congress to take steps to stop forest pests: **change.org/stopforestpests**

Read more about the forest pest problem: **treesmarttrade.org**

Watch a recent panel discussion with science and policy experts: **caryinstitute.org/save-our-trees-video**

GREEN INFRASTRUCTURE **BY ANY OTHER NAME**

Cities around the world face unprecedented challenges. As urban populations grow and climate change magnifies the risk of flooding, extreme heat, and air pollution, cities are turning to green infrastructure (GI) as a tool to improve the health of city residents and the environment.

Green infrastructure includes natural areas and built structures that work together to provide habitat for wildlife, absorb stormwater, clean pollution from the air, and cool hot city streets. Parks, stream corridors, and open natural spaces are part of 'green infrastructure', as are stormwater management systems like rain gardens, green roofs, and bioswales.

In a new study, a team of Cary researchers explored the question: How do US city plans define GI? What does this mean for how GI is implemented?

Lead author Zbigniew Grabowski, a postdoctoral researcher at Cary Institute, says, "There is widespread interest among cities to incorporate green infrastructure projects in planning. But what city plans mean by 'green infrastructure' varies. Without clear definitions, programs and policies can be misaligned with resident needs. We've also found that departments working in the same municipality can define GI differently, leading to conflicts in design and maintenance."

The team analyzed 122 sustainability plans from 20 cities across the US. They found that many don't define green infrastructure, and those that do tend to focus on stormwater management to meet regulatory goals, and not larger amenities like parks and trail systems. In contrast, some plans excluded water management altogether, which could mean missed opportunities for funding and maintenance support. Based on an analysis of the plans, the team synthesized a definition of green infrastructure to help guide future research and planning.

Grabowski concludes, "Embracing green infrastructure as a planning tool can help cities become healthier, resilient to environmental extremes, and more sustainable. However, to maximize benefits, thoughtful cross-cutting planning is key. Residents' needs, like access to public green spaces, should be taken into account alongside more utilitarian aims, like water management. We hope this work helps policymakers to clarify the scope and intent of GI programs, policies, and funding. Project success starts with a clear understanding of the task at hand."

NYC Parks

Rooftop gardens are a form of 'engineered' green infrastructure.

OUR THANKS TO YOU

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Miss an event?

Topping Out Ceremony
Virtual event celebrating the placement of the highest beam on the renovated Cary headquarters
caryinstitute.org/topping-out

Restoring Resilient Tropical Forests
Cary Science Conversation featuring Cary's Sarah Batterman
caryinstitute.org/resilient-tropical-forests

Pharmaceuticals in Our Rivers & Streams
Cary Science Conversation featuring Cary's Emma Rosi
caryinstitute.org/drugs-in-freshwaters

We asked **Aldo Leopold Society Members Kathy and Gonzalo de las Heras** why they support Cary Institute:

"Cary Institute has been a space where residents of Millbrook and the surrounding areas can meet and hear directly from scientists about their research. Our lives have been enriched through our association with Cary, and we are proud to have supported the Institute since 1994."

– Kathy and Gonzalo de las Heras, members of the Campaign for Cary Steering Committee

THANK YOU TO THE MARY FLAGLER CARY **LEGACY SOCIETY MEMBERS**

We would like to extend our deepest gratitude to the following individuals, as well as several anonymous donors, for generously including Cary Institute in their estate plans:

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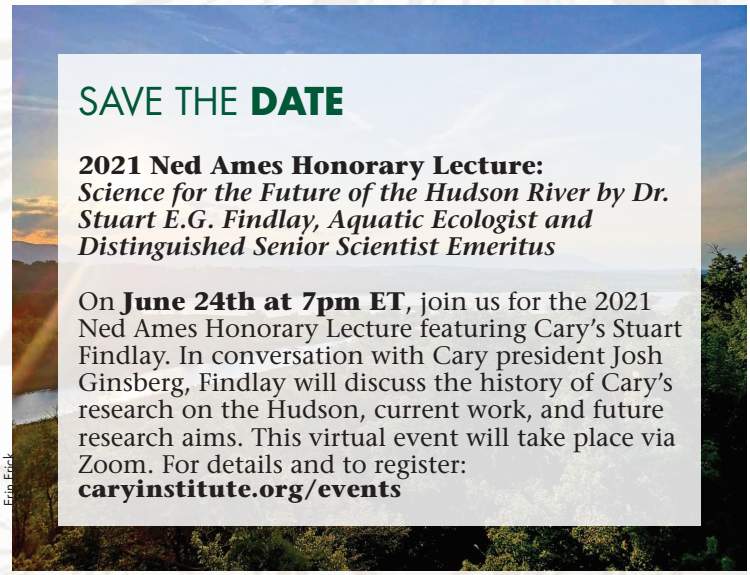

Erin Frick

SAVE THE **DATE**

2021 Ned Ames Honorary Lecture:
Science for the Future of the Hudson River by Dr. Stuart E.G. Findlay, Aquatic Ecologist and Distinguished Senior Scientist Emeritus

On **June 24th at 7pm ET**, join us for the 2021 Ned Ames Honorary Lecture featuring Cary's Stuart Findlay. In conversation with Cary president Josh Ginsberg, Findlay will discuss the history of Cary's research on the Hudson, current work, and future research aims. This virtual event will take place via Zoom. For details and to register:
caryinstitute.org/events

SUPPORT SCIENCE

Leslie Tumbleby

Ticks are now active. When spending time outside, be sure to take precautions to avoid tick bites. Wear long pants and sleeves; light colors are best as this makes it easier to spot ticks. Use a repellent containing DEET and consider treating clothes with permethrin. Be sure to do a thorough tick check when you come inside, and don't forget to check your gear and pets.

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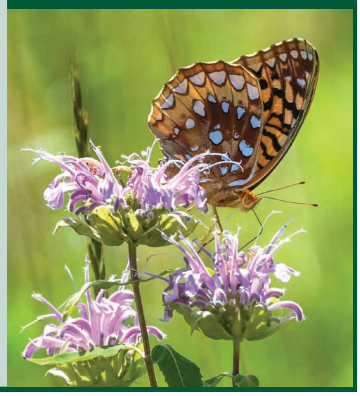

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SUMMER ECO-EDUCATION **AT HOME**

Explore our free summer education resources, with options for children entering 2nd grade through to adults. New this year: materials for EcoQuest at Home and Cary Art + Science will be offered in both Spanish and English.

EcoQuest at Home (*Entering grades 2-5*) Through hands-on activities, participants will learn how to think and explore like an ecologist, and earn badges along the way. Jumpstart your child's experience with two weeks of virtual meetings with Cary educators: July 6-9 (Naturalist badge) + July 12-16 (Field Tech badge). Meetings will be offered in Spanish and English.
caryinstitute.org/ecoquest-2021

Cary Art + Science (*Ages 12 and up – including adults*) Learn how to observe nature with a closer eye and experiment with new ways of recording what you see through a series of drawing prompts (available in Spanish). Join artist Hara Woltz for four virtual meetings during the weeks of July 6-9 and July 12-16. There will be sessions for youth and adults.
caryinstitute.org/art-and-science-2021

Michelle Forster