STROUD™
WATER RESEARCH CENTER

2020 Annual Report

A YEAR IN REVIEW

Challenging Times, Changing Solutions

AT A GLANCE 2020


A.

A | CITIZEN SCIENCE
In support of her master's thesis at West Chester University, Patty Haug, who is also a Penn State Master Watershed Steward, is collaborating with the Stroud Center's citizen science team in using EnviroDIY™ Monitoring Stations to investigate impacts of road salts and de-icers on streams draining the Borough of West Chester, Pa.

B | THE WATER'S EDGE
Jill Tidman, executive director of the Redford Center, received the Stroud Award for Freshwater Excellence on Tuesday, September 22, 2020 during a virtual celebration. Co-founded in 2005 by Robert Redford and his son, James Redford, the Redford Center uses the power of film and media to engage people through inspiring stories leading to environmental action.


B.

C | RESTORATION
The Pa. Department of Conservation and Natural Resources recognized David Wise as a Good Natured Pennsylvanian. As watershed restoration manager, Wise sets up programs with incentives for landowners to restore streamside forests.

C.

D | SCIENTIST HONORED
J. Denis Newbold, Ph.D., research scientist emeritus, was honored with the 2020 Society of Freshwater Science Award of Excellence (SFS). The award is given to a single recipient for outstanding contributions to freshwater science. SFS noted that Newbold's research on nutrient spiraling "has influenced an entire generation of stream scientists," and that his metrics in the area of stream biogeochemistry" are now considered fundamental measures of ecosystem function."


D.

E | EDUCATION
Stroud Center educators pose proudly with their fleet of canoes, which expanded on-the-water education programming in 2020 thanks to generous support from the McLean Contributionship, the Rotary Club of Longwood, the Redwoods Group Foundation, and an anonymous individual donor.

E.

Front cover photo: Penn Manor School District

Photo: Yeda Arscott

MESSAGE FROM THE EXECUTIVE DIRECTOR

The year 2020 was like no other. As a population, we have experienced significant loss of lives and jobs caused by the coronavirus pandemic. Across the globe, we are in the midst of an international human rights movement against discrimination, violence, and injustices toward people of color, people with disabilities, ethnic minorities, the LGBTQ+ community, and women. And as scientists, we have experienced an assault on the integrity and value of science that has been amplified by negative rhetoric on vaccine efficacy and safety and the causes of climate change and its proposed solutions. Through it all, and with your support, Stroud™ Water Research Center has remained strong in our resolve to adapt and pursue our mission.

The Stroud Center has changed so much over one year. We have adapted our in-person operations to COVID-19 safety protocols to help protect our staff and the public. We have learned to work from home when we can. We have adopted virtual technologies to maintain our communications and team environment. We are working diligently to enhance the diversity of our staff and board, to ensure equitability and access to our education programs, to maintain our scientific excellence and ensure the integrity and continuity of our research efforts, and to provide a welcoming and engaging environment for all.

In this year's annual report, we highlight our portfolio of long-term research on the ecology and restoration of our freshwater landscapes and our successes adapting to virtual education programs that improved equitable access. We have learned through the lens of our science that natural systems are resilient and can recover from the damages we have made when we work in concert with ecosystem processes and recognize the time required for healing. Here we emphasize the patience and perseverance that science demands and the consideration of changing our solutions to achieve restoration success. The pandemic has had an immense impact on our children, our teachers, and our learning environments. Here we share our success in creating engaging virtual programs that have improved access for all, and we recognize that providing equitable and inclusive access to learning must be a priority as we slowly return to in-person learning.

We cannot be successful in our mission without your support. We are so thankful to our wonderful community of supporters that have helped us navigate these incredibly challenging times and changing solutions! We are indebted to you all.

Executive Director, President, and Research Scientist

"We have learned through the lens of our science that natural systems are resilient and can recover from the damages we have made when we work in concert with ecosystem processes and recognize the time required for healing."

what you can do

Implement ways to reduce your carbon footprint and reduce water use. **Visit stroudcenter.org/mec for more information.**

RESEARCH

"The research takes a long time as it is both time- and labor-intensive, but it's worth the effort. … This is a win for the farmer and a win for fresh water."

— MELINDA DANIELS, PH.D., ASSOCIATE RESEARCH SCIENTIST, STROUD WATER RESEARCH CENTER

Saving Streams With Good Science

By James G. Blaine, Ph.D.

2020 was a year when science was disparaged at the highest levels of government and then vindicated by the unprecedented development of several COVID-19 vaccines. It was a year when laboratories closed for quarantine, and streams and watersheds provided safe and productive workplaces. It was a year that exposed public misconceptions about scientific research and emphasized the need to rebuild trust in the scientific process. At Stroud™ Water Research Center, that starts with communicating our research to non-scientists, clarifying the need for a realistic timeline, and describing the patience and the persistence required to gather the long-term data necessary to ensure clean fresh water. To that end, we share snapshots of three long-term experiments, three scientists, and their roles in our ongoing research.

PROJECT

Long-Term Research in Environmental Biology: Trajectory for the Recovery of Stream Ecosystem Structure and Function During Reforestation

Funding:
National Science Foundation

Dates: 1998–present

Team: Almost all Stroud Center scientists have worked on this 22-year project.

John Jackson, Ph.D.,
Senior Research Scientist,
Entomology Group

Testing Methods to Improve Stream Health by Growing a Forest

Because the Stroud Center has built an enduring body of research that identifies watershed restoration as the most effective path to stream recovery, it's tempting to dismiss the persistence of large-scale channel engineering projects as a relic of the past. On the contrary, says entomologist John Jackson, "they're alive and well and looking to get bigger."

Left, from left: Laura Zgleszewski, Jinjun Kan, Marc Peipoch (standing), and Jennifer Matkov collect simulated rainfall from soil in a cornfield in the White Clay Creek watershed while making it rain from above with a precisely tuned shower sprayer on a tripod.
Above, from left: Sherman Roberts, Jennifer Matkov, Laura Zgleszewski, and Mike Broomall survey the fish community in White Clay Creek in February 2020. Conducted seasonally, these surveys track the populations of over 20 fish species in White Clay Creek and allow scientists to evaluate how well reforestation along the stream has helped restore the fish community in this High Quality, Exceptional Value stream.

The problem is that they don't address the true cause of degradation. "The primary pollution sources are not in the stream channel," says Jackson. "They're in the watershed," where poor land management allows topsoil, pesticides, and other pollutants to run off the landscape and into the stream and impair its ecological health. "Our approach is to work with landowners to improve their management practices, and then let nature heal itself."

This is not a quick fix. It takes time to plant trees and let them grow, time to restore the soil's health, time to install agricultural practices that keep manure, stormwater, and sediment out of streams, time to do the long-term research. "Those things often take years," says Jackson. "But we're dealing with centuries of abuse." The result of improved land management is cleaner water and more productive land. "By keeping the water where it falls, you keep the sediment where it needs to be."

WHAT WE LEARNED

The ultimate outcome is both more effective and more economical. "Cutting down trees to re-engineer a stream's channel does not improve water quality," Jackson says. "It does not restore aquatic diversity. It does not improve stream function. It does not save money. We believe watershed restoration is a better investment than channel engineering, and we have measured the positive outcomes."

PROJECT

Evaluating How Conventional, Conservation, and Organic Farming Practices Enhance Soil Health and Improve Water Quality

Funding: William Penn Foundation

Dates: 2018–present

Team: Jinjun Kan, Melinda Daniels, Diana Oviedo-Vargas, Marc Peipoch, Dave Arscott, Matt Ehrhart, Bern Sweeney, and collaborators from Rodale Institute

Melinda Daniels, Ph.D., Associate Research Scientist, Fluvial Geomorphology Group

The Rainmakers: How to Fake a Downpour

Melinda Daniels is, literally, a rainmaker. The Stroud Center's fluvial geomorphologist adapted a design from a U.S. Department of Agriculture circular to create a rainfall simulator. "It's like a showerhead built on a tripod," she says. Water runs up from a tub through a hose and then sprinkles onto the ground like rainfall. When the ground below is saturated, the water begins to run downhill, where samples are captured and taken to the lab for analysis.

With Americans increasingly demanding healthier food and less agricultural pollution, regulators, farmers, and consumers need robust scientific evidence on the impact of conservation practices on both the environment and food production. That requires field-scale experiments to measure actual runoff amounts and their nutrient, pesticide, and sediment loads.

"But one of the greatest challenges in environmental science," says Daniels, "is catching nature in action — in our case, sampling rainstorms." It's particularly difficult when the experiment requires simultaneous replication in several fields "because we can't be in several places at once. So instead of trying to do the impossible storm chasing, we try to mimic Mother Nature by creating artificial rainstorms" and then measure the capacity of conservation practices, such as cover cropping, to keep runoff out of the stream. "The more soil, nutrients, and water that stay in the field," she says, "the better it is for the environment and for the farmer, whose fertilizer costs are reduced."

Above, from left: At Stroud Preserve, Laura Zgleszewski, Jennifer Matkov, and Diana Oviedo-Vargas pose in front of a rainfall simulator protected from the wind with tarps to ensure the "rain" falls straight down to the field below.

WHAT WE LEARNED

"The research takes a long time," says Melinda Daniels, speaking of one project but describing them all, "as it is both time- and labor-intensive, but it's worth the effort," as according to Daniels, "our preliminary results show that cover cropping decreases runoff and holds more of the nutrients in the soil, so fewer get into the stream. This is a win for the farmer and a win for fresh water."

PROJECT

Mitigating Agricultural Pollution of Fresh Water and Combating Climate Change by Restoring Soil Health Through Conservation and Organic Agricultural Practices

Funding: Prince Albert II of Monaco Foundation

Dates: 2018–present

Team: Melinda Daniels, Jinjun Kan, Diana Oviedo-Vargas, and Marc Peipoch

Diana Oviedo-Vargas, Ph.D., Assistant Research Scientist, Biogeochemistry Group

Sleuthing Out How Bee-Killing Chemicals Reach Streams

It's the stuff you can't see that does the real damage to a stream — pharmaceuticals, microplastics, road salt, neonicotinoids … neo … what?

Introduced in 1994 and named for their resemblance to nicotine, neonicotinoids first gained notoriety as a suspect in the alarming honeybee die-off a decade ago. Although they are the world's most widely used insecticide, little is definitively known about their impact on stream life.

Because "neonics" can be toxic to aquatic macroinvertebrates, it's critical to understand both how they get into a stream and how they impact its ecosystem. "That isn't easy," says biogeochemist Diana Oviedo-Vargas. "There are so many contaminants out there; it's hard to say what's causing what."

She and her colleagues have become scientific detectives, documenting these insecticides' journey from field to stream. In 2018 they selected four experimental fields with long histories of neonic use and planted two of them with treated seeds and two with untreated seeds. After about a year of collecting overland runoff, the fields with the untreated seeds already appear to show lower concentrations of neonicotinoids.

WHAT WE LEARNED

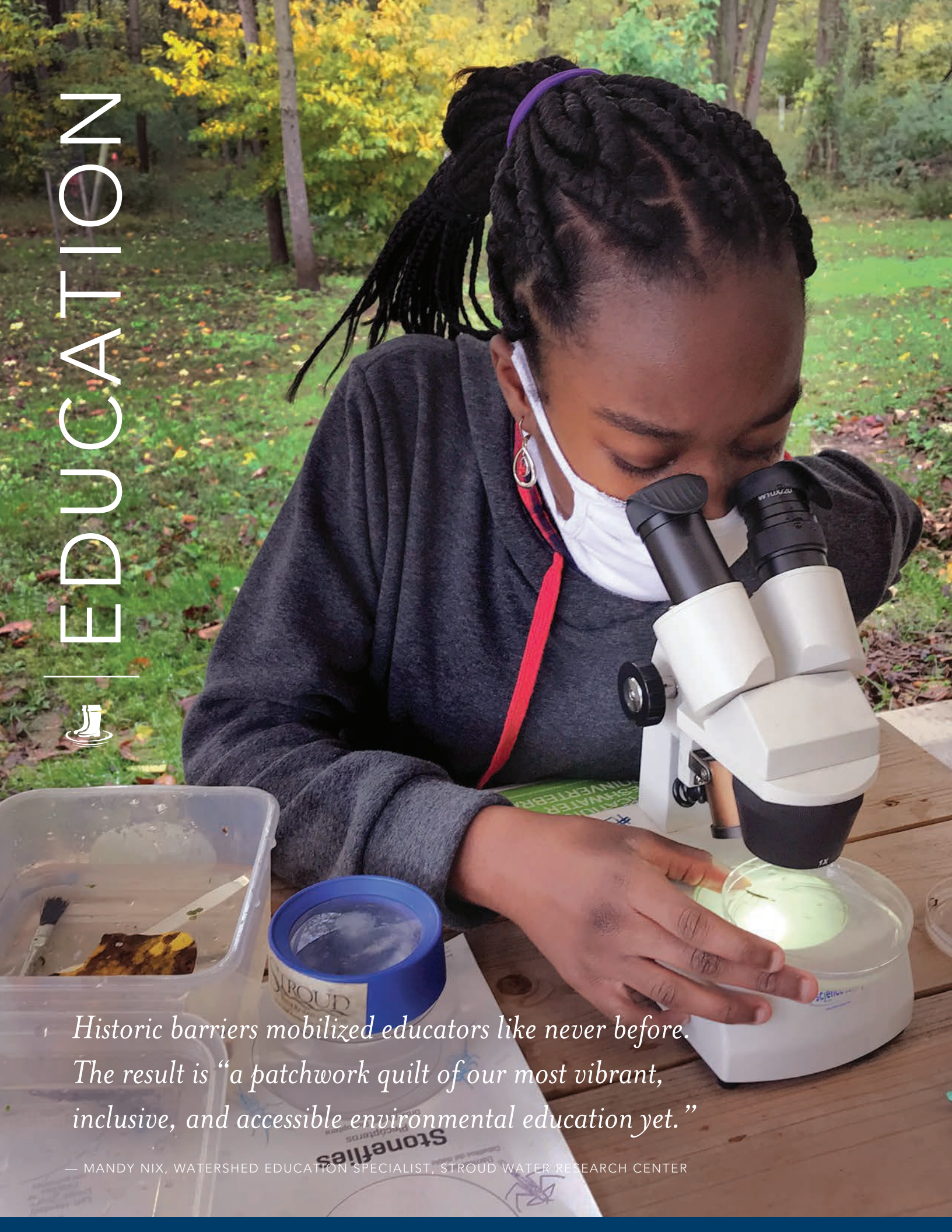
Although the research is in its early stages, the preliminary results indicate that neonicotinoids are transported by rainwater from the seed coats to the soil and eventually into the stream, where their widespread use poses a significant threat to the aquatic ecosystem. "This is very troubling," says Oviedo-Vargas, "all the more so because for some crops — soybeans in particular — these insecticides appear to offer the farmer little, if any, economic benefit."

Above: Most neonicotinoid pesticides applied to seeds and crops end up in soils. How much ends up in streams? Photo: Will Parson, Chesapeake Bay Program

learn more

From projects to publications to podcasts, there is so much more to learn.
Visit stroudcenter.org/research for more information.

EDUCATION



Historic barriers mobilized educators like never before. The result is "a patchwork quilt of our most vibrant, inclusive, and accessible environmental education yet."

— MANDY NIX, WATERSHED EDUCATION SPECIALIST, STROUD WATER RESEARCH CENTER

Left: A fifth-grade student from Hambright Elementary School peers into a microscope to examine an aquatic macroinvertebrate, an important indicator of stream health. Photo: Katie Harnish. Right: While filming from the banks of White Clay Creek, Assistant Director of Education Tara Muenz engages high school environmental science students in a live virtual education program and watershed walk.

Expanding Global Learning Opportunities During the Coronavirus Pandemic

By Mandy Nix and Tara Muenz

In Stroud™ Water Research Center's education wing in early March, the air felt electric — but not with the familiar crackle of excitement as hundreds of students engulfed the campus for boots-in-the-water education.

"It felt like a storm was rolling in," reflects Assistant Director of Education Tara Muenz. The "storm" was the viral disease that would define 2020: COVID-19. "I vividly remember being in my office as I heard of a rapidly spreading virus. I thought to myself, 'A big shift is coming to our lives. One that will change us forever. One that will drive us to think, act, and instruct on an entirely different level than we ever have before.'"

The shift was a tectonic one, with global pandemic numbers rising by the minute and schools transitioning almost overnight into emergency remote learning conditions. When Muenz departed the Stroud Center that day, nimbus clouds hung like cobwebs over the parking lot. Muenz and 12 environmental education staff wouldn't return for months.

Instead, they transfigured their personal homes into offices and virtual classrooms, invested in a suite of advanced educational technologies, and braced themselves for a pandemic that would shake foundational approaches to teaching.

Springing Into Global Action in a Digital Learning Landscape

Inquiry-driven learning is happening in real time in real places, but not always in person.

"During the coronavirus pandemic, teachable moments can be fostered on the screen rather than in the stream," says Watershed Education Specialist Mandy Nix. Together with innovative education staff, Nix develops and delivers stream-to-screen virtual education programs for audiences of all ages. By combining live online instruction on video conferencing platforms like Zoom with prerecorded stream studies and watershed hikes, educators transport hands-on, minds-on learning to viewers' homes.

"While snacking at their kitchen-tables-turned-desks or curled up with their pets, 'K through gray' audiences can safely explore our

1,800-acre experimental watershed during stream-to-screen virtual education," explains Nix. "They can still hike through our streamside forests and tally the aquatic insects that call our streams home. They can still observe caddisfly larvae crawling across the creekbed, and they can still discover a dragonfly nymph's last molt stuck like cellophane to a sycamore trunk. They're still getting an immersive learning experience — just from the other side of a computer screen!"

In 2020, virtual learning experiences comprised over 50% of Stroud Center education programming. Educators met immediate needs by sharing a suite of new and existing virtual learning resources, including the Stroud Center's award-winning WikiWatershed Toolkit, in 17 education e-newsletters to readers worldwide. Carefully curated to engage audiences online or in nearby nature, these resources were shared on new webpages visited by viewers in 48 countries from every continent except Antarctica.

While tapping into remote learning more than ever before, 2020 also marked the debut of the new Leaf Pack Stream Ecology Kit. Improved metrics, identification tools, instructional videos, and digital learning tools supported stream studies worldwide — including over 500 miles away in Ontario, Canada. Kits were mailed right to the doorsteps of undergraduate students enrolled in a hybrid model of a Limnology of Natural and Polluted Water course at the University of Guelph.

Partnering for Greater Collective Impacts

To help bridge community-level and statewide barriers to environmental literacy and justice, the education department served on several national and statewide workgroups in 2020, including Pennsylvania Health Environment and Reopening Schools Workgroup; the National COVID-19 Outdoor Learning Committee; Updating Pennsylvania Science, Technology, and Environment and Ecology Standards; and the NOAA Pa. Environmental Literacy and Watershed Education Capacity-Building Task Force (NOAA Task Force). The Pennsylvania Association of Environmental Educators honored the NOAA Task Force with the 2020 Outstanding Environmental Education Program Award, which recognized the Task Force's Pennsylvania Meaningful Watershed Educational Experience Ambassador Training Program for classroom teachers, school administrators, and non-formal educators.

"Students still get to experience fieldwork," says Sheri Hincks, Department of Integrative Biology lab coordinator, who ordinarily wades knee-deep with students in Guelph's Speed and Eramosa rivers to take physical and biological samples. During the pandemic, the Stroud Center's kits are blended with virtual instruction to help students independently conduct water quality monitoring with aquatic macroinvertebrates. "This is real-life stuff that aquatic biologists would be doing."

"However," Nix points out, "the emergency learning landscape has also exposed and exacerbated the biggest cracks in our education systems worldwide — cracks like access to internet connectivity, advanced technologies, outdoor green space, and socioeconomic supports needed to succeed."

These historic barriers mobilized educators like never before. Staff synthesized the very best digital, remote, and in-person teaching methods at their disposal, while also developing remote learning kits and tailored programming for local high-needs audiences and learners of all abilities. The result, says Nix, is "a patchwork quilt of our most vibrant, inclusive, and accessible environmental education yet."

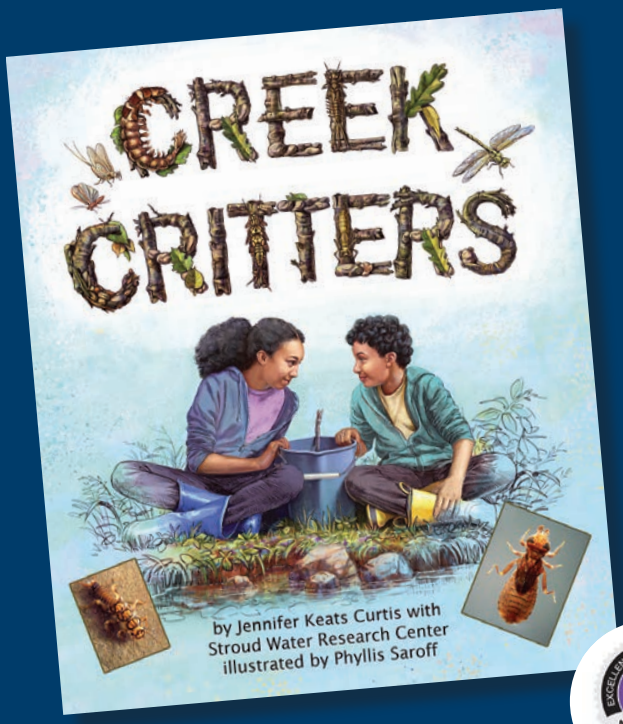
The department expanded their capacity to support global audiences, learners of all abilities, and marginalized communities during the pandemic and in preparation for the future.

Dipping Their Toes in the Water Again

Watershed education was not only fostered on the screen or in the mail. "After offering six months of entirely virtual programming for K–12 schools, universities, and adult audiences, while also growing our library of virtual learning resources, by fall 2020, there was a window of time to step back — lightly and literally — into the arena of in-person outdoor learning," says Muenz.

Pulling from their contributions on the National COVID-19 Outdoor Learning Initiative and the Pennsylvania Healthy Environment and Reopening Schools Workgroup, as well as the best science available on pandemic safety, the department mapped scenarios and implemented data-driven safety procedures for in-person education programs. Throughout the fall, educators engaged audiences of all ages in on-the-water canoeing education and boots-in-the-water stream study education, all while adhering to rigorous sanitation protocols, physical distancing, and mask requirements.

For teachers like Katie Harnish, fifth-grade teacher at Hambright Elementary School in Lancaster, Pennsylvania, these outdoor experiences opened critical pathways to "hands-on experiential learning in the midst of a pandemic."



New Science Picture Book for Kids!

The education department kickstarted 2020 with the publication of *Creek Critters* or *Animalitos de Arroyo*, a multicultural STEM picture book written by Jennifer Keats Curtis in close collaboration with the Stroud Center's Steve Kerlin, Mandy Nix, and Tara Muenz! Vibrantly illustrated by Phyllis Saroff, this engaging story follows two siblings on their quest to understand what aquatic macroinvertebrates can tell them about stream health. What will they find as they turn over rocks, sift through leaves, and explore the creekbed?

Creek Critters is available in English and Spanish with hardcover, paperback, and eBook options. Back-of-the-book activities, bilingual printables, and a teaching activity guide make this picture book a handy companion for exploring nearby nature.

Creek Critters was one of four finalists in the 2021 Hands-On Science Book category of the American Association for the Advancement of Science (AAAS) / Subaru SB&F Prize for Excellence in Science Books! This honor celebrates outstanding science writing and illustration for children and young adults.

CREEK CRITTERS® is a registered trademark of the Audubon Naturalist Society (ANS) of the Central Atlantic States, Inc. ANS's CREEK CRITTERS mobile app helps people find and identify aquatic macroinvertebrates and report on stream health (www.anshome.org/creek-critters).

"The Stroud Center created a safe, physically distanced experience that allowed my students to explore, learn, and have lots of fun while maintaining stringent health protocols," says Harnish. "My students' experience was not only an engaging academic study. It also helped show them the beauty of the water in a way that has formed lasting connections between them and the natural world."

Harnish's students weren't the only ones empowered by the natural world. "Like the incredible life cycles of aquatic insects we connect audiences to, our team's secret to success and survival during the coronavirus pandemic was metamorphosis," confesses Nix. "An insect doesn't get its wings without profoundly disruptive, uncomfortable, and vulnerable transformation. We experienced those exact growing pains in 2020, while also building our long-term capacity for truly responsive education."

In a year defined by global trauma and transformation, the education team spearheaded education initiatives for 14 new projects externally funded by federal, state, and local agencies with community-level and international impacts. By the time snow cloaked the Stroud Center campus in the last days of 2020, educators had successfully reached over 2,500 program participants around the world.

"There were moments throughout 2020 that were extremely challenging for our team, but if you focus on the positive and on what you can accomplish, you'll never sink," maintains Muenz. "Our educators used the opportunity and momentum to bring about creative, thoughtful, supportive programming with global significance and reach."

During a boots-in-the-water stream study led by Stroud Center educators, fifth-grade teacher Katie Harnish helps a student analyze pH to assess the health of the local Little Conestoga Creek.

get involved

On-site and off-site school and Scout programs for youth, professional development workshops for adults, and family programs in virtual, remote, and in-person settings are just some of our available education options. **Visit stroudcenter.org/education for more information.**

WATERSHED RESTORATION

"Our work perfectly integrates the three parts of the Stroud Center's mission 'to advance knowledge and stewardship of freshwater systems through global research, education, and watershed restoration.' Not only are we investigating how to better restore our freshwater resources, we are putting what we learn into practice and sharing our knowledge with others who we hope will do the same."

— MATTHEW EHRHART, DIRECTOR OF WATERSHED RESTORATION, STROUD WATER RESEARCH CENTER

Left: Marcy Hostetler, a retired music teacher and wife of the Stroud Center's Lamonte Garber, maintains newly planted forest buffers on an Amish farm in Lancaster County, Pa. as part of a project with Lancaster Clean Water Partners and Penn State. Right: Lila and Kellen Deininger, niece and nephew of Garber and Hostetler, were some of the youngest volunteers helping to maintain forest buffers on an Amish dairy farm in Ronks, Pa. Photo: Lindsey Garber Deininger

Doing Good Better:

REFINING BUFFER RESTORATION METHODS

By David Wise

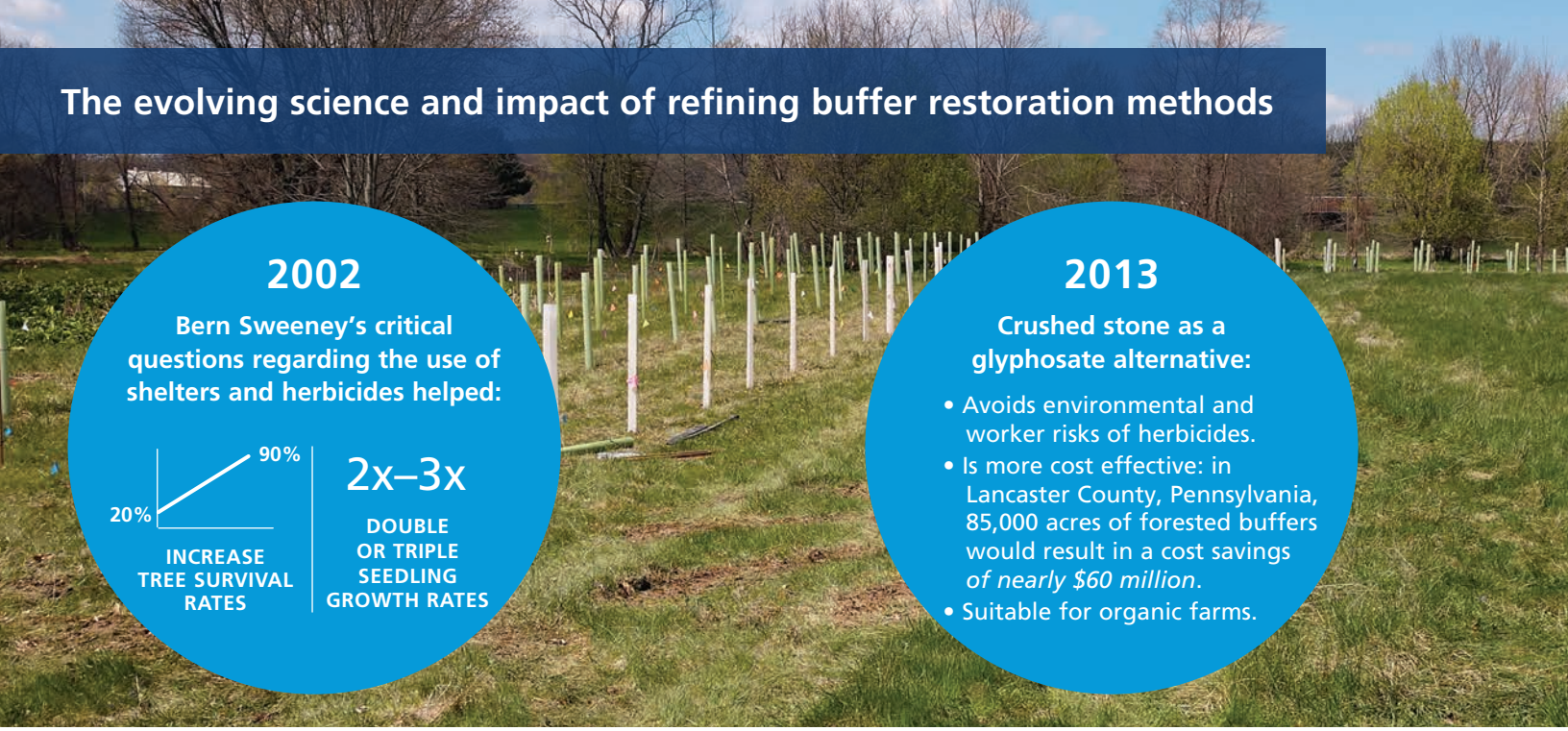
What if we tried? That phrase comes up regularly when Matt Ehrhart, Lamonte Garber, and David Wise put heads together. For them, figuring out better ways of doing things is a fun part of their work — and integral to their team since 1997, beginning at the Chesapeake Bay Foundation. Their creative thinking covers many aspects of restoring forest buffers along streams, such as how to get farmers to say yes to forested buffers; how to elevate buffers as a priority in federal, state, and private conservation funding; and the seemingly simple detail of how to get trees to survive once planted.

The goal of improving the survival and growth of trees has persisted through it all. "We put a man on the moon in 1968 when I was 8 years old, but in 2000, we still didn't know how to get streamside forests to grow," says David Wise. Early buffer plantings often had survival rates under 20%. The methods suggested by foresters working on timberlands with poor soils didn't work on the deep, rich streamside agricultural lands where buffers were needed.

Bern Sweeney, Ph.D., former director and distinguished research scientist of Stroud™ Water Research Center, was asking many of the same questions about streamside forests and using his evenings and weekends to conduct field trials of reforestation methods. In 1989, he was one of the first in North America to test the idea of using tree shelters, which had recently been developed in England for reforesting active sheep and goat pastures, to protect streamside tree seedlings from deer, rabbits, vines, and the like. He combined this with insights from nursery growers and orchardists on how herbicides could help keep rodents from damaging fruit and ornamental trees in their nurseries. Early field trials that focused solely on either shelters or herbicides gave way to larger, more complicated trials involving both methods at once. The relationship between the green industry and the Stroud Center flourished, and buffer reforestation methods did too.

In 2013, Ehrhart and Wise began working at the Stroud Center in what would become known as the Robin L. Vannote Watershed Restoration Program, with Garber joining soon after. Their expertise added to Sweeney's efforts to improve reforestation methods. The greatly expanded field effort of the team to restore forest buffers on many sites throughout Pennsylvania and the mid-Atlantic region provided dozens of opportunities for tweaking the installations at little or no additional cost in order to explore basic research on how to improve overall success on the installations. The team recruited

The evolving science and impact of refining buffer restoration methods



THE GOAL OF IMPROVING THE SURVIVAL AND GROWTH OF TREES HAS PERSISTED THROUGH DECADES OF RESEARCH.

interns, graduate students, partners, and volunteers to help collect the data. This, combined with the expertise of other Stroud Center scientists and statisticians, enabled them to analyze the outcomes and answer basic questions that were perplexing conservationists as they attempted to reforest streams and rivers locally, regionally, and throughout the world.

By 2002, Sweeney had already answered numerous critical questions regarding the use of shelters and herbicides, helped take tree survival rates from below 20% to about 90%, and helped double or triple seedling growth rates.

Yet with every advance, new questions arose: How do you keep the nets used on tree shelters, which protect birds from falling down the tubes, from tangling a tree's growing tip and permanently disfiguring and weakening the tree? In response to that question, Sweeney developed multiyear field trials and, with the help of a graduate student, developed a simple solution by adjusting the way the netting was placed on top of the shelter to give the seedling a small exit hole the size of a half dollar.

Subsequent large field trials explored which of the many brands of tree shelters were best for local conditions. To find the answer, Sweeney and his team evaluated the survivorship and growth of different brands of tree shelters in experimental side-by-side comparisons.

Other studies involved strategically removing shelters at various stages of seedling growth to determine when and how to remove tree shelters safely in order to avoid tree death due to antler rub by adult deer. Additional field trials were needed to figure out how to protect shrubs with multiple stems using short 2-foot shelters from deer when the field data showed them not doing well in the 5-foot-tall shelters.

In many cases, what seemed like simple questions turned into large field trials involving thousands of seedlings, as was the case in figuring out what kind of shelter stakes were needed to keep seedlings form snapping in flood-prone areas along streams and rivers. Another difficult issue was to determine if reforestation was even possible on streamside areas where thick deposits of sediment had accumulated due to the previous existence of milldams. The answer was yes, but finding the answer required three to five years of data and dogged determination to see things through — so, too, did the many other questions.

Left: Researchers at the Stroud Center have learned how to adjust netting on the top of tree shelters to allow room for trees to grow.

Through the years, many answers have become clear. Some have required both forest buffer practitioners and funders to rethink standard practices. For example, Sweeney's 2002 breakthrough publication revealing that spraying herbicides around sheltered trees could keep most herbivores and invasive plants from killing seedlings would greatly help practitioners to petition government funding agencies to support the cost of shelters and use of wetland-safe forms of glyphosate (like Rodeo) as part of the standard best management approach to buffer installations.

By 2013, the Stroud Center was looking for alternatives to using glyphosate because of concerns over the environment, worker exposure, and how to reforest streams on organic farms. Sweeney and the team began field trials of multiple options. Three successive generations of field trials, each several years long, have now shown that the use of crushed stone (specifically, 2A modified stone, a mixture of coarse and fine stone material) around the base of shelters can protect seedlings from rodents and invasive plants about as well as herbicides do. Beyond avoiding the environmental and worker risks of herbicides, the stone mulch is cheaper — about one-third the cost of herbicide applications — and seems to provide longer lasting protection. If, for example, Lancaster County, Pennsylvania, implements the 85,000 acres of forested buffers called for in official water quality cleanup plans, the cost savings would amount to nearly $60 million.

These insights and successes underscore the value of coupling Stroud Center research with on-the-ground restoration. Through the Stroud Center's education and outreach efforts, other organizations have learned this as well. In 2020, the Watershed Restoration Program spoke dozens of times to audiences of more than 1,900 individuals involved in buffer restoration: funders, contractors, fellow conservation professionals, landowners, and others. Many of these presentations included information generated through research on buffer restoration methods.

According to Ehrhart, "Our work perfectly integrates the three parts of the Stroud Center's mission 'to advance knowledge and stewardship of freshwater systems through global research, education, and watershed restoration.' Not only are we investigating how to better restore our freshwater resources, we are putting what we learn into practice and sharing our knowledge with others who we hope will do the same."

Above: In January, Lamonte Garber shared some of what the Stroud Center has learned about forest buffers and soil health with farmers, landowners, and community members who attended the Fishing Creek Watershed Public Forum in Holtwood, Pa.

learn more

Want to learn how to better restore your own streamside forest? Check out the Stroud Center fact sheet *Tips for Successful Riparian Forest Buffer Planting and Establishment*.

Visit stroudcenter.org/restoration/resources for more information.

Rachel Johnson, research engineer, installs an EnviroDIY™ Monitoring Station on Octoraro Creek; the station will relay water quality data in real time to the Monitor My Watershed® data portal.

Research Projects

Note: Stroud Water Research Center scientists and staff are indicated in bold.

Assessment of Environmental Conditions in Bennett's Run at Kendal-Crosslands Based on Physical, Chemical, Macroinvertebrate, and Fish Monitoring

Funded by: Phoebe A. Driscoll and the Phoebe Internship Fund

Bennett's Run is a small tributary to Brandywine Creek in southern Chester County, Pa., where a watershed conservation plan is being developed. To inform this plan, this study is measuring water chemistry, temperature, aquatic macroinvertebrates, and fish to quantify the condition of Bennett's Run between Longwood Gardens and Kendal-Crosslands Communities, and again downstream from Kendal-Crosslands.

Principal Investigators: John K. Jackson and **Bernard W. Sweeney**

Assessment of Environmental Conditions in Streams of the Runnymede Sanctuary Based on Physical, Chemical, and Macroinvertebrate Monitoring

Funded by: Runnymede Sanctuary

The 1,670-acre Runnymede Sanctuary preserves historic and scenic resources including forests, shrublands, meadows, and hayfields that offer important habitat for local and migratory wildlife and ensure replenishment of groundwater that feeds tributaries of Doe Run. This study measures water chemistry and aquatic macroinvertebrates of Doe Run and its tributaries as they enter and exit the sanctuary and at other streams in the region.

Principal Investigators: John K. Jackson and **Bernard W. Sweeney**

Collaborators: Melinda D. Daniels and Valérie Ouellet

Back From the Past: Recovery of Nutrient Processes and Microbial Communities in Relict Hydric Soils Following Restoration

Funded by: U.S. Department of Agriculture

This research explores how microbes and biogeochemical processes in buried relict soils evolve after restoration and how these organisms and processes can be harnessed to remove nitrogen before it pollutes streams. This will help practitioners design restoration projects with conditions that fast-track microbial recovery and nitrogen processing.

Principal Investigators: Jinjun Kan and **Marc Peipoch**

Collaborator: Shreeram Inamdar (University of Delaware)

Biological Nitrogen Removal in Sediment Plumes: A Critical but Missing Component of Watershed Models

Funded by: U.S. Department of Agriculture

Nutrient export from rivers is closely tied to sediment plumes that form during storms. By using experiments and methods to peer inside these sediment plumes, this project will discover how biological processes change nutrients while sediment plumes move downstream. The results will lead to more accurate watershed management models and better decisions on where best management practices can be most effective in agricultural watersheds.

Principal Investigators: Marc Peipoch and **Jinjun Kan**

Collaborator: Shreeram Inamdar (University of Delaware)

Brandywine Stream Stewards: Community Action in Support of Healthy Waters

Funded by: William Penn Foundation

The Stream Stewards Program engages adults and youth from Wilmington, Del., to monitor water resources in the 1,100 acres of open space in the First State National Historical Park. This educational program and citizen science effort galvanizes people around watershed protection and leads to conservation and improved management of land and water resources.

Principal Investigators: The Nature Conservancy – Delaware Chapter; **John K. Jackson** and **Matthew J. Ehrhart**

Collaborators: Jinjun Kan, **Melinda D. Daniels**, and **David B. Arscott**

Delaware River Watershed Initiative — Phase II Monitoring, Evaluation, Scientific Support, and Capacity Building for Watershed Protection and Restoration Projects

Funded by: William Penn Foundation

This project collects and interprets data on macroinvertebrate specimens from stream sites to provide a baseline to evaluate goals for restoration and protection projects in the Delaware River Basin.

Principal Investigator: John K. Jackson

Collaborators: Matthew J. Ehrhart, **David B. Arscott**; Roland Wall, Stefanie A. Kroll, Richard J. Horwitz, Marie J. Kurz, David Keller, Lin Perez, and David J. Velinsky (Academy of Natural Sciences of Drexel University)

Delaware River Watershed Initiative — Phase II Monitoring, Evaluation, and Scientific Support for Protecting and Restoring Places of Ecological Significance (Brandywine-Christina, Middle Schuylkill, Schuylkill Highlands Clusters)

Funded by: William Penn Foundation

Professional and volunteer monitoring of chemistry, macroinvertebrates, and fish to support restoration and protection efforts represent an invaluable (and often neglected) tool to evaluate short- and long-term progress toward conservation priorities and goals. This project develops and implements monitoring and evaluation efforts as part of restoration and protection plans for targeted watersheds in the Brandywine-Christina, Middle Schuylkill, and Schuylkill Highlands clusters in the Delaware River Basin.

Principal Investigators: John K. Jackson and **Matthew J. Ehrhart**

Collaborators: Audubon Pennsylvania; Berks Nature; Brandywine Conservancy; Brandywine Red Clay Alliance; French and Pickering Creeks Conservation Trust; Green Valleys Watershed Association; Natural Lands; Partnership for the Delaware Estuary; The Nature Conservancy of Delaware; University of Delaware

Ecotoxicity Study for Mayflies Exposed to Elevated Concentrations of Chloride at Different Temperatures

Funded by: Pa. Department of Environmental Protection

Chloride concentrations in surface waters have been increasing over the last several decades across the United States and at times may reach levels that threaten aquatic organisms. To test this, laboratory experiments are performed with four mayfly species exposed to elevated chloride concentrations and temperatures ranging from 5–25 degrees Celsius.

Principal Investigators: John K. Jackson and **David H. Funk**

Evaluating How Conventional, Conservation, and Organic Farming Management Practices Enhance Soil Health and Improve Water Quality

Funded by: William Penn Foundation

This project investigates how different agricultural management practices influence water quality and soil health. Using Rodale Institute's 37-year-old Farming Systems Trial and a recent transition to organic farming at the Stroud Preserve, it examines the effect of farming techniques on water infiltration, runoff, and nutrient, contaminant, and sediment export. Results will inform practices that can reduce contamination and flooding in the Delaware River watershed.

Principal Investigators: Jinjun Kan, **Melinda D. Daniels**, **Diana Oviedo-Vargas**, **Marc Peipoch**, **David B. Arscott**, **Matthew J. Ehrhart**, and **Bernard W. Sweeney**

Collaborators: Jeff Moyer, Emmanuel Omondi, Andrew Smith, Gladis Zinati, Diana Martin, Yichao Rui, and Kirsten Pearsons (Rodale Institute); Raven Bier (Savannah River Ecology Lab, University of Georgia)

Evaluating the Effects of Watershed-Scale Agricultural Best Management Practices on Water Quality

Funded by: Stroud Water Research Center

In early 2020, stream bank fencing, forested buffers, and barnyard improvements were installed on Amish farms in Lancaster County, Pa. This project is monitoring stream nutrient and sediment loads before, during, and after the implementation of the best management practices to detect changes in water quality due to these efforts.

Principal Investigators: Jinjun Kan; **Diana Oviedo-Vargas**, and **Marc Peipoch**

Collaborator: Lamonte Garber

Experimental Streamside Forest Restoration to Improve Water Quality – Fat Chance Farm

Funded by: TreeVitalize Watersheds, a partnership between the Pa. Department of Environmental Protection and the Pa. Horticultural Society

This project planted 675 trees and shelters on 2.01 acres of riparian land along an unnamed tributary of Doe Run in West Marlborough Township, Pa. The project was designed to test the long-term effectiveness of two types of tree shelters (Combitube, Tubex) on growth and survivorship of nine species of trees.

Principal Investigator: Jessica M. Provinski and **Calen Wylie**

Collaborators: Southern Chester County Chamber of Commerce; Voya Financial

Impact of Management of Practices on Winter Squash Yield and Post-Harvest Nutrient Density

Funded by: Pa. Department of Agriculture

By examining the bacteria, Archaea, and fungi living in soils, this project will provide insights on how farming practices and land management affect the microbes that make soils healthy. This information will help improve guidelines for growing squash and managing nutrients on farm fields.

Principal Investigator: Jinjun Kan

Collaborators: Gladis Zinati (Rodale Institute); Lavanya Reddivari (Purdue University)

Integration of Physiological, Life-History, and Macro-Ecological Approaches for Understanding Thermal Limitation in Aquatic Insects: Implications for Freshwater Biodiversity in a Warming World

Funded by: National Science Foundation

This project tests the hypothesis that temperature limits the distributions of aquatic insects through its effect on resource allocation, and that warming decreases reproduction by shunting energy away from egg production to other metabolic processes.

Principal Investigators: Bernard W. Sweeney, **John K. Jackson**, and **David H. Funk**

Collaborators: David B. Buchwalter (North Carolina State University); Charles P. Hawkins (Utah State University); Goggy Davidowitz (University of Arizona)

Land Protection Impact Assessment in Support of Delaware River Watershed Initiative

Funded by: Open Space Institute

This project evaluates the hypothesis that protection and/or maintenance of natural land maintains ecological stream quality by limiting, preventing, or redirecting changes to land cover and use away from headwaters, stream buffers, and wetlands. The project will be conducted in two steps — looking first at available chemical, macroinvertebrate, and fish data, and then collecting additional data specifically focused on the relationship between protecting forests and stream quality.

Principal Investigators: John K. Jackson and **Charles L. Dow**

Collaborators: Stefanie A. Kroll, Marie J. Kurz, David Keller, and Lin Perez (Academy of Natural Sciences of Drexel University)

Dave Montgomery collects water samples during Tropical Storm Isaias.

Long-Term Research in Environmental Biology (LTREB): River Ecosystem Responses to Floodplain Restoration

Funded by: National Science Foundation

After 25 years of litigation, a massive ecological restoration is under way in the Upper Clark Fork River, Mont. Metal-laden floodplain soils are being removed, floodplains are being reconnected with river floods, and over 70 kilometers of floodplains are being restored. This project uses long-term monitoring data to discover how river ecosystem structure and function respond to changing nutrient concentrations and large-scale floodplain restoration. By testing fundamental theories and frameworks of ecology, these discoveries will guide future river restorations.

Principal Investigator: Marc Peipoch

Collaborators: Maurice Valett and Michael DeGrandpre (University of Montana); Rob Payn and Juliana D'Andrilli (Montana State University)

Long-Term Research in Environmental Biology (LTREB): Trajectory for the Recovery of Stream Ecosystem Structure and Function During Reforestation

Funded by: National Science Foundation

Stream restoration in the United States is a multibillion-dollar industry, yet long-term monitoring of its effectiveness is virtually nonexistent. To fill this gap, the Stroud Center restored a portion of White Clay Creek by reforestating meadows and pastures with native deciduous trees and removing invasive plant species. Decadal changes in the aquatic biological communities and how they function are being monitored as this forest matures. This project is producing discoveries and insights that will guide future restoration techniques and train teachers to use long-term environmental data to enhance math skills, analytical abilities, and environmental knowledge of students and teachers.

Principal Investigators: John K. Jackson, **Jinjun Kan**, **Melinda D. Daniels**, **Diana Oviedo-Vargas**, and **Marc Peipoch**

Collaborators: J. Denis Newbold, **David B. Arscott**, **Charles L. Dow**, **Steven C. Kerlin**, **Tara K. Muenz**, **Louis A. Kaplan**, and **Bernard W. Sweeney**

Stroud Center researcher Stephanie Bernasconi and Eva Bacmeister, a graduate student at the University of Delaware, install samplers to collect rising stormwater. Bacmeister is studying how suspended sediment influences nutrient distribution.

Low-Head Milldams as Hotspots for Denitrification and Nitrogen Consumption: Hydrologic and Biogeochemical Controls

Funded by: National Science Foundation

Dam removal, especially of low-head milldams, has increased in recent years particularly in the mid-Atlantic U.S. While improvement in fish habitat and reduction in financial liability have been the primary motivators for dam removal, few studies have addressed the consequences of these removals for water quality and regulatory compliance. This project investigates the role of low-head milldams on nitrogen and sediment transport in stream ecosystems.

Principal Investigator: Marc Peipoch

Collaborators: Shreeram Inamdar (University of Delaware) and Art Gold (University of Rhode Island)

Macroinvertebrate Monitoring at Sites in White Clay Creek, Pa., Flint River, Ga., Susquehanna River, Pa., and Delaware River, Pa.

Funded by: Various public and private sources

These projects use aquatic macroinvertebrates such as mayflies, stoneflies, and caddisflies to provide assessments of current water quality in these streams and rivers. Where long-term data are available, the most recent conditions are compared to historical conditions.

Principal Investigator: John K. Jackson

Collaborator: Bernard W. Sweeney

Microbial Population Dynamics of Periphyton Biofilms in White Clay Creek

Funded by: Stroud Water Research Center

Using glass microscope slides as tiny gardens to grow microbial biofilms, this project explored differences in microorganisms between three reaches of White Clay Creek with different streamside vegetation. Molecular DNA fingerprints of biofilms on glass slides differed in the three reaches, as did the biofilms on natural underwater surfaces. This revealed how subtle differences in surfaces and surroundings affect microbial communities and their distribution.

Principal Investigator: Jinjun Kan

Mitigating Agricultural Pollution of Fresh Water and Combating Climate Change by Restoring Soil Health Through Conservation and Organic Agricultural Practices

Funded by: Prince Albert II of Monaco Foundation

Plowing, disking, synthetic fertilizers, and pesticides have damaged the health of agricultural soils, resulting in reduced rainfall infiltration and storage, increased stormwater and pollutant runoff, degraded streams, and contaminated groundwater. This project measures how no-till seeding, multi-species cover cropping, and elimination of synthetic fertilizers and pesticides (in particular, neonicotinoids) can rejuvenate agricultural soils and protect water quality.

Principal Investigators: Melinda D. Daniels, **Jinjun Kan**, **Diana Oviedo-Vargas**, and **Marc Peipoch**

Model My Watershed — Delaware River Basin

Funded by: William Penn Foundation

This project expands the Model My Watershed® application to the entire Delaware River Basin and supports restoration efforts funded by the William Penn Foundation. This application will provide higher-resolution modeling for developing effective restoration plans in targeted watersheds.

Principal Investigators: David B. Arscott and **Steven C. Kerlin**

Collaborators: Anthony Aufdenkampe (LimnoTech); Robert Cheetham (Azavea, Inc.); Emilio Mayorga (University of Washington); David Tarboton (Utah State University)

Molecular Ecology of Archaea in Aquatic and Terrestrial Environments

Funded by: Southern University of Science and Technology (SUSTech), China

Less is known about Archaea than the other two domains of life on Earth (Bacteria and Eukarya), particularly the role they play in ecosystem functions and nutrient cycling (e.g., ammonia oxidation). Applying cutting-edge molecular approaches, this project is characterizing community composition and spatiotemporal distribution of Archaea in White Clay Creek, Costa Rica, the Chesapeake Bay, and terrestrial environments.

Principal Investigator: Jinjun Kan

Collaborator: Chuanlun Zhang (SUSTech)

Monitoring Fish Populations and Stream Habitat Quality for the National Park Service

Funded by: National Park Service

This project monitors biological conditions, water quality, habitat integrity, and fish at 37 sites in 10 national parks in the National Capital Region Network around Washington, DC. The findings of this project are used by the National Park Service to make conservation and management decisions.

Principal Investigators: Marc Peipoch, **Melinda D. Daniels**, **Diana Oviedo-Vargas**, **John K. Jackson**, **Jinjun Kan**, and **Scott Ensign**

North American Macroinvertebrate Taxonomic Certification Program

Funded by: Society for Freshwater Science

This program coordinates and executes the taxonomic certification program for the Society for Freshwater Science, conducting family- and genus-level tests throughout the year.

Principal Investigators: John K. Jackson and **Bernard W. Sweeney**

Collaborator: Michael C. Broomall

Phytoplankton Dynamics at the Brandywine River

Funded by: Stroud Water Research Center

High-frequency temperature, oxygen, and chlorophyll sensors, canoe float trips, and nutrient monitoring are the tools being used to study how much and how fast algae grow while they travel down the Brandywine River. By understanding how suspended algae respond to storms and how dams affect patterns in algae, this project will improve predictions of future changes in the river if dams are removed.

Principal Investigators: Marc Peipoch, **Scott Ensign**, and **Diana Oviedo-Vargas**

Restoration Project Impact Assessment in Support of Delaware River Watershed Initiative

Funded by: National Fish and Wildlife Foundation

This project quantifies the positive impact of one or several restoration projects associated with the Delaware River Watershed Initiative, namely those funded by the National Fish and Wildlife Foundation's Delaware River Restoration Fund. Responses will be measured in the stream as water temperature and chemistry, algae, macroinvertebrates, and fish, and in farm fields as soil health (hydrologic, chemical, texture, microbiological).

Principal Investigators: John K. Jackson, **Matthew J. Ehrhart**, **Melinda D. Daniels**, **Jinjun Kan**, **Diana Oviedo-Vargas**, and **Marc Peipoch**

Collaborators: Stefanie A. Kroll, Marie J. Kurz, David Keller, and Lin Perez (Academy of Natural Sciences of Drexel University); Green Valleys Watershed Association; French and Pickering Creeks Conservation Trust, Berks Nature; Musconetcong Watershed Association, The Nature Conservancy – New Jersey; North Jersey Resource Conservation & Development Council; Trout Unlimited; South Jersey Land and Water Conservancy; Rutgers University; New Jersey Audubon

Sediment Stabilization by Animals in Stream Ecosystems: Consequences for Erosion, Ecosystem Processes, and Biodiversity

Funded by: National Science Foundation

Like underwater engineers, caddisflies and other net-spinning macroinvertebrates attach gravels to one another on the bottom of streams

Stroud Center researcher Courtland Hess collects samples of macroinvertebrates in Northkill Creek in Berks County, Pa.

in a way that stabilizes the stream bed and reduces erosion. Using laboratory experiments in experimental streams, conducting field experiments and surveys, and modeling the landscape-scale effects, scientists are discovering how these tiny ecosystem engineers affect ecosystem processes and stabilize habitat for biofilms and macroinvertebrates. This science is translated into learning resources and teacher professional development workshops.

Principal Investigator: Melinda D. Daniels

Collaborators: Tara K. Muenz; Lindsey Albertson and Wyatt Cross (Montana State University); Leonard Sklar (San Francisco State University)

Source Tracking and Spatial/Temporal Dynamics of Bacterial Contaminants in Red Clay Creek

Funded by: Starrett Foundation

Scientists monitored fecal indicator bacteria and water chemistry on a monthly basis in the east and west branches of the Red Clay Creek watershed.

Principal Investigators: Jinjun Kan, **Raven Bier**, and **David B. Arscott**

Stroud EnviroDIY Monitoring Stations in Red Clay Creek

Funded by: Cabot-Kjellerup Foundation

The purpose of this project was to build and deploy two water monitoring sensor stations in tributaries of Red Clay Creek (RCC) and provide maintenance support and educational/technical assistance for staff at The Land Conservancy for Southern Chester County (TLCSCC).

Principal Investigator: David B. Arscott

Using Microbial Source Tracking (MST) to Identify Potential Bacterial Sources in White Clay Creek to Target Best Management Practices (BMPs) and Implementation Strategies

Funded by: White Clay Watershed Association and White Clay Creek Wild & Scenic River Program

Scientists monitored fecal indicator bacteria in White Clay Creek during summer and identified potential bacterial contamination by molecular microbial source tracking.

Principal Investigator: Jinjun Kan

Collaborator: Shane Morgan (White Clay Creek Wild & Scenic River Program)

Water Quality Modeling to Support Source Water and Aquatic Life Protection, Octoraro Creek, Pennsylvania and Maryland

Funded by: Environmental Protection Agency

This project supports water quality monitoring and development of a water quality model to guide an alternative restoration plan for the Octoraro Creek Watershed. The data, model, and plan will guide Pa. Department of Environmental Protection in implementing nutrient reduction strategies that restore designated uses of Octoraro Creek.

Principal Investigator: Marc Peipoch

After a discovery-based paddle along the Brandywine River during an on-the-water education program, two participants enjoy a shore-based study of aquatic macroinvertebrates.

Education Projects

Advancing Education Programs and Community Outreach With Oxford Area Audiences

Funded by: Oxford Area Foundation

Continued support enables the Stroud Center to further expand education and outreach to the local Oxford community and schools in southeastern Pa. It includes increased opportunities for programs for schools and youth groups, educator professional development, and citizens, and provides education resources.

Project Lead: Steven C. Kerlin

Collaborators: Tara K. Muenz, **David Kline**, and **Mandy Nix**

Capacity-Building for Girls-in-STEM Watershed Education

Funded by: Pa. Department of Environmental Protection (DEP)

This project expanded meaningful and inclusive education in water-focused environmental science, technology, engineering, and math (E-STEM) for K–12 girls across southeastern Pa., including the piloting of Environmental Justice (EJ) programs for high-needs and marginalized girls residing in DEP EJ Areas.

Project Leads: Mandy Nix and **Steven C. Kerlin**

Collaborator: Tara K. Muenz

Consortium for Scientific Assistance to Watersheds

Funded by: Pa. Department of Environmental Protection's Growing Greener Program

Educators provided technical assistance to groups on statewide conservation so they can conduct effective watershed assessment, monitoring, and restoration.

Project Leads: Scott Ensign, **David B. Arscott,** and **Tara K. Muenz**

Collaborators: Alliance for Aquatic Resource Monitoring at Dickinson College; Conemaugh Valley Conservancy; Delaware Riverkeeper Network; Pennsylvania Lake Management Society; United States Geological Survey; Pocono Northeast Resource Conservation and Development Council

Equity and Environmental Education (EE) in the Time of COVID-19 to Support EE Providers

Funded by: Chesapeake Bay Trust and Pa. Department of Education (PDE)

Educators modified existing watershed education programming, created new programming, and piloted programming for virtual and in-person engagement during the coronavirus pandemic. Additional funding from PDE supported the initial planning of a website to further support EE providers like classroom teachers, non-formal educators, and guardians/caregivers.

Project Leads: Steven C. Kerlin and **Tara K. Muenz**

Collaborators: Mandy Nix and **Heather P. Brooks**; Tamara Peffer (Pa. Department of Education); Chesapeake Bay Program

Expanding Environmental Literacy and Meaningful Watershed Educational Experience (MWEE) Implementation Capacity Across Pa.

Funded by: National Oceanic and Atmospheric Administration

This 2020–2022 statewide project builds capacity for environmental literacy and stewardship of the Chesapeake Bay and other watersheds in Pennsylvania by expanding the inclusion and implementation of environmental education, particularly MWEEs in Pa. schools.

Project Leads: Steven C. Kerlin; Tamara Peffer (Pa. Department of Education)

Collaborators: Mandy Nix; Bert Myers and Allison Acevedo (Pennsylvania Department of Environmental Protection); Jessica Kester (Pennsylvania Association of Environmental Educators); Carissa Longo (Pennsylvania Bureau of State Parks); Nanette Marcum-Dietrich (Millersville University); Jenn Fetter (Penn State Extension); Paul Joyce (West Chester Area School District)

Girls-in-STEM Education Programs Fund

Funded by: Donna Queeney and Nick Kerlin

This fund supports ongoing efforts to engage and empower future female leaders in science, technology, engineering, and math (STEM) during dedicated programs for K–12 girls, including Girl Scouts and girls' groups.

Project Leads: Mandy Nix and **Steven C. Kerlin**

Collaborator: Tara K. Muenz

Independent K–12 Student Research Projects

Funded by: Auman Family

The establishment of this fund makes staff support available to assist K–12 students interested in conducting independent scientific research in freshwater ecology.

Project Lead: Tara K. Muenz

Lancaster Area Outdoor Learning Network Initiative

Funded by: Chesapeake Bay Trust

Educators planned and delivered teacher professional development in watershed education content and skills for Conestoga Valley, Ephrata, and Columbia school districts in Pennsylvania.

Project Lead: Dan Daneker (Conestoga Valley School District)

Collaborators: Steven C. Kerlin and **Tara K. Muenz**; Nanette Marcum-Dietrich (Millersville University); Chesapeake Bay Foundation; Lancaster County Conservation District

Lawrenceville School Partnership for Student Water Quality Monitoring of Shipetaukin Creek

Funded by: Fair Play Foundation

Educators are partnering with The Lawrenceville School to create and implement opportunities for students to study water quality impacts on the school campus using EnviroDIY Monitoring Stations.

Project Leads: Steven C. Kerlin and **Tara K. Muenz**; Stephen Laubach (The Lawrenceville School)

Collaborator: David Bressler; Darcy Brewer (The Lawrenceville School)

Leaf Pack Stream Ecology Kit and Network

Funded by: Stroud Center Education Product Development

This international program, which is bilingual in English and Spanish, engages students, teachers, families, and the public in water quality monitoring through the lens of aquatic macroinvertebrates.

Project Lead: Tara K. Muenz

Learning to See, Seeing to Learning

Funded by: National Science Foundation

This project continued to enhance the Macroinvertebrates.org. site, in addition to creating aquatic macroinvertebrate identification resources for learners, teachers, and trainers.

Project Lead: Marti Louw (Carnegie Mellon University)

Collaborators: Tara K. Muenz, Steven C. Kerlin, **Mandy Nix**, **John K. Jackson**, and **Michael C. Broomall**; John Morse (Clemson University); Lauren Allen (Carnegie Mellon University); John Wenzel (Carnegie Museum of Natural History)

On-the-Water Education Programs

Funded by: Education Program fees, National Park Trust, and Education Improvement Tax Credit Program

Stroud Center educators provided on-the-water canoeing watershed education experiences on local streams, lakes, and reservoirs for schools, Scouts, community groups, and audiences of all ages.

Project Leads: Steven C. Kerlin and **Tara K. Muenz**

Collaborators: David Kline and **Mandy Nix**

Pa. Environmental Literacy and Meaningful Watershed Education Experience (MWEE) Programming Capacity-Building

Funded by: National Oceanic and Atmospheric Administration

This 2017–2020 statewide project improved environmental literacy and stewardship of K–12 students by building capacity across Pennsylvania for high-quality environmental education and MWEE programming.

Project Lead: Steven C. Kerlin

Collaborators: Mandy Nix; Bert Myers (Pa. Department of Environmental Protection); Tamara Peffer and Judd Pittman (Pa. Department of Education); Jenn Fetter (Penn State Extension); Jessica Kester (Pa. Association of Environmental Educators); Carissa Longo (Pa. Bureau of State Parks); Nanette Marcum-Dietrich (Millersville University)

Pa. Healthy Learning Environments Advisory Council to the Pa. Department of Health's COVID-19 Initiative

Funded by: U.S. Center for Disease Control

Educators provided feedback on technical plans, guidance, and resources to develop a cohesive system of professional development and classroom materials to create healthy schools and childcare environments that prevent the spread of COVID-19.

Project Leads: Pa. Department of Health; Drexel University; Pa. Department of Education

Collaborators: Steven C. Kerlin and **Tara K. Muenz**

Pa. Trout in the Classroom (PA TIC) Program Support

Funded by: Pa. Council of Trout Unlimited (PATU)

The Stroud Center education department provided staffing and other supports to the PA TIC program, including the design and development of a new PA TIC website.

Project Leads: Mandy Nix and **Steven C. Kerlin**

Collaborators: Stephen Mohapp; Rachel Kester (PATU); Amidea Daniel and Cody Whipple (Pa. Fish and Boat Commission)

Quantify and Support Installation and Restoration of Best Management Practices (BMPs) at Schools to Contribute Directly to Bay Restoration Goals

Funded by: Chesapeake Bay Trust

Educators sampled school districts and conducted extensive research on sustainable school recognition programs across the Chesapeake Bay Watershed, with a focus on connections between teaching/learning and the implementation of BMPs on school properties.

Project Lead: Steven C. Kerlin

Collaborators: David Kline, **Charles L. Dow**, **Tara K. Muenz**, and **Scott Ensign**; Nanette Marcum-Dietrich (Millersville University)

School Study on the Effects of Outdoor Learning

Funded by: Anonymous

This school-case-study research project surveyed and interviewed middle school students and teachers to determine if and how outdoor learning experiences are impacting students.

Project Leads: Steven C. Kerlin; Nanette Marcum-Dietrich (Millersville University)

Completed in mid-2019, the education pavilion provides a multi-use outdoor learning space for education and outreach, including in-person, outdoor-only, and physically distanced programming during the coronavirus pandemic.

Environmental educator Steve Mohapp engages fifth-grade students in an inquiry-driven stream habitat study. During the coronavirus pandemic, outdoor experiences foster critical opportunities for safe but meaningful learning.

Scout Education Programs

Funded by: Components of other projects supported by various funders

Educators engage and empower K–12 youth from Boy Scouts of America (BSA) and Girl Scouts of the USA in environmental merit badges, journeys, awards, service projects, and other boots-in-the-water education programs.

Project Leads: Steven C. Kerlin, **Mandy Nix**, and **Tara K. Muenz**

Collaborators: Chester County Council, BSA; Girl Scouts of Eastern Pa.

Scout Watershed STEM Education, Recreation, and Stewardship Programs and Educator Professional Development

Funded by: National Park Trust

Educators delivered a series of hands-on, minds-on events to engages Boy Scouts of America, Girl Scouts USA, and adult educators in watershed STEM topics during on-the-water canoeing watershed education, recreation, and stewardship programs.

Project Leads: Steven C. Kerlin and **Tara K. Muenz**

Collaborators: Lorin Felter, Cinda Waldbuesser, and Samantha Baranski (First State National Historical Park)

Stream Study Programs for Public Schools

Funded by: The Education Improvement Tax Credit Program

Educators provided boots-in-the-water stream study programs for K–12 students, who learned about their impact on waterways and how they can protect and improve this vital resource for all life.

Project Leads: Steven C. Kerlin, **Tara K. Muenz**, and **Kristine C. Lisi**

Collaborators: Mandy Nix, **David Kline**, **Jessica M. Provinski**, and **David B. Reinfeld**

Watershed Awareness Using Technology and Environmental Research for Sustainability (WATERS)

Funded by: National Science Foundation

Educators developed and piloted a new national curriculum and extensive learning resources using universal design for learning (UDL) principles in California, Pennsylvania, and Virginia, with special attention to students who are English Language Learners.

Project Lead: Steven C. Kerlin

Collaborators: Melinda D. Daniels, **Diana Oviedo-Vargas**, **David Kline**, **Tara K. Muenz**, and **Mandy Nix**; Nanette Marcum-Dietrich (Millersville University); Carolyn Staudt (Concord Consortium)

Watershed STEM Meaningful Watershed Educational Experience (MWEE) After-School Programming

Funded by: U.S. Department of Education

Educators engaged high-needs students from four 21st Century Community Learning Center (CCLC) sites in Pa. through an eeBLUE grant program administered by the North American Association for Environmental Education and the National Oceanic and Atmospheric Administration to provide Watershed STEM MWEEs.

Project Lead: David Kline

Collaborators: Mandy Nix, **Steve C. Kerlin**, and **Tara K. Muenz**; 21st CCLC sites in Coatesville Area, Oxford Area, and Avon Grove school districts

Water Quality Mobile App

Funded by: Stroud Center Education Product Development and National Science Foundation

The Water Quality App for mobile devices received updates to the macroinvertebrate digital field guide and pollution tolerance index and water chemistry parameters for both Apple and Android devices.

Project Leads: Steven C. Kerlin and **Tara K. Muenz**

Collaborators: Heather Mayfield (Foundation for Ohio River Education); Miriam Steinitz-Kannan (Northern Kentucky University - Retired); and Josh Simmons (CodeSpout)

West Chester Area School District (WCASD) Water Quality Education Center

Funded by: Pa. Department of Environmental Protection

Educators and restoration staff provided assistance for establishing three outdoor learning stations with interpretive signs, teacher professional development, watershed education curricula, and restoration projects at elementary and middle school properties of WCASD in Pennsylvania.

Project Lead: Paul Joyce (WCASD)

Collaborators: Steven C. Kerlin, **Tara K. Muenz**, and **Mandy Nix**

Virtual Learning Resources

Funded by: Connelly Foundation, Oxford Area Foundation, and Longwood Rotary Foundation

In response to COVID-19 emergency learning conditions, educators created and delivered new and modified watershed education resources for use in nearby nature and in virtual learning settings, both the coronavirus pandemic and beyond.

Project Lead: Mandy Nix

Collaborators: Tara K. Muenz, **David Kline**, and **Steven C. Kerlin**

Watershed Restoration Projects

Agricultural Best Management Practices and Forested Buffers for Chester County Focus Areas

Funded by: Pa. Department of Environmental Protection

This project implements agricultural conservation practices on three Plain sect farms in the Honey Brook, Pa., area.

Project Lead: Matthew J. Ehrhart

Collaborators: Brandywine Conservancy; Brandywine Red Clay Association; Mowery Environmental, LLC

Agricultural Best Management Practices and Forested Buffers for Lancaster Focus Areas

Funded by: Pa. Department of Environmental Protection

This project implements whole-farm conservation on all four farms in the catchment of a very small unnamed tributary to Pequea Creek in Lancaster County, Pa. The farmers are undertaking comprehensive conservation planning and implementation to address major water quality issues from their dairy operations. Coordination with Stroud Center science staff is underway to document response to restoration efforts.

Project Lead: Matthew J. Ehrhart

Collaborator: TeamAg, Inc.

Agricultural Best Management Practices and Buffers for Middle Schuylkill Focus Area

Funded by: National Fish and Wildlife Foundation

Farmers receive assistance to plan and implement at least 80 agricultural best management practices (BMPs) on the condition that they also install forested buffers on their streams.

Project Lead: Matthew J. Ehrhart

Collaborators: Berks County Conservation District; Cover Crop Coaching, LLC (Steve Groff); Pa. No-Till Alliance; Red Barn Consulting, Inc.; TeamAg, Inc.

Delaware River Watershed Initiative Circuit Rider for Technical Assistance to Grantees

Funded by: William Penn Foundation and National Fish and Wildlife Foundation

The Stroud Center provides technical assistance to grantees of the William Penn Foundation and the National Fish and Wildlife Foundation to develop and implement watershed restoration efforts and grants to monitor the impact of projects implemented in the Delaware River Watershed Initiative clusters.

Project Leads: Matthew J. Ehrhart, **John K. Jackson**, and **David B. Arscott**

Collaborators: Bernard W. Sweeney, **Jinjun Kan**, and **Melinda D. Daniels**

Delaware River Watershed Initiative Citizen Science II

Funded by: William Penn Foundation

This project engages watershed residents to be active participants in efforts to document conditions across the focus areas of the Delaware River Watershed Initiative. Work includes efforts to support monitoring, communication, technical support via a circuit rider, work with farmers of the Pa. Association for Sustainable Agriculture, and technical report details.

Project Leads: Matthew J. Ehrhart, **John K. Jackson**, and **David B. Arscott**

Collaborators: David Bressler, **Jinjun Kan**, **Melinda D. Daniels**, and **Steven C. Kerlin**

Delaware River Watershed Initiative Phase II Work in Focus Areas

Funded by: William Penn Foundation

This funding supports the Stroud Center's Robin L. Vannote Watershed Restoration Program to participate in the Delaware River Watershed Initiative's focus areas within the Brandywine-Christina, Middle Schuylkill, and Schuylkill Highlands focus areas where restoration efforts are underway in highly targeted locations.

Project Leads: Matthew J. Ehrhart and **John K. Jackson**

Delaware River Watershed Initiative Rodale–Stroud Center Collaboration

Funded by: William Penn Foundation

This project enables a collaboration with Rodale Institute to advance knowledge on soil health and impacts on water quality, including a comparison of till, no-till, and organic-based cropping systems. Related efforts will engage farmers and service providers in strategies for soil health and regenerative agriculture.

Project Lead: Matthew J. Ehrhart

Forest Buffer Tree Seedling Care Initiative 2020

Funded by: Marshall Reynolds Foundation

This project includes site visits to check the status of recently planted buffers, replanting of any mortality, and providing feedback to landowners on status and success of their buffer plantings.

Project Lead: Matthew J. Ehrhart

Healthy Soils, Healthy Streams Training, and Technical Assistance

Funded by: Pa. Department of Environmental Protection and National Fish and Wildlife Foundation

This project will conduct trainings on soil health and stream health for nearly 6,000 farmers, conservation professionals, and others. The Pa. No-Till Alliance will offer technical assistance on cover crops and no-till farming to at least 24 farmers. The potential for synergy between the alliance and the Stroud Center is promising. The same biological principles — nurturing the microbes and other organisms that do the real work — apply to achieving both healthy soils and healthy streams.

Project Lead: Matthew J. Ehrhart

Collaborators: Pa. No-Till Alliance; Cover Crop Coaching, LLC

Improving Success and Cutting Costs on Riparian Buffers

Funded by: Chesapeake Bay Foundation

Chesapeake Bay Foundation's Keystone 10 Million Trees Partnership contracts with the Stroud Center to test tree planting and maintenance-related materials. The goal is to demonstrate methods that maintain high levels of forested buffer success while reducing herbicide use and total costs. This work is occurring in the west branch of Red Clay Creek.

Project Lead: Matthew J. Ehrhart

Modeling Land Protection Impact Assessment for the Open Space Institute

Funded by: Open Space Institute and William Penn Foundation

This project uses Model My Watershed to communicate the value of forest protection by estimating its impact on water quality.

Project Lead: David B. Arscott

Collaborators: Barry Evans, Lin Perez, and Ali Shokoufandeh (Academy of Natural Sciences of Drexel University); Claire Jantz (Center for Land Use and Sustainability, Shippensburg University)

Outreach and Installation of Agricultural Best Management Practices in Brandywine-Christina

Funded by: National Fish and Wildlife Foundation

This project installs conservation practices on farms to improve watershed health. It provides outreach, technical assistance, and financial assistance to farmers to plan and implement whole-farm conservation.

Project Lead: Matthew J. Ehrhart

Collaborators: Brandywine Conservancy; Brandywine Red Clay Alliance; Chester County Conservation District; Mowery Environmental, Inc.; Red Barn Consulting, Inc.; TeamAg, Inc.

Partnering for Accelerated Agricultural Best Management Practices in South Central Pa.

Funded by: National Fish and Wildlife Foundation

This project supports the Stroud Center's continuing efforts on soil health, particularly for outreach and education on cover crops and no-till farming. It also installs conservation practices on farms to improve watershed health.

Project Lead: Matthew J. Ehrhart

Collaborators: Cover Crop Coaching, LLC (Steve Groff); Pa. No-Till Alliance; Red Barn Consulting, Inc.; TeamAg, Inc.

Forested Buffers for Farms in the Chesapeake Bay Watershed

Funded by: Pa. Department of Conservation and Natural Resources

This project provides funding for five farms in Lancaster and Chester counties in Pennsylvania to install forested buffers and any needed infrastructure to protect streams from livestock.

Project Lead: Matthew J. Ehrhart

Collaborators: Alliance for Chesapeake Bay; Mowery Environmental, LLC; Salisbury Township; TeamAg, Inc.

Soil Health and Stream Health for Red and White Clay Creeks

Funded by: National Fish and Wildlife Foundation

This project engages two farmers to implement more than 1,000 acres of cover crops, conduct trials of eight or more innovative methods to advance cover crop and no-till techniques, and create infrastructure that lessens soil compaction and nutrient losses from fields. More than 20 acres of forested buffers will be restored in these watersheds.

Project Lead: Matthew J. Ehrhart

Collaborators: Brandywine Conservancy; Brandywine White Clay Association; Chester County Conservation District; Cover Crop Coaching, LLC (Steve Groff); Mowery Environmental, LLC; Red Barn Consulting, Inc.; TeamAg, Inc.

South Central Pa. Conservation Partnerships

Funded by: National Fish and Wildlife Foundation

This project helps about two dozen farms in Lancaster and Chester counties to install nearly 200 agricultural best management practices, including nine miles of forested buffers and nearly 21,000 acres of cover crops. It also provides outreach and training to more than 11,000 farmers and conservation professionals.

Project Lead: Matthew J. Ehrhart

Collaborators: Alliance for the Chesapeake Bay; Chesapeake Bay Foundation; Chester County Conservation District; Crow and Berry Land Management; Lancaster County Conservation District; Mowery Environmental, Inc.; Penn State Agriculture and Environment Center; Red Barn Consulting, Inc.; TeamAg, Inc.

Stroud Center–Alliance for Chesapeake Bay Partnership

Funded by: Alliance for Chesapeake Bay

This project supports installation and care of about 25 acres of forested buffers after they are planted in the west branch of Red Clay Creek.

Project Lead: Matthew J. Ehrhart

Stroud Center–Pa. Department of Conservation and Natural Resources Buffer Collaborative

Funded by: Pa. Department of Conservation and Natural Resources

This project installs nearly 80 acres of forested buffers and demonstrates the income potential from buffers for fruits, nuts, and salable horticultural materials.

Project Lead: Matthew J. Ehrhart

Collaborators: Brandywine Conservancy; Berks County Conservation District; Chester County Conservation District; Crow and Berry Land Management; Mowery Environmental, Inc.; Red Barn Consulting, Inc.; TeamAg, Inc.

Stroud Center–Pa. Department of Conservation and Natural Resources Forested Buffer Partnership 2020

Funded by: Pa. Department of Conservation and Natural Resources

This project restores 30 acres of forested buffer in the west branch of Red Clay Creek and includes care after planting. The buffers are part of whole-farm work on a former dairy farm in the headwaters of the watershed.

Project Lead: Matthew J. Ehrhart

Collaborator: Hicks Brothers, LLC

Targeted Agricultural Best Management Practices and Forested Buffers

Funded by: National Fish and Wildlife Foundation

In targeted portions of the Chesapeake Bay watershed in Lancaster and Chester counties, Pa., the project implements whole-farm systems of best management practices on about two dozen farms, restores about 50 acres of forested buffers, and prepares Comprehensive Nutrient Management Plans.

Project Lead: Matthew J. Ehrhart

Collaborator: TeamAg, Inc.

Targeted Agricultural Best Management Practices and Forested Buffers for Chester County Focus Areas 2020

Funded by: National Fish and Wildlife Foundation

This project implements agricultural best management practices (BMPs) and forested buffers on farms, which includes stormwater-runoff controls for barnyards and mushroom compost processing areas, new and seasonally earlier cover crops, improved no-till practices, riparian forest buffers and related infrastructure, and more.

Project Lead: Matthew J. Ehrhart

Collaborators: Hicks Brothers, LLC; Mowery Environmental, LLC

Emily Smedley of Lancaster Clean Water Partners gets help with buffer maintenance from Kellen Deininger. Photo: Lindsey Garber Deininger

Published Titles

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Above: Stroud Center research technicians Courtland Hess (left) and Adam Gochnauer (right) sample macroinvertebrates on the Susquehanna River as part of an annual survey for aquatic health.

Gifts and Contributions

We gratefully acknowledge the following 359 donors who generously contributed $471,796 to the 2020 Annual Fund. These vital funds cover expenses associated with all the work done at the Stroud Center. On behalf of our research scientists, environmental educators, the watershed restoration team, and all other employees, **thank you** for strengthening our work.

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— BRYAN COLKET

" Life, as we know it, depends on water. The Stroud Center was founded to learn all we can about ways to preserve fresh water for health and sustenance as well as recreation. In the 53 years since its founding, dedicated Stroud Center professionals have advanced our understanding of how best to protect this irreplaceable resource. The Hayward family, through its 1916 Foundation, is proud to have been an early and continuing supporter of the Stroud Center's work."

— NATHAN HAYWARD III

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PROGRESS 34% | GOAL $8M

1 | RESEARCH

Empower renowned scientists to further their work and recommend ways to deliver fresh, healthy water around the world for generations to come.

PROGRESS 54% | GOAL $2M

2 | EDUCATION

Enable educators to utilize technology to enhance and expand education beyond the classroom.

80% remaining on our $50,000 Challenge Match Grant generously sponsored by the Colket Family Foundation.

PROGRESS 97% | GOAL $4M

3 | RESTORATION

Implement collaborations and partnerships necessary to achieve the highest level of freshwater conservation and restoration.

PROGRESS 45% | GOAL $5M

4 | BERNARD W. SWEENEY, Ph.D., EXECUTIVE DIRECTOR'S FUND

Honor the legacy of Bern Sweeney's 40+ year career and provide critical funds for centerwide initiatives.

PROGRESS 97% | GOAL $1M

5 | UNRESTRICTED PROJECTS

Afford institutional leadership the flexibility to apply funds where they are needed most.

$2,000,000 and More

Mr. and Mrs. Rodman W. Moorhead III – Director's/Restoration

$1,000,000 to $1,999,999

Meg and Dick Hayne – Restoration

$500,000 to $999,999

Cabot-Kjellerup Foundation – Restoration/Director's

John and Barbara Vogelstein Foundation – Unrestricted

$250,000 to $499,999

Mr. and Mrs. Francis H. Abbott Jr. – All Funds

Anne Stroud – Research/Director's

Mr. and Mrs. Stephen M. Stroud – Research

Mr. and Mrs. W.B. Dixon Stroud Jr. – Unrestricted/Director's

Dr. Robin L. Vannote – Director's/Restoration

$100,000 to $249,999

Anonymous – Education

Anonymous – Research

Blue Yak Foundation – Research/Education

The Boudinot Foundation – Unrestricted

The Davenport Family Foundation – Education/Restoration

David Family Charitable Remainder Trust – Unrestricted

Nathan and Marilyn Hayward – Restoration/Director's

The Leafglen Foundation – Restoration/Research/Education

Marian S. Ware 2003 Charitable Lead Annuity – Restoration/Director's

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Mrs. Elizabeth R. Moran † – Research

Mr. and Mrs. Michael Moran – Unrestricted/Director's

Morris and Boo Stroud – Director's/Research

The Marjorie P. Kraus Freshwater Fund – Research

Welfare Foundation – Research

$50,000 to $99,999

Anonymous – Education

Thomas P. Bentley Muddy Boots Fund – Education

Colket Family Foundation – Education Challenge Match

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Crystal Trust – Research/Director's

Gerry and Marguerite Lenfest – Unrestricted

The Laffey-McHugh Foundation – Restoration

Marshall-Reynolds Foundation – Restoration

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H. Donnan Sharp – Director's

Spurlino Family Foundation – Research/Research Challenge

$20,000 to $49,999

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Cabot Wellington Foundation – Restoration

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Mr. and Mrs. Michael Matz – Director's

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Marmot Foundation – Research/Director's

Oxford Area Foundation – Education

Rittenhouse Builders – Research

Allen Wise – Restoration/Director's, *in honor of Rod Moorhead*

$10,000 to $19,999

Anonymous – Education

Jessie and Richard Benjamin – Director's/Education

Maggie Brokaw – Research/Director's

Bessemer National Gift/24th Fund – Director's/Restoration

Connelly Foundation – Education

Herman O. West Foundation/ West Pharmaceuticals – Education

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Bert Kerstetter – Unrestricted/ Director's/Restoration/Research

Jane C. MacElree Foundation – Research

The McLean Contributionship – Education

Rencourt Foundation – Education/Director's

Weglicki Family Foundation – Education

$5,000 to $9,999

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Michael and Katherine Bucklin – Unrestricted/Director's

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Mr. and Mrs. Bryan Colket – Education

Mr. and Mrs. Charles Cruice – Education

Charles and Karen Dow* – Unrestricted/Director's

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George and Betsy McFarland – Restoration

Mr. and Mrs. Ranney Moran – Restoration

John and Mary Pepe* – Unrestricted/Research/Director's

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Barbara Cushing Riegel – Unrestricted

Mr. Edgar Scott Jr. – Director's

The Roemer Foundation – Unrestricted/Education

Mr. and Mrs. Robert Whetzel – Unrestricted/Director's Fund

The RJM Foundation – Unrestricted

$1,000 to $4,999

Anonymous (3) – Unrestricted

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Dr. and Mrs. Thomas L. Bott* – Director's/Research

Mary Sue Boyle – Education

Dr. Linda Carter – Director's, *in memory of Pat Hardesty*

Comer Foundation Fund: The Chicago Community Trust – Director's

A. Reeve Draper – Director's

Matt and Andrea Ehrhart* – Restoration/Director's

Dr. and Mrs. William L. Elkins – Director's/Restoration

Drs. Scott Ensign and Michelle Duval* – All Funds


A.


B.


C.

(A) Among other great foods, guests enjoy cheese from the Farm at Doe Run and apples from Barnard's Orchards at Trail Creek Outfitters' Wild & Scenic Film Festival in February. (B) From left: Umbreit Wileczek & Associates foursome Mark Wileczek, Kathy Wileczek, Holly Graber, and Chris Sotiropolous play golf on a beautiful day at Bidermann Golf Course. (C) From left: Adam Mowery, Clipper LaMotte, Richard Laird, and Sean Connolly tee off Fore Fresh Water.

Susan Ensign – Director's/Education

Robert and Marcy Fenza – Director's

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Cynthia Hewitt and Dan Holloway – Education

Patricia Kraus Holt – Research

Kristin Gamble – Unrestricted

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Denis J. Lawler – Unrestricted

Susan LeGros, Esq. – Director's/Unrestricted

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Sally Peirson and John Baker* – Restoration/Director's

David B. Reinfeld* – Director's/Education

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H. Rodney Sharp III and Lynn Herrick – Director's

Nancy and Peter Shoudy – Unrestricted

L. Peter Temple/Larmore Scarlett LLP – Director's

Sharp Foundation – Education

Stewart Huston Charitable Trust – Education

A. Roy Smith – Director's

The John Lazarich Foundation – Director's

The Magnolia Fund – Director's/Education

Brock and Yvonne Vinton – Director's/Restoration

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Peter Welling – Director's/Restoration

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$500 to $999

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Barbourtown Foundation – Director's

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David J. Callard – Director's

Davis Family Giving Fund – Restoration

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Alexandra Dow– Director's

Drs. Rush and Phoebe Fisher – Director's

Charles and Blair Fleischmann– Director's

Marilyn Forney (The Forney Family Foundation) – Director's

Dr. Mark Fortunato – Director's

Mr. and Mrs. William H. Frederick Jr. – Director's

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Matthew and Jessica Provinski* – Unrestricted/Director's

Mrs. Martha Ryan – Research

Charles P. Schutt Jr. – Director's

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Ann Percy Stroud – Director's

Octoraro Native Plant Nursery, Inc. – Director's

Passive Capital Management, LLC. – Unrestricted/Director's

The Redwoods Group Foundation – Education

$150 to $499

Anonymous – Director's

Cody Abbott – Unrestricted, *in honor of Franny Abbott*

Max Abbott – Unrestricted, *in honor of Franny Abbott*

Tres Abbott – Unrestricted, *in honor of Franny Abbott*

Tylee Abbott – Unrestricted, *in honor of Franny Abbott*

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Up to $149

We are very grateful to 117 donors for their contribution.

Please contact President and Executive Director David B. Arscott at 610-268-2153, ext. 278, or darscott@stroudcenter.org to inquire about making a gift, multiyear pledge, or to review naming opportunities and available challenge grants.

Financials

OPERATING STATEMENT

for the year ended December 31, 2020

REVENUES & SUPPORT	
Endowment	$ 1,721,826
Watershed Restoration	1,641,138
Research Programs (Grants and Contracts)	1,623,304
Other Contributions and Income	1,188,604
Annual Fund	473,011
Education/Public Programs	410,577
Total Revenues & Support	$7,058,460

EXPENDITURES	
Research	$ 2,334,989
Watershed Restoration	1,516,065
Facilities	1,194,028
Finance and Administrative	695,600
Information Services	438,619
Education	430,380
Development/Outreach	372,153
Communications	48,884
Other	27,742
Total Expenditures	$7,058,460

Financial Information

Stroud™ Water Research Center is a 501(c)(3) nonprofit organization registered with the Pennsylvania Bureau of Charitable Organizations. Gifts to Stroud Water Research Center are tax deductible on a U.S. return as allowed by law. The Stroud Water Research Center Employer Identification Number (EIN) is 52-2081073. The fiscal year is January 1 to December 31. The annual audit is performed by Belfint, Lyons & Shuman. Investment assets are managed by New Providence Asset Management, Passive Capital Management, and Brown Advisory. The Stroud Center is also the beneficiary of the Morris W. Stroud 3rd Pennswood No. 2 Trust managed by the Glenmede Trust Company.

Privacy Statement

Stroud Water Research Center donor records are not sold, bartered, leased, exchanged, or otherwise provided to any outside organizations.

SECURING THE FUTURE

Your continued generosity through annual, endowed, and planned gifts is vital to our research, education, and watershed restoration programs. Below is a brief list of ways you can make a tax-deductible gift:

ONLINE

Visit www.stroudcenter.org/donate

CASH OR CHECK

Please mail donations to:
Stroud Water Research Center, 970 Spencer Road, Avondale, PA 19311

CREDIT CARD

Stroud Water Research Center accepts VISA, Mastercard, and American Express. Credit card gifts can be made as a one-time gift or as a monthly or quarterly contribution.

STOCK

Gifts of appreciated securities are an outstanding way to avoid 15 percent capital gains tax. Prior to transferring assets, please contact Stroud Water Research Center Development staff, since no name will be attached to the deposit of funds. Your broker can use this information:
Charles Schwab & Co.; DTC Clearing Number: 0164 – Code 40
Account name: Stroud Water Research Center; Account number: 1749-3778

WIRE TRANSFER

Funds may be wired directly to Stroud Water Research Center's financial institution. Please contact the development department for instructions.

PLANNED GIVING

A planned gift can meet your short-term or long-term charitable and financial goals. Planned gifts include, but are not limited to, bequest intentions, charitable gift annuities, IRA payments, retirement plan assets, insurance policies, and other various trusts to fit your needs.

CORPORATE MATCHING GIFT

Several companies match an employee's personal charitable contribution. Double your gift by simply asking your HR person if your company participates in a gift-matching program.

MEMORIAL AND HONOR GIFTS

Remember a friend, neighbor, or loved one with a gift in his/her name. All tributes will be listed in the annual report, and when an address is provided, a letter will be sent on your behalf.

Please visit our website: www.stroudcenter.org or contact Associate Director of Special Events and Corporate Relations Jessica Provinski at 610-268-2153, ext. 288, to learn about special giving opportunities.

get involved To learn how you can get involved, go to www.stroudcenter.org/volunteer.

Left: Clean Water Paddle Push participant Betsy Pinsky enjoys a day on the water at Trap Pond State Park. Right: Volunteers from Southern Chester County Chamber of Commerce Young Business Leaders help plant 675 trees. Photo: Casey Smith

Sponsors and Volunteers

We gratefully acknowledge and appreciate all of our sponsors and volunteers, especially our staff members who volunteer on top of their other responsibilities. By generously donating time, talents, or treasures, this dedicated group directly benefits our research, education, and watershed restoration programs. *Thank you!*

Celebrate the 2020 River of the Year: Delaware River Webinar Series

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Clean Water Paddle Push

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WHITEWATER SPONSOR

American Pension

ALL ABOARD SPONSORS

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Virtual Science Seminar Series II: The Hidden World of Stream Insects

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Virtual Science Seminar Series III: Better Gardens, Better Soils

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Wild & Scenic Film Festival

Hosted by Trail Creek Outfitters

We are grateful to the many sponsors, volunteers, and attendees who make this event so successful.

Fall Tree Planting

SPONSORS

Colonial Pipeline

TreeVitalize

VOLUNTEERS

Voya Financial

Southern Chester County Chamber of Commerce Young Business Leaders

Plus many individual volunteers for whom we are very grateful.

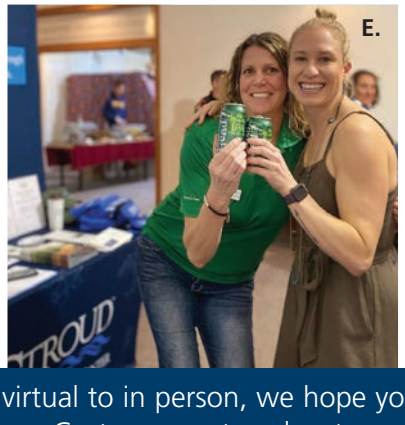
Ashley Spotts from Chesapeake Bay Foundation helps plant trees on a farm in Lancaster County, Pa.

A.

B.

C.

D.



E.

F.

join us! From virtual to in person, we hope you'll join us for fabulous events this year. Go to www.stroudcenter.org/events to learn more.

(A) Film crew hard at work recording the presentation of the 2020 Stroud Award for Freshwater Excellence. Executive Director David B. Arscott in foreground, board co-chairman, Porter Schutt in stream with award. (B) Presenting sponsors of the Fore Fresh Water Golf Invitational, Rod and Alice Moorhead enjoy a socially distanced day on the green with son, Rod Moorhead IV. (C) Stroud Center staff dined to donate at Victory Brewing Company in August. (D) From left: Glenn Marshall, Shane Stolzer, Anthony Civitello, and Matt Provinski of First Resource Bank tee off in September at Bidermann Golf Course. (E) Remember when we were able to cheers with friends? (F) Jim Petro III and his father, Jim Petro Jr., from Triple Fresh Market serve up sliders to guests at Trail Creek Outfitters' Wild & Scenic Film Festival in February. This event equally benefits the Stroud Center and The Land Conservancy for Southern Chester County.

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David Wise
Watershed Restoration Manager

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Watershed Restoration Program Assistant

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Senior Research Scientist Emeritus

J. Denis Newbold, Ph.D.
Research Scientist Emeritus

Bernard W. Sweeney, Ph.D.
Distinguished Research Scientist Emeritus

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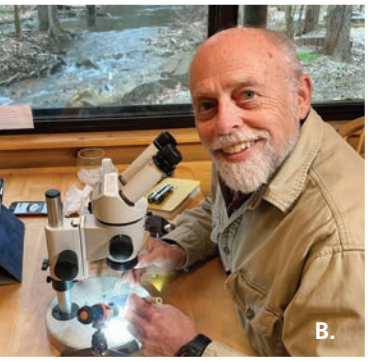
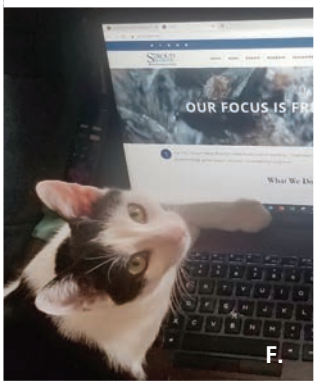
Adjunct Research Scientist, LimnoTech

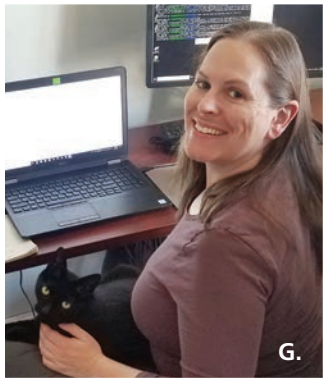
Barry M. Evans, Ph.D.
Adjunct Research Scientist, Penn State University

Nanette Marcum-Dietrich, Ph.D.
Adjunct Education Faculty, Millersville University

* *The Maritza Biological Station staff is employed by the Asociación Centro de Investigación Stroud, a nongovernmental organization in Costa Rica that serves as the umbrella organization for all of the Stroud Center's research and education activities in Central and South America.*







(A) Rebecca Duczkowski helps plant trees on a sunny day. (B) Dave Funk identifies mayflies from local streams near his secluded cabin near the Buffalo River in the Ozarks (photo: Barbara Funk). (C) Dave Arscott and his dog, Teddy, canoe on Grand Lake in Michigan. (D) Vince O'Donnell, part-time educator, instructs a virtual herpetology class for the Pennsylvania Master Naturalist program. (E) Libby Gregg and Denis Newbold play their flutes during a lunchtime concert series for Stroud Center staff. (F, G, K) Furry friends and young helpers provide welcome companionship while staff work remotely during the coronavirus pandemic: (F) Mandy Nix's cat, Magpie, and (G) Laura Zgleszewski's cat, Sprocket, patiently await friendly scratches (photo G: David Zgleszewski). (K) Jinjun Kan's daughter, Zoe, looks over her father's work (photo: Tracy Sun). (H) Sherman Roberts carries gear into the field. (I) Jan Battle and Courtland Hess enjoy boating while safely practicing mask wearing and social distancing. (J) Lisa Blazure measures water infiltration using a double-ring infiltrometer.

Board of Directors

2020

**At the December 2020 board of directors meeting, the board acknowledged the many years of dedicated service of Rodman W. Moorhead III and Carol Ware, Ph.D., and each were granted emeritus status.*

STROUD™ WATER RESEARCH CENTER

ADDRESS SERVICE REQUESTED

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Avondale, PA 19311-9514
USA

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610-268-0490 Fax
www.stroudcenter.org

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our mission

Stroud™ Water Research Center seeks to advance knowledge and stewardship of freshwater systems through global research, education, and watershed restoration.