A | STEM EDUCATION EXPANDED FOR WOMEN
Stroud Center educators are working to build diversity and bridge gender gaps in freshwater-focused science, technology, engineering, and math (STEM) through a new Girls-in-STEM Education Programs Fund.

B | THE WATER'S EDGE
The Stroud Award for Freshwater Excellence was presented to Chad Pregracke, founder of Living Lands & Waters, at Longwood Gardens on September 17, 2019 by Porter Schutt, board co-chair, Bill LaFond, Wilmington Trust (presenting sponsor), and Dave Arscott.

C | RESEARCH
Stroud Center scientists simulate rain to perform cutting-edge research on the links between farming practices and healthy streams.

D | STREAM WORKSHOP
The Watershed Restoration Program hosts a stream and buffer ecology workshop to share the impacts of best management practices, like buffers, on stream health.

E | MASTER WATERSHED STEWARDS
Dave Bressler leads a training in a Plum Run tributary at the Berks Ag Center in Berks County, Pa, in association with the Delaware River Watershed Initiative.

Front cover photo: Stroud Center field tech, Joey Roberts, installing soil moisture sensors in the fields of the Rodale Institute’s Farming Systems Trial with Dr. Atanu Mukherjee, one of our collaborators at Rodale Institute. The research area at Rodale mirrors our Stroud Preserve study site. These sensors measure soil moisture content over multiple depths and provide data for the William Penn Foundation-sponsored Farming Practices collaborative research effort between Stroud Water Research Center and Rodale Institute. These data allow us to quantify how the soil in fields is managed using different farming practices that respond to rainfall events.

Back cover photo: In partnership with the Coatesville Youth Initiative’s Brandywine Discovery Day Camp, Stroud Center’s education department helped campers explore their local watershed. The week-long camp was filled with fun stream exploration activities to gain traditional ecological knowledge, as well as learn about their important role in cultivating a bright healthy future for the Brandywine and all life within it.
As I write this letter today, reflecting on our 2019 accomplishments, we are in the midst of the Covid-19 pandemic that has engulfed all our lives. On behalf of everyone here at the Stroud Center, we send our best wishes to everyone affected. Through this ordeal, we have gained further perspective on how globally connected we are to each other; it is truly a small world we live in. As businesses are told to close or reduce services and we all practice social distancing, we reflect on the impact of our actions. It is a time to learn rapidly and adjust our personal and business norms, so we can act collectively, as a community, to slow down the spread of a virus that has taken many of us by surprise.

At the Stroud Center, we have long recognized that having a healthy and vibrant environment depends enormously on the global community to make decisions based on the best scientific knowledge we have. Freshwater ecosystems are, of course, critical to maintaining human health and prosperity. We have also long recognized that we cannot achieve sound scientific advancements and understanding without a broad network of dedicated science colleagues and an engaged and supportive community. This theme is highlighted in all our programs, from freshwater research to environmental education to watershed restoration.

The Stroud Center will be resilient in our resolve to enter this new world with fresh sustenance, thanks to your continued support and the strong community that interacts with us, for which I am so grateful. Our staff and board of directors, colleagues, supporters, and the public have shown great curiosity, appreciation, and generosity for our work. You all help us to continue our mission to enhance knowledge and stewardship of freshwater systems worldwide. Thank you all so much for your interest and your support!

“The environment and the economy are really both two sides of the same coin. If we cannot sustain the environment, we cannot sustain ourselves.”

— WANGARI MAATHAI

what you can do
Implement ways to reduce your carbon footprint and reduce water use.
Visit stroudcenter.org for more information

Executive Director, President, and Research Scientist
Research can no longer be confined to the laboratory. Scientists must be engaged with the outside world. To truly make a difference requires, not only understanding freshwater systems, but working with all kinds of communities to protect them.
Stream Reach

BUILDING COMMUNITIES FROM WHITE CLAY CREEK TO THE YANGTZE BASIN

By James G. Blaine, Ph.D.

Let’s begin in White Clay Creek, in which Stroud Water Research Center scientists have waded for more than 50 years. The knowledge Stroud Center scientists have gained flows out from this small stream to the world, mingles with the work of others, and then flows back to the Stroud Center, carrying fresh ideas and new hypotheses. It’s a story of going out and returning, told here through the voices of five scientists from diverse backgrounds and different disciplines, all working to build disparate communities with a single mission: to advance knowledge and stewardship of freshwater systems.

"The Stroud Center doesn’t advocate. We educate."

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

For more than 30 years, John Jackson’s macroinvertebrates have traced the impact of humans on stream health. His current research involves salt, which Americans spread on their roads in massive amounts. Pennsylvanians alone use more than 900,000 tons a year, and the ensuing runoff he says, “contaminates not only our streams, but increasingly our groundwater.” There are several reasons why salt use has doubled since the 1990s (and quadrupled since the 1970s), but the overriding motivation is public safety – and the political pressure to quickly clear winter roads. The problem, says Jackson, is that “we now apply salt as if it has no environmental, human health, or infrastructure consequences.” But it does: polluting our water and eroding our infrastructure carry huge, often underestimated costs.

Other kinds of salt have also increased dramatically, such as carbonate from mountaintop mining, salt sequestered in shale deposits released by fracking, agricultural runoff, and industrial waste. Elevated salt even contributed to the mobilization of lead that poisoned the drinking water in Flint, Michigan.

Jackson believes that Pennsylvania could reduce its salt use by 50% without sacrificing safety. That decision, however, is not his to make. His role is to get his data into the public arena, which he does through peer-reviewed journals, workshops, and expert testimony – and all by engaging with as many people as he can. “I’ll talk to anybody,” he says. “Anybody.”
The Stroud Center and Rodale Institute are in year two of a six-year, $6 million grant from the William Penn Foundation. The project compares four agricultural methods on four plots at the Stroud Preserve: conventional, conservation (no-till with a cover crop), organic tilling, and organic no-till. “Our hypothesis,” says Diana Oviedo-Vargas, who leads the Biogeochemistry Group, “is that improved agricultural practices will produce better soil and better crops with less risk for the farmer, resulting in healthier streams and cleaner water. The Stroud Center team is focused on everything related to the water. Rodale is focused on everything related to the soil.”

The scientists are measuring a number of changes over time: surface water and nutrient runoff in the farm fields, soil quality and filtration, nitrogen, and pesticide levels in the stream. Those changes may be small, but “farms cover so much land across the country,” says Oviedo-Vargas, “that small changes can have a big cumulative impact.” The goal is to improve agricultural practices, reduce environmental impacts, and increase profitability.

Because the search for practical solutions leads the researchers beyond science, Meadow Springs Farm, and farmer, Jamie Hicks are an essential piece of the project. The fourth generation local farmer “knows the area and is experienced in all four agricultural methods,” says Oviedo-Vargas. “We need to find the most appropriate practices that are least expensive for farmers.”

Freshwater scientists have long chronicled the destructive effects of the Army Corps of Engineers’ massive river-engineering projects. But fluvial geomorphologist Melinda Daniels sees the old ways giving way to a strong interest in ecosystem restoration and nature-based design within the Corps. That, she says, is “a huge culture change.”

Daniels sits on the Department of Defense’s Army Science Board, where she brings an outside scientist’s perspective to the deliberations, helping to review policies and suggest changes. “I know what the old low-head dams do to a river. I know why it’s good to remove them,” Daniels says. “Change comes slowly, however, and while the Corps is often the public villain, Congress controls the money, and politicians still determine priorities. To have an impact, it’s no longer enough to understand the science. You must also understand the politics,” she says.

Much of Daniels’ research focuses on sustainability. She knows that community decisions are critical, yet she says, “too often the most vulnerable people are also the most resistant to science. Add climate change to the mix, and you have really scary scenarios.” Yet along with resistance to science, she has witnessed land ethics deeply ingrained in local cultures. We must listen to, and participate in, our communities, she says. “Policies imposed from the top, ignorant of local culture, rarely succeed. Changes will only happen if we, as scientists and managers, are active in, members of, and open to the community itself.”

Scientists come to the Stroud Center from across the globe. John Jackson was born in Colorado, Diana Oviedo-Vargas in Costa Rica, Melinda Daniels in Hawaii, Marc Peipoch in Spain, Jinjun Kan in China, and their personal journeys are as varied as their backgrounds. But there is an overarching theme to their work: that research can no longer be confined to the laboratory, scientists must be engaged with the outside world, and to truly make a difference requires not only understanding freshwater systems, but working with all kinds of communities to protect them.
Sometimes communities arise serendipitously. **Marc Peipoch**, an aquatic ecologist who studies the growth of algae in the Brandywine River, wanted to protect his water sensors. So he asked the City of Wilmington’s water utility if he could install them on its premises. In exchange, he offered to share his data.

From that conversation arose a relationship that benefits the scientist, the utility, and 110,000 water consumers in Delaware. Peipoch hadn’t anticipated being part of such a community. “I just didn’t want my sensors stolen,” he says. As for the water company, its interest was economic, not scientific. “The cleaner the water they take from the river, the less they need to spend on filters.”

As they pursue their own ends, but realizing that each goes hand-in-hand, the scientist and the utility’s staff continue to explore new ways to work together. Peipoch will soon monitor the reservoir, which periodically suffers from algal bloom. “It’s a great ‘natural’ project for me, and my data can provide an early warning system for them,” he says. What began as basic research has evolved into an unexpected community of interests. And that has spurred Peipoch to pay more attention to the world beyond the stream: “I have become increasingly interested in interdisciplinary collaboration and the study of socio-ecological systems” – that is to say, of communities.

The Yangtze, which flows 4,000 miles from Tibet to the East China Sea, is the largest river in Asia. Its watershed is home to 10 big cities and more than 400 million people. Its waters teem with nitrogen, phosphorus, and microorganisms. Microbial ecologist **Jinjun Kan** wants to know where all those nutrients and microbes go and how they impact the Yangtze’s water, its estuary, and ultimately, the ocean. The questions he and his colleagues are asking have enormous implications, not only for China, but for the world’s oceans and the earth’s atmosphere.

Kan’s collaboration with his Chinese colleagues is mainly focused on freshwater science and estuary ecology. “Our work is about sharing ideas and learning from each other,” he says. “Water is a big issue there, and we want to do the research, answer the question, and share our results with the watershed communities.”

Their work flows in both directions. Kan and his Chinese collaborators have recently embarked on a new study comparing conditions in China’s Pearl River Basin with those in the Chesapeake Bay 7,500 miles away. Their findings, he hopes, will lead to a better understanding of the issues affecting heavily urbanized watersheds everywhere. “Creating international communities of scientists and communicating our scientific discoveries,” he says, “is critical to protecting water resources worldwide.”

**“They just wanted to save money.”**

– Marc Peipoch, Ph.D., Assistant Research Scientist, Ecosystem Ecology Group

**“All water is connected.”**

– Jinjun Kan, Ph.D., Associate Research Scientist, Microbiology Group
“Every student gained a greater understanding about the importance of our watershed and the various threats that can impact the quality of our water system.”

— JOE DELL’ARCIPIRETE, 6TH GRADE SCIENCE TEACHER, STETSON MIDDLE SCHOOL, WEST CHESTER, PENNSYLVANIA
Nestled within the Brandywine, Chester, and Ridley Creek watersheds and a stone's throw from Stroud Water Research Center, West Chester Area School District (WCASD) serves a 75-square-mile region in central Chester County, Pennsylvania. Here, the district is known for its diversified businesses and historic countryside in suburban, urban, and rural communities. Each day, the hallways of its 10 elementary schools, three middle schools, and three high schools are flooded with nearly 12,000 students from the West Chester Borough and seven surrounding townships.

“The district values student acquisition of knowledge, concepts, and skills necessary to succeed in an ever-changing, 21st century, global society,” says WCASD Science and Technology Education Supervisor Paul Joyce, Ed.D. “This includes global citizenship among our students, which transfers directly to the need for watershed education and stewardship.”

The district’s commitment to high-quality watershed education and stewardship led them to the Stroud Center in the spring of 2017, when a group of WCASD teachers and administrators toured the Stroud Center’s LEED Platinum building, streamside outdoor learning stations, and experimental watershed, to learn about the educational opportunities offered by the Stroud Center’s education department.

“There was no question of whether we should work with the Stroud Center. The power of that potential partnership was clear,” recalls Joyce. “The debate was where to start and how to cultivate and maximize a relationship with an organization that had so much to offer to our K-12 students.”

A Partnership Begins by the Thousands

Following this visit, the district leadership launched a series of collaborative meetings that led to a first experience for WCASD students. Throughout the fall of 2017, 1,000 WCASD fourth-graders swarmed the Stroud Center for hands-on stream study programs. Stroud Center educators and WCASD staff worked collaboratively to ensure the programs enhanced WCASD curriculum, while also engaging students in inquiry-based learning designed to meet Pennsylvania State Academic Standards.
Students learned about human impacts on watersheds while exploring stream habitats, studying adaptations of aquatic macroinvertebrates, and collecting real data on forest restoration projects. They recorded their investigations in stream study field notebooks, a significant contribution to the district’s literacy expectations.

“The field notebook is grade-appropriate and helps us model good science practice,” says Rene Rodríguez, the science advocate at Westtown Thornbury Elementary. “I have been very impressed with the quality of experience that the Stroud Center has provided our students. The [educators] are very knowledgeable and experienced working with elementary students; this is evident in how they relate with the children.”

By 2018, the Stroud Center had become an annual outdoor field experience for fourth graders across the district that did not end when students departed the Stroud Center. Instead, WCASD administrators like Joyce collaborated with Stroud Center educators to craft a four-day mini-unit for fourth-grade students before and after their field trip.

“This corresponds with our philosophy that while one-time visits to environmental education centers are valuable, more learning can be achieved,” says Joyce. “By creating a full unit that corresponds to the one-day field experience at the Stroud Center, we provided more opportunities for educational relevance, such as students’ deeper understanding of the concepts and stronger connections to real-world science.”

The Partnership Expands

With the organizations’ feet wet for community-driven partnership, Joyce collaborated with Steve Kerlin, Ph.D., Stroud Center director of education, to expand student learning beyond the fourth-grade level. Together in 2018, Joyce and Kerlin submitted an environmental education grant proposal to the Pennsylvania Department of Environmental Protection (DEP) to grow watershed education capacity for WCASD’s middle school watershed education curriculum. The proposal was successful, with the awarded grant now funding forest enhancement efforts and an outdoor water quality education center at Stetson Middle School.

“We’re excited that the grant not only supports student-focused watershed education and stewardship at Stetson Middle School,” says Kerlin. “It also funds WCASD’s revision of the watershed education curriculum for sixth graders across the district, with every teacher participating in this curricular revamp and Stroud Center educators lending our own unique perspectives.”

In spring of 2019, 300 sixth-grade students participated in DEP-funded action projects to remove invasive species and plant more than 300 native trees, one tree for every Stetson Middle School student, followed by a field trip to the Stroud Center to bring their learning full-circle.

“Stroud Water Research Center was exceptional,” recalls Joe Dell’Arciprete, sixth-grade science teacher at Stetson Middle...
School. “Every student gained a greater understanding about the importance of our watershed and the various threats that can impact the quality of our water system. The staff provided an excellent program that was engaging for all of our students.”

The next phase of the grant includes the design and building of three outdoor classrooms by WCASD students and staff, including interpretive signs to help the community interact directly with the watershed.

Meanwhile, 120 eighth graders from WCASD visited the Stroud Center for field experiences in 2019, and at the high school level, the partners are integrating watershed education into the biology curriculum and developing a new elective course on freshwater ecology. WCASD high school biology teachers visit the Stroud Center for field trips of their own, gaining professional development during orientations to the WikiWatershed Toolkit, exposure to related freshwater learning tools, and shadowing of Stroud Center education programs.

Watershed Education in One District Leaves a National Footprint

The partnership that began in one school district is growing further through the Pennsylvania Watershed Education Task Force, an initiative of the NOAA-funded Pennsylvania Environmental Literacy and Meaningful Watershed Educational Experience (MWEE) Programming Capacity-Building grant project for which Kerlin is the project lead. Joyce was selected as a Task Force representative in 2017.

“The partnership between WCASD and the Stroud Center education department has become a model for building formal and non-formal education partnerships in systemic watershed education,” says Kerlin, who collaborated with Joyce to design and lead the first NOAA-funded Pennsylvania Environmental Literacy and Meaningful Watershed Educational Experience (MWEE) training for Pennsylvania school administrators.

“The partnership between WCASD and the Stroud Center education department has become a model for building formal and non-formal education partnerships in systemic watershed education,” says Kerlin, who collaborated with Joyce to design and lead the first NOAA-funded Pennsylvania Environmental Literacy and Meaningful Watershed Educational Experience (MWEE) training for Pennsylvania school administrators.

THE SHARED VISION OF BOTH PARTNERS: SYSTEMIC AND SCAFFOLDED K-12 EDUCATION THAT follows STUDENTS AND STAFF THROUGH EVERY STAGE OF LEARNING.
We are particularly active with farmers. They manage nearly a billion acres in this country, and restored habitats on their farms can transform the landscape.”

— Lamonte Garber, Watershed Restoration Coordinator, Stroud Water Research Center

Restoring the River Continuum Community

By James G. Blaine, Ph.D., and Lamonte Garber


The publication of the River Continuum Concept 40 years ago changed forever the world’s understanding of streams and rivers. In it, the Stroud Center’s Robin Vannote and his colleagues describe the river itself, from its headwaters to its mouth, as a single, albeit ever-changing, community of living organisms. Indeed, the entire watershed, land and waters, is to be understood as an interconnected community in which a change to one part ripples through the entire system.

For millions of years before the advent of human civilization, rain fell to earth and then moved through a matrix of forests, wetlands, and thriving streams and rivers before ending its journey in one of the planet’s five oceans. Recreating parts of this once-massive “green sponge” on our heavily deforested, farmed, and developed landscape is both the art and science of restoration. It is also, as we will see on the next two pages, critical for the protection of clean water.

Because the Stroud Center’s Robin L. Vannote, Ph.D., Watershed Restoration Program believes that humans are a central part of the watershed community, the staff works with our partners and land users to implement natural solutions to regenerate soils and safeguard fresh water, solutions that benefit both human communities and the entire ecosystem. “We are particularly active with farmers,” says Lamonte Garber. “They manage nearly a billion acres in this country, and restored habitats on their farms can transform the landscape and contribute constructively to issues ranging from soil health to climate change.”

Stroud Water Research Center works hand in hand with landowners, helping them use their land more effectively through whole-farm planning and watershed stewardship. Visit stroudcenter.org/restoration for more information.
“HE SAW THAT THE WATER CONTINUALLY FLOWED AND YET IT WAS ALWAYS THERE; IT WAS ALWAYS EVERY MOMENT IT WAS NEW.”

— HERMAN HESSE, SIDDHARTHA
The words and pictures on these pages trace the life of a stream from the forested highlands where it begins to the ocean into which it ultimately flows. Along the way, a stream passes through a variety of land uses and habitats that are essential for clean, fresh water. In addition to restoring and protecting these and other natural resources, we must continue to take actions to reduce pollution, including advances in sewage treatment, stormwater management, and agriculture.

1 | Forests
Forested watersheds produce cleaner fresh water than any other land use. We need to preserve existing forests, restore previously wooded lands, and sustainably manage timber.

2 | Wetlands and Meadows
These ecosystems are critical habitat for many plants and animals. They support pollinator plants, recharge freshwater sources, mitigate flooding, and protect endangered wildlife.

3 | Healthy Soils
Healthy soils on cropland and pasture improve water infiltration and reduce runoff. No-till planting and cover cropping also improves agricultural productivity.

4 | Well-Managed Farms
Structural and management improvements on farms – including contour planting, grass waterways, and filter strips – control erosion and reduce runoff to streams.

5 | Riparian Forested Buffers
Streamside trees are the life-support system for streams and rivers, providing shade, food, and habitat for all life. Trees are the essential “cover crops” for our floodplains.

6 | Backyard Habitat
Homeowners can help restore watersheds by replacing lawns with wildflower meadows, capturing rainwater, and using native plants, which also support pollinators and birds.

7 | Healthy Streams and Rivers
The capacity of streams and rivers to process pollutants in the water, from neutralizing nitrogen to consuming organic matter, is a crucial ecosystem service, which sends cleaner water downstream and reduces the treatment costs of our drinking-water supply systems.

8 | Green Infrastructure
Communities can implement rain gardens, pervious pavements, green roofs, and street trees to reduce the volume of stormwater reaching streams and sewage treatment plants.

9 | Woody Debris
A tree that falls into a stream bestows its final gift to the ecosystem, creating new fish habitat and a more diverse streambed. Fallen trees should be removed only if they are a hazard.

10 | Submerged Grasses and Salt Marshes
Restoring submerged aquatic vegetation is key to restoring estuaries like Chesapeake Bay. These underwater meadows are nurseries for young fish and crabs, provide food for waterfowl, and slow erosion.

11 | Bays and Oceans
Every stage of the stream's journey impacts the ocean into which it ultimately flows. Reducing pollution, combined with restoring diverse natural habitats - such as oyster reef replenishment pictured here - is critical to the health of the entire system.
Research Projects

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

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

Funded by: Phoebe A. Driscoll and the Phoebe Internship Fund
Bennetts Run is a small tributary to Brandywine Creek in southern Chester County, Pennsylvania, including portions of Kendal-Crosslands Communities and Longwood Gardens. This study focuses on more upstream segments, using water chemistry, temperature, aquatic macroinvertebrates, and fish to quantify the condition of Bennetts Run as it exits Longwood Gardens and enters Kendal-Crosslands, and then again when it exits the Kendal-Crosslands property.

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 was created to preserve the extensive natural, historic, and scenic resources harbored by the property and to facilitate appropriate study and use of those resources. Its forests, shrublands, meadows, and hayfields offer important habitat for local and migratory wildlife and ensure replenishment of groundwater that supports the many water sources feeding Doe Run. This study quantifies the condition of Doe Run and its tributaries as they enter and exit the sanctuary based on water chemistry and aquatic macroinvertebrates at 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

Brandywine Stream Stewards: Community Action in Support of Healthy Waters

Funded by: William Penn Foundation
The Stream Stewards Program, centered on 1,100 acres of open space in the First State National Historical Park, engages the community and targets youth from Wilmington in a sustainable citizen science program. It contributes to land and water management through monitoring water resources and education programs that lead to conservation action. Another goal of the program is to create a replicable citizen science model that develops a committed and active constituency for watershed protection.

Principal Investigators: The Nature Conservancy – Delaware Chapter, John K. Jackson, and Matthew J. Ehrhart
Collaborators: Jinjun Kan, Melinda D. Daniels, and David B. Arscott

CNH: Coupled Climate, Cultivation, and Culture in the Great Plains: Understanding Water Supply and Water Quality in a Fragile Landscape

Funded by: National Science Foundation
This collaborative project develops a model to predict the potential impact of climate variability, climate change, land use, and human activity on water resources across decades and centuries in the Central Great Plains of North America. It also identifies the most effective strategies to achieve sustainability and optimize policy.

Principal Investigator: Melinda D. Daniels
Collaborators: Marcellus Caldas, Jessica Hein-Stamm, Jason Bergtold, Aleksey Sheshukov, Martha Mather, and David Haukos (Kansas State University)

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

Funded by: National Science Foundation
Caddisflies and other net-spinning macroinvertebrates attach gravels to one another within the streambed. These attachments result in more force required for flowing water to move the gravels, limiting erosion and creating a more stable habitat for biofilm and other macroinvertebrates. Researchers are running laboratory experiments in experimental streams, conducting field experiments and surveys, and modeling the landscape-scale effects of these tiny ecosystem engineers on stream-ecosystem processes. Education staff are developing learning resources and leading 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)


Funded by: William Penn Foundation
This project collects and interprets data on macroinvertebrate specimens from stream sites to provide a baseline for the evaluation of goals defined for restoration and protection projects funded by the William Penn Foundation in its efforts to restore and protect water quality 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, Donald F. Charles, 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 represents 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: Pennsylvania Department of Environmental Protection
Chloride concentrations in surface waters have been increasing over the last several decades at multiple locations throughout the United States. At times, it appears that ambient chloride concentrations now reach levels that may have a negative effect on aquatic organisms. This project measures responses of four mayfly species exposed to elevated chloride concentrations at temperatures that range from 5–25 degrees Celsius.
Principal Investigators: John K. Jackson and David H. Funk

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 newly established transition to organic farming at the Stroud Preserve, it examines the consequences of farming techniques for water infiltration or runoff, and nutrient, contaminant, and sediment export. The findings will be used to inform practices that can reduce contamination and flooding in the Delaware River Watershed. Results will be disseminated through scientific publications, public messages, and training events.
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, and Diana Martin (Rodale Institute); Raven Bier

Experimental Streamside Forest Restoration to Improve Water Quality – Ranch at Doe Run
Funded by: TreeVitalize Watersheds, a partnership between the Pennsylvania Department of Environmental Protection and the Pennsylvania Horticultural Society
This project involved an experimental planting of 900 trees and shelters on 2.75 acres of riparian land along a headwater tributary of the Brandywine Creek in East Fallowfield Township, Pennsylvania. The project was designed to test the long-term effectiveness of three types of tree shelters (Plantra, Combitube, Tubex) on growth and survivorship of six species of trees.
Principal Investigators: Bernard W. Sweeney
Collaborators: Wilmington Trust, Lincoln University, Southern Chester County Chamber of Commerce, Exelon Generation

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
In this project, we test 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)

Long-Term Research in Environmental Biology (LTREB): River Ecosystem Responses to Floodplain Restoration
Funded by: National Science Foundation
After 25 years of litigation, ecological restoration is recently under way in the Upper Clark Fork River, Montana. The restoration includes removal of metal-laden floodplain soils, lowering of the floodplain to reconnect it with peak flows, and re-vegetation of over 70 kilometers of river riparian system. This LTREB project capitalizes on long-term monitoring data to address how river ecosystem structure and function respond to the simultaneous influences of changing nutrient abundance and large-scale floodplain restoration. Comparisons of past and future dynamics of the river provide an opportunity to address fundamental theories of ecology in response to a system manipulation of rare scope, and provide an empirical and theoretical framework for understanding effects of massive-scale floodplain manipulation that will be applicable to future river restoration projects.
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.
Fluvial Geomorphology technician Joey George installs a rainfall simulator sampling frame in one of our experimental crop fields.

Yet long-term monitoring of its effectiveness is virtually nonexistent. Stroud Center scientists are studying restoration within White Clay Creek that involves the reforestation of meadows or pastures with native deciduous trees and the removal of invasive plant species. As the planted forest matures, researchers characterize the changes in the aquatic biological communities and their associated activity. Teachers are trained in the use of long-term environmental data as a means to enhance math skills, analytical abilities, and environmental knowledge of both 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

**Low-head Milldams as Hotspots for Denitrification and Nitrogen Consumption: Hydrologic and Biogeochemical Controls**  
**Funded by:** National Science Foundation  
Dam removal, especially low-head milldams, have increased in recent years with the highest removal rate 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., Mississippi River, Mo., 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  
Starting in the summer of 2011, Stroud Center scientists deployed glass slides into three reaches of White Clay Creek with distinct streamside land uses: mature forest, restored but immature forest, and meadow from upstream to downstream; microbial biofilms colonized the glass slides. Molecular DNA fingerprints demonstrated variations of biofilm population structures on both natural surface and glass slides. Comparing the results from other projects, the Stroud Center found that the surfaces on which microorganisms grow may be one of the most important environmental drivers for the growth of microorganisms.

**Principal Investigator:** Jinjun Kan

**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 Freshwater and Estuaries**  
**Funded by:** Southern University of Science and Technology (SUSTech), China  
Compared to other microorganisms, we know very little about Archaea in our backyards. However, they may play important roles in ecosystem functions and nutrient cycling (e.g., ammonia oxidation). Applying cutting-edge molecular approaches, we will characterize community composition and spatiotemporal distribution of Archaea in White Clay Creek, Costa Rica, the Chesapeake Bay, and Pearl River estuaries.

**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  
For this project, scientists are monitoring 37 sites distributed among 10 parks in the National Capital Region Network. At each site, our team performs a standard biological stream monitoring to characterize water quality, habitat integrity, and fish populations. The findings of this project are directly influencing conservation and management decisions by the National Park Service.

**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  
Using high-frequency sensors, canoe field trips, and watershed monitoring, our team is trying to understand how much and how fast can algae grow in the water column of the Brandywine River. We are monitoring temperature, dissolved oxygen, nutrient concentrations, and chlorophyll abundance at multiple locations of the Brandywine River to understand how suspended algae respond to stormflow and how much they contribute to the overall ecological function of river ecosystems. A closer look is given to the effects of 12 consecutive dams near the river’s mouth on the growth of suspended algae to predict future changes in the river now that some of them are or will be removed.
Principal Investigators: Marc Peipoch, Scott Ensign, and Diana Oviedo-Vargas

Significance of Streambank Legacy Sediments as Nutrient Sources and Their Implications for Aquatic Nutrient Cycling

Funded by: U.S. Department of Agriculture
The potential for streambank legacy sediments as nutrient sources for aquatic ecosystems has been understudied and is a critical gap in our knowledge. We hypothesize that erosion of streambank legacy sediments, especially from mid-Atlantic and northeastern watersheds, will result in substantial inputs of nitrogen and phosphorus to receiving waters. Contribution of legacy sediments/nutrients to sediment loads suspended by storm events will be determined using mixing models based on elemental, isotopic, biomarker, and microbial fingerprints and next-generation sequencing techniques.

Principal Investigator: Jinjun Kan
Collaborator: Shreeram Inamdar (University of Delaware)

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

Funded by: Starrett Foundation
Scientists monitored fecal indicator bacteria 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 Mayfly Sensor 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

Transforming Water Quality in the Sharitz Run Headwaters of Brandywine Creek

Funded by: Pennsylvania Department of Environmental Protection
This Watershed Renaissance Initiative grant will enable Stroud Water Research Center to implement extensive watershed restoration projects designed to capture and control excess water and sediment production from agricultural hillslopes. The grant also provides funding to support extensive and highly rigorous monitoring efforts targeted at measuring the effectiveness of restoration projects. Results will help provide guidance to maximize the effectiveness of future restoration designs and investments at the regional and national levels.

Principal Investigators: Melinda D. Daniels and Matthew J. Ehrhart
Collaborators: Bernard W. Sweeney, Louis A. Kaplan, Diana Oviedo-Vargas, Marc Peipoch, Jinjun Kan, John K. Jackson, and 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
Collaborators: Shane Morgan (White Clay Creek Wild & Scenic River Program)

Water-Quality Monitoring at Fair Hill Training Center

Funded by: Fair Hill Training Center, Md.
Scientists are monitoring fecal indicator bacteria, sediment, and water chemistry from the barns at the Fair Hill Training Center. Based on the data collected, the scientists and restoration team will apply effective best management practices to reduce the potential contaminants to the adjacent streams and rivers.

Principal Investigators: Jinjun Kan and Bernard W. Sweeney
Collaborators: Matthew J. Ehrhart and Melinda D. Daniels

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

Funded by: Foundation Prince Albert II De Monaco
Conventional agricultural activities (plowing, disking, synthetic fertilizer use, widespread pesticide application) have contributed to poor soil health, reduced rainfall infiltration and storage, increased stormwater runoff and export of sediment, nutrients, pesticides, and other pollutants from farm fields which have significantly degraded surface and groundwater systems, and released massive amounts of carbon dioxide from soil to the atmosphere. Therefore, developing farming practices that restore soil health and reduce runoff is vital to improving water quality and promoting carbon sequestration in soils. This project evaluates water quality and soil health impacts of new approaches to agriculture, including no-till seed placement, multi-species continuous cover cropping, and elimination of synthetic fertilizers and pesticides (in particular, neonicotinoids).

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

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

Funded by: Stroud Water Research Center
In early 2020, a number of agricultural best management practices will be implemented on Amish farms in Lancaster County, Pa. The farms are nested in a small watershed drained by a heavily impaired headwater stream. As part of the restoration, stream bank fencing and forested buffer plantings will protect the stream along with barnyard improvements and field practices. We will monitor stream nutrient and sediment concentrations and loads before, during, and after the implementation of the BMPs. This effort is unique for two main reasons: first, the farmland extends over the watershed area almost entirely (a scenario that is hard to find in the landscape) and provides an opportunity to more accurately capture the effects of the restoration; and second, the monitoring will start prior to the implementation, which is often hard to achieve.

Principal Investigators: Jinjun Kan; Diana Oviedo-Vargas, and Marc Peipoch
Collaborator: Lamonte Garber

Dr. Marc Peipoch and Research Technician Laura Zgleszewski collected rock biofilm and sediment samples in Rock Creek Park in Washington, DC to study the microbial community in the National Park.
Girl Scout Juniors and Cadettes learn about water chemistry during the first-ever STREAM Girls program held in Southeastern Pennsylvania at Stroud Water Research Center. STREAM Girls is a national Trout Unlimited initiative that combines science, technology, engineering, and math with arts and recreation, fly-fishing.

Education Projects

**Brandywine Watershed Discovery Day Camp**
Partially funded by: PA Department of Environmental Protection Environmental Education Office
The Brandywine Watershed Discovery Day Camp, coordinated by the Coatesville Youth Initiative, is a youth leadership and environmental awareness program that combines outdoor learning over five days along the Brandywine River. Trek activities build leadership skills, promote cultural and historical competence, and increase understanding of watershed management and water resource quality related to community impact over time.

Project Lead: Steven C. Kerlin
Collaborators: Tara K. Muenz; Jarvis Berry (Coatesville Youth Initiative)

**Schuylkill Acts & Impacts River Trek**
Funded by: Schuylkill Headwaters Association, Fairmount Water Works, William Penn Foundation, Education Programs
Schuylkill Acts & Impacts is a weeklong river trek for 12 high school students from across all counties that touch the Schuylkill. Students travel from the headwaters to downtown Philadelphia learning about the history of human impacts on the river and collect stream quality data to compare different sections of the river.

Project Lead: Alexa Kramer (Schuylkill Headwaters Association)
Collaborators: Steven C. Kerlin and Tara K. Muenz; Ellen Schultz (Fairmount Water Works)

**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. It includes increased opportunities for programs for schools and youth groups, educator professional development, citizens, and education resources.

Project Lead: Steven C. Kerlin
Collaborators: Tara K. Muenz and Mandy Nix

**Captain John Smith Chesapeake National Historic Trail Contact Point, Program, and Training Initiative**
Funded by: United States Department of the Interior, National Park Service
As a partner in this cooperative agreement with the National Park Service and Sultana Education Foundation, Stroud Center educators continue to expand teacher professional development and school programs in Pennsylvania’s lower section of the Susquehanna River Basin. Education programs with Octorora High School focus on the history and human impact on the river and feature school, streamside, and canoe programs.

Project Lead: Drew McMullen (Sultana Education Foundation)
Collaborators: Steven C. Kerlin and Tara K. Muenz

**Consortium for Scientific Assistance to Watersheds (C-SAW)**
Funded by: Pennsylvania Department of Environmental Protection’s Growing Greener Program
Stroud Center educators, scientists, and restoration staff provided technical assistance to county conservation districts, municipal environmental advisory committees, watershed associations, and citizen action groups as part of a partnership of nine organizations across Pennsylvania whose goal is to teach conservation groups how to conduct effective watershed assessments and restoration efforts.

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

**Greening STEM Technologies: A Model for Advancing Do-It-Yourself (DIY) Environmental Sensing Networks to Support Citizen Science and Primary and Secondary Education**
Funded by: U.S. Environmental Protection Agency
Stroud Center education and technical staff created STEM technologies to enhance public capabilities in citizen science. Partnerships with schools will lead to curricula and tools in 2017 and the installation of stream-monitoring stations.

Project Leads: David B. Arscott and Tara K. Muenz
Collaborators: Shannon Hicks, Steven C. Kerlin, and Heather P. Brooks

**Learning to See, Seeing to Learning**
Funded by: National Science Foundation
Stroud Center educators in collaboration with Carnegie Mellon University created and implemented a national survey of macroinvertebrate trainers and training programs. Education and entomology staff helped decide which 150 macroinvertebrates will be shown as gigapan images on Macroinvertebrates.org. Education staff continue to contribute to the development of the site.
On-the-Water Education Programs

Funded by: McLean Contributionship, Franny and Franny Abbott, and Redwoods Group Foundation

This new project includes the purchase of eight canoes, two kayaks, paddling gear, trailer, and safety gear for Stroud Center On-the-Water Education Programs. Building off the success of our boots-in-the-water streamside programs student and adult participants will now be able to learn about our watersheds while canoeing down our local streams or around our local lakes and reservoirs.

Project Lead: Steven C. Kerlin
Collaborator: David B. Reinfeld

Pennsylvania Environmental Literacy and MWEE Programming Capacity Building

Funded by: National Oceanic and Atmospheric Administration

The goal of this statewide project is to improve environmental literacy and stewardship of K-12 students by building capacity of environmental education programs across Pennsylvania for increased implementation of high-quality, meaningful watershed educational experience programming. Highlights of the project include research about successful watershed education programs, training programs, and the creation of a statewide providers network.

Project Lead: Steven C. Kerlin
Collaborators: Mandy Nix; Bert Myers (Pennsylvania Department of Environmental Protection); Judd Pittman (Pennsylvania Department of Education); Scott Cope (Pennsylvania Association of Environmental Educators); Carissa Longo (Pennsylvania Bureau of State Parks); Nanette Marcum-Dietrich (Millersville University of Pennsylvania)

SFS Leaf Pack Workshop

Funded by: Society for Freshwater Science

Stroud Center staff and members of the SFS Education and Diversity Committee held a Leaf Pack workshop in Detroit, Michigan, prior to the society’s annual meeting. The workshop introduced educators and citizens to the Leaf Pack Experiment and its utility as a stream assessment and teaching tool for middle school and high school teachers and interested conservationists.

Project Lead: Bernard W. Sweeney
Collaborators: Tara K. Muenz and Michael C. Broomall

Stroud Center Stream Study Programs for Public Schools

Funded by: The Education Improvement Tax Credit Program (EITC)

Stroud Center educators conduct a four-hour, boots-in-the-water stream program for students in fourth through 12th grade. During their visit at the Stroud Center, students learn about freshwater research, aquatic insect collection and identification, and the importance of trees for stream health. The program helps students better understand their impact on waterways and how they can protect and improve this vital resource for all life.

Project Leads: Steven C. Kerlin, Kristine C. Lisi, and Tara K. Muenz
Collaborators: Jessica M. Provinski, Mandy Nix, David Kline, and David B. Reinfeld

Teaching Environmental Sustainability — Model My Watershed

Funded by: National Science Foundation, Discovery Research K-12

Stroud Center educators and scientists continued to enhance the Model My Watershed application and refined the model curriculum for middle and high school students. This project is completed in partnership with the Concord Consortium, which leads teacher professional development and curriculum implementation, and Millersville University of Pennsylvania, which conducted research on learning. The geographic extent of this expansion is the contiguous 48 states. Master teachers from eight states received advanced training and are disseminating the curriculum and resources.

Project Leads: Steven C. Kerlin and Melinda D. Daniels; Nanette Marcum-Dietrich (Millersville University of Pennsylvania); Carolyn Staudt (Concord Consortium)
Collaborators: Anthony Aufdenkampe (LimnoTech); Emilio Mayorga (University of Washington); Robert Cheetham (Azavea, Inc.)

Thomas P. Bentley Muddy Boots Fund for Chester County Council, BSA Programs

Funded by: Greg, Keith, and Ray Bentley

The establishment of the Muddy Boots fund has made Stroud Center education programs free for youth in Chester County Council, Boy Scouts of America. Programs have expanded to include a Cub Scout STEM award, environmental related merit badges, and other watershed education programs for scouts including overnight experiences at the Stroud Center.

Project Lead: Steven C. Kerlin
Collaborators: Mandy Nix and David Reinfeld; Craig Sims and Rick Curth (Chester County Council, BSA)

Leaf Pack Kit and Network

Funded by: Stroud Center Education Product Development

Discover the value of macroinvertebrates as living indicators of water quality through the Leaf Pack Network! This international program, bilingual in Spanish, engages students, teachers, families and the public in water quality monitoring. A new and improved kit was launched in 2019 and includes full-color flashcards, dichotomous key, sorting sheets, a comprehensive manual, and all the apparatus needed for collecting, sorting, and identifying aquatic insects.

Project Lead: Tara K. Muenz

Water Quality Mobile App Software Updates

Funded by: Stroud Center Education Product Development

The Water Quality App™ received updates to separate net-spinning caddisflies in the digital field guide to macroinvertebrates and improved functionality.

Project Leads: Steven C. Kerlin and Tara K. Muenz
Collaborators: Heather Mayfield (Foundation for Ohio River Education); Miriam Steinitz-Kannan (Northern Kentucky University - Retired)

Part-time educator Vince O’Donnell shares his reptile collection and knowledge with Cub Scouts during ScoutReach Camp.
Published Titles


Above: Entomologist Dave Funk is anchoring the bottom of a fish seine. In order to weigh, measure and identify fish, Stroud scientists cordon off 20-meter reaches, so fish can’t swim into an adjacent reach. This another method to determine stream health.
Independent K-12 Student Research Projects
Funded by: Auman Family
Sparked by Maggie Auman and her family, who with the Leaf Pack Network tools researched her local streams for two years as part of a science fair project. The establishment of this fund is to make staff support available to assist K-12 students interested in conducting independent scientific research in freshwater ecology.
Project Lead: Tara K. Muenz

West Chester Area School District Water Quality Education Center
Funded by: Pennsylvania Department of Environmental Protection
Stroud Center educators and restoration staff will provide assistance in this newly funded project in forest restoration, establishment of three outdoor learning stations, teacher professional development, and curricula development in watershed education and restoration at the Starkweather Elementary School and Stetson Middle School properties of West Chester School District.
Project Lead: Paul Joyce (West Chester Area School District)
Collaborators: Steven C. Kerlin and Tara K. Muenz

PA Trout in the Classroom Program Support
Funded by: Pennsylvania Council of Trout Unlimited
In partnership with the PA Council of Trout Unlimited (PATU), the Stroud Center education department provided staffing and other supports to the PA Trout in the Classroom (PA TIC) program, in which over 40,000 students annually raise trout eggs from fingerlings in the classroom while growing their appreciation for coldwater resources. As part of this unique partnership, Stroud Center staff assisted with collaborations between TU Chapters and TIC teachers, administration of the PATU TIC Existing Program Grant, planning of the first-ever PA TIC Summit to connect statewide partners/teachers, and designing a new PA TIC website to enhance its meaningfulness to program participants.
Project Leads: Mandy Nix and Steven C. Kerlin
Collaborator: Stephen Mohapp

Watershed Awareness Using Technology and Environmental Research for Sustainability (WATERS)
Funded by: National Science Foundation
This education research project focuses on the development of a new curriculum and refinement of learning resources using universal design for learning (UDL) principles, with special attention to students that are English Language Learners. The project also includes teacher training and pilot implementation of the curriculum in CA, PA, and VA and continues to build on successful educational use of the WikiWatershed Toolkit of resources from prior funded projects.
Project Lead: Steven C. Kerlin
Collaborators: Melinda D. Daniels, Diana Oviedo-Vargas, David Kline, Tara Muenz, and Mandy Nix; Nanette Marcum-Dietrich (Millersville University); Carolyn Staudt (Concord Consortium)

Quantify and Support Best Management Practice (BMP) Installation and Restoration at Schools to Contribute Directly to Bay Restoration Goals
Funded by: Chesapeake Bay Trust
Research includes interviews of sustainable school recognition programs and a sample of school across the Chesapeake Bay Watershed about implementation of BMPs on school properties and connections to teaching and learning. A GIS product is also being created to help Chesapeake Bay Program partners assess the status of BMPs on school properties and prioritize efforts to increase installation of BMPs. The project also includes a report with recommendations and development of a decision matrix to help make prioritization decisions.
Project Lead: Steven C. Kerlin
Collaborators: David Kline, Charlie L. Dow, Tara K. Muenz, Scott Ensign and Matthew J. Ehrhart; Nanette Marcum-Dietrich (Millersville University)

Girls-in-STEM Education Programs Fund
Funded by: Orvis Downingtown Retail Store
Following the success of the first Trout Unlimited (TU) STREAM Girls program in southeast PA co-led by the Stroud Center and the Valley Forge Chapter of TU, the Orvis Downingtown Retail Store raised funds to help create the Girls-in-STEM Education Programs Fund. This account supports future STREAM Girls programming by the Stroud Center in partnership with local TU chapters, as well as other environmental science, technology, engineering, and math (E-STEM) programs that bring the importance of fresh water, outdoor aquatic recreation, and related careers to local K-12 girls.
Importantly, the fund helps the Stroud Center reach girls whose families lack the financial means to participate in E-STEM education. The fund has grown through a significant donation from an education staff’s family member, who recalls breaking through gender barriers in her own career. Future donations will continue to support this dedicated effort to engage, educate, and empower local girls.
Project Leads: Mandy Nix and Steven C. Kerlin
Collaborator: Tara K. Muenz
Watershed Restoration Projects

Ag BMP Planning and Implementation for Berks County (DEP); Leveraging Ag BMPs and Forested Buffers for Middle Schuylkill Cluster (NFWF); Delivering the Berks-Chester RCPP (DEP)

Funded by: Pennsylvania Department of Environmental Protection and National Fish and Wildlife Foundation
This project operates the Farm Stewardship Program in Berks County, assisting farmers to implement whole-farm conservation while leveraging U.S. Department of Agriculture funding for work including forested buffers. Work on roughly 20 farms will leverage nearly $1 million in USDA funds. Incentives to install forested buffers are working well, with buffers averaging roughly 80 feet per side.

Project Lead: Matthew J. Ehrhart
Collaborators: Red Barn Consulting, Inc.; TeamAg, Inc.; Berks County Conservation District; Berks Nature; Partnership for the Delaware Estuary; USDA; others

Ag BMP Planning and Implementation for Chester County

Funded by: Pennsylvania Department of Environmental Protection
This project operates the Farm Stewardship Program in Chester County, assisting farmers to implement whole-farm conservation while leveraging U.S. Department of Agriculture funding for work, including forested buffers. The project will assist 13 farms to install nearly 100 agricultural best management practices including more than five miles of forested buffers with average width over 50 feet per side.

Project Lead: Matthew J. Ehrhart
Collaborators: Red Barn Consulting, Inc.; TeamAg, Inc.; Chester County Conservation District; Brandywine Conservancy; Brandywine Valley Association; USDA; others

Ag BMPs and Buffers for Middle Schuylkill Focus Area

Funded by: National Fish and Wildlife Foundation
This project will assist at least eight farmers to plan and implement at least 80 agricultural best management practices on the condition that they also install forested buffers on their streams. Outreach and education will engage at least 125 persons and help promote adoption of soil health measures along with traditional BMPs.

Project Lead: Matthew J. Ehrhart
Collaborators: Berks County Conservation District; Cover Crop Coaching, LLC (Steve Groff); Pennsylvania No-Till Alliance; Red Barn Consulting, Inc.; TeamAg, Inc.

Delaware River Watershed Initiative Citizen Science II

Funded by: William Penn Foundation
This project will engage watershed residents to be active participants in efforts to document conditions across the focus areas of the Initiative. Work includes efforts to support monitoring, communication, technical support via a circuit rider, work with farmers of the Pennsylvania 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 Watershed Restoration Group participation in the 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 Collaboration

Funded by: William Penn Foundation
This project will enable a collaboration with Rodale Institute to advance knowledge on soil health and impacts on water quality, including a comparison of (1) cropping systems using tillage, (2) cropping systems under no-till management, and (3) 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

Delivering the National Fish and Wildlife Foundation Regional Conservation Partnership Program in Lancaster County, Pa.

Funded by: National Fish and Wildlife Foundation
This project provides outreach and technical assistance to farmers to ensure full implementation of funds provided by the U.S. Department of Agriculture’s Regional Conservation Partnership Program for constructing agricultural best management practices. The Stroud Center is NFWF’s lead partner in this effort.

Project Lead: Matthew J. Ehrhart
Collaborators: USDA Natural Resources Conservation Service; National Fish and Wildlife Foundation; Red Barn Consulting, Inc.; TeamAg, Inc.; others

Healthy Soils, Healthy Streams Training, and Technical Assistance

Funded by: Pennsylvania 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. Pennsylvania 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: Pennsylvania No-Till Alliance; Cover Crop Coaching, LLC
Leveraging Farm Bill Funds for Water Quality in the Brandywine-Christina and Middle Schuylkill Clusters (NFWF); Delivering the Berks-Chester RCPP (DEP)

**Funded by:** Pennsylvania Department of Environmental Protection; National Fish and Wildlife Foundation

The Stroud Center secured more than $1 million in funding from the U.S. Department of Agriculture’s Regional Conservation Partnership Program and is ensuring full delivery of best management practices on all enrolling farms, including forested buffers. Supporting funding is provided by the Pennsylvania Department of Environmental Protection in Chester and Berks counties.

**Project Lead:** Matthew J. Ehrhart

**Collaborators:** USDA Natural Resources Conservation Service; Chester County Conservation District; Berks County Conservation District; Berks Nature; Partnership for the Delaware Estuary; Mowery Environmental, LLC; Brandywine Conservancy; Red Barn Consulting, Inc.; TeamAg, Inc.; others

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

**Funded by:** National Fish and Wildlife Foundation

This project will install conservation practices on farms to improve watershed health. It will provide outreach, technical assistance, and financial assistance to farmers to (1) plan and implement whole-farm conservation, including forested buffers; (2) leverage state and federal funds for the majority of costs; and (3) help fill the remaining financial gap as an incentive for farmers to agree to install forested buffers.

**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 Ag BMPs in South Central PA

**Funded by:** National Fish and Wildlife Foundation

This project will support Stroud Center’s continuing efforts on soil health, particularly for outreach and education on cover crops and no-till farming, with modest funds for implementing these practices. It will also install conservation practices on farms to improve watershed health. It will provide outreach, technical assistance, and financial assistance to farmers who agree to install forested buffers as an integral part of wider work to install conservation practices.

**Project Lead:** Matthew J. Ehrhart

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

Soil Health and Stream Health for Red and White Clay Creeks

**Funded by:** National Fish and Wildlife Foundation

This project will engage two local farmers who are thought-leaders to implement more than 1,000 acres of cover crops, conduct trials of 8+ innovative methods on more than 1,100 acres to advance cover crop and no-till techniques, and create infrastructure to enable 270 acres of dragline manure injection that lessens soil compaction and nutrient losses from fields, with benefits to streams. 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 will assist roughly 24 farms in Lancaster and Chester County to install nearly 200 agricultural best management practices, including nine miles of forested buffers and nearly 21,000 acres of cover crops. It will also reach more than 11,000 farmers and conservation professionals to bolster training and outreach efforts.

**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.

Stoud Center/DCNR Buffer Collaborative

**Funded by:** Pennsylvania Department of Conservation and Natural Resources

This project includes two separate awards of funds from DCNR. The combined efforts will install nearly 80 acres of forested buffers, including efforts to demonstrate multi-functional buffers where income potential from buffers for fruits, nuts, and salable horticultural materials is a motivator. These non-federal funds help fill niches for landowners who are either ineligible for or prefer non-federal options, such as some Plain sect farmers.

**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.

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 estimate water quality benefits of forest land protection. The overall objectives of this work product are to provide information that communicates the impact and value of forest protection/conservation activities within the Delaware River Watershed Initiative (and beyond) and improve modeling tools for future land protection modeling.

**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)

Thanks, Donors, for the new tractor for Watershed Restoration!
Gifts and Contributions

We gratefully acknowledge the following 355 donors who generously contributed $437,935 to the 2019 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 group, and all other employees, thank you for strengthening our work.

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$5,000 to $9,999

Mr. and Mrs. Francis H. Abbott Jr.
Mr. and Mrs. Martin S. Brown Jr., Atticus Trust Advised Fund of the Community Foundation of Middle Tennessee, in honor of Rod Moorhead III
Gerrish H. Milliken Foundation
Mr. and Mrs. Stephen Milliken
MSB Cockayne Fund Inc.
Rencourt Foundation
RJM Foundation
Morris and Boo Stroud, in honor of Kay Dixon’s many years of service at SWRC
Peter Welling

$1,000 to $4,999

Anonymous Friend
American Mushroom Institute – Mushroom Farmers of PA
Carol Armstrong
Dr. and Mrs. Max Barus
Blue Yak Foundation
Mr. and Mrs. Christopher W. Brody, in honor of Rod Moorhead’s Leadership
Maggie Brokaw
Mr. Henry L. Brown III
Mr. Lawrence D. Brownell, in honor of Rod Moorhead
Mr. and Mrs. Michael Burns, in honor of Dr. John R.S. Fisher
David J. Callard, in honor of Dr. John R.S. Fisher
Chester County Community Foundation
CCCF Grantmaking Fund for Chesco honoring Richard I. G. Jones
Mrs. Dorothy S. Chidester
Mr. and Mrs. Bryan Colket
Mr. and Mrs. Tristan C. Colket Jr.
Mr. and Mrs. Charles Cruice
Alexandra C. Dow
The Farm at Doe Run/Doe Run Dairy
Dr. and Mrs. John R.S. Fisher
Drs. Rush and Phoebe Fisher
Mrs. Marilyn G. Forney – Forney Family Foundation
Foundation for the Carolinas/The Rafells Charitable Gift Fund
Mrs. Nancy Frederick
Kristin Gamble, in honor of Alice and Rod Moorhead
Hutton Family HeLP Fund
Mr. and Mrs. M. Roy Jackson
Mr. Bert Kerstetter
Mr. and Mrs. William LaFond
Mr. William O. LaMotte III
Legacy Advisors LLC
Mr. and Mrs. Thomas Leonard, Esq.
Mrs. Marta Santelices-Maldonado
Katharine and Whit Maroney
Mountain Laurel Foundation
Mr. and Mrs. Wade McDevitt
Peter G. Milliken and Linzee Weld
Dr. Weston F. Milliken
Mr. and Mrs. Clay W. Moorhead
Mr. and Mrs. Rodman Moorhead IV
Mrs. Bonnie Musser
The Nor’Easter Foundation
Octoraro Native Plant Nursery
Patagonia
The Roemer Foundation
Thomas and Frances Roosevelt
Mr. and Mrs. Richard Sanford
Mr. and Mrs. Charles P. Schutt III
Mr. Edgar Scott Jr.
H. Donnan Sharp
Sharp Foundation
Lynn Herrick and Rodney Sharp, in honor of Donnan Sharp
Anne Stroud
Dr. and Mrs. Bernard W. Sweeney*
Mr. and Mrs. Robert Whetzel
Winky Foundation

$500 to $999

Anonymous Friend
Ann and Joe Armstrong
David and Yeda Arscott,* in memory of Alison Ann Arscott
Barbourtown Foundation
Mr. and Mrs. Richard Bauer
Paul and Henrietta Bente
Blank Rome LLP
Dr. and Mrs. Thomas L. Bott*
Dr. Linda Carter
Mr. and Mrs. Jeffrey Chambers
Mr. Joseph Cieslukowski
The Dansko Foundation
Lesley Dawson and Gerald Stein
Mr. and Mrs. Charles E. Day III
Mr. and Mrs. Robert M. DiFilippo
Dr. Wendy Dixon and Mr. Jeff Itell
Matt and Andrea Ehrhart*
Mrs. Helen Kleberg Groves
Mr. William Hauser
David R. Hawk and Patricia L. Beitel
Johnson & Johnson Family of Companies
The Lipstein Family Foundation
Mr. and Mrs. Ian A. MacKinnon
Mr. and Mrs. Mark B. Myers
Mr. and Mrs. Thomas W. Nale III
Sally Peirson* and John Baker, in memory of Jean and Buck Peirson
Ms. Ujjwala Pothula
Barbara Cushing Riegel
Mr. and Mrs. Christoph A. Roth
S.E.C.R.A.
Mr. and Mrs. Jesse D. Saunders
Mrs. Evelyn P. Scott
Mr. and Mrs. William M. Sharp, in memory of Billy Wister
Dr. Barbara Stewart and Richard Brown – The William K. Stewart Foundation
Maria A. Taylor, in memory of John H. Taylor Jr.
Mr. Daniel Topp

$250 to $499

Anonymous Friend
Aquatera Technologies Inc.
L. David Arscott, in memory of Alison Ann Arscott and in honor of David B. Arscott
Atwater Designs
Jim and Vickie Chandler
Craig and Kristin Coleman
Charles and Karen Dow*
Avery and Nina Draper
Dr. Mark Fortunato, in honor of Bern Sweeney
Mr. and Mrs. W. Robert Irvin
Sarah Jackson
Dr. Louis Kaplan and Mrs. Leslee A. Schad*
Don and Carol Kirkland
Di and Dallas Krapf
Ms. Susan P. LeGros, Esq.
Kristine and Janson Lisi*
Mr. and Mrs. Thomas Lisi
Drs. Gordon C. Manin and Margot L. Waitz
Katherine Gates McCoy
Dr. and Mrs. Alexander McCurdy
Holly A. Michael, Ph.D.
Floyd and Joy Montgomery
Mr. and Mrs. Michael Moran
Douglas Myers and Kimberlee Brosnan-Myers
Naylor Family Foundation
Chris and Mary Patterson

Bob Johnston and Bill LaFond enjoyed a board retreat at the Maritza Station in Costa Rica.
Chris Livadas put together a great foursome at the 4th annual Fore Freshwater golf outing at Bidermann Golf Club.

These annual fund gifts were given in honor of Annie McFadden and Brook Stroud’s wedding on October 12:

- Mr. and Mrs. Antelo Devereux Jr.
- Mr. and Mrs. Wesley Gottesman
- Mr. and Mrs. Sanford Miller
- Mr. Jay Baldwin
- Mr. Zachary Nagelberg
- Paul and McKenzie Furber
- Hillary Scanlan

The Weeders Garden Club
Mr. William Wylie Jr.

$100 to $249
ACTS Retirement–Life Communities
Mr. Thomas Allen
Mr. and Mrs. A. Joseph Armstrong III
Susan D. Armstrong
Melanie and Scott Arnold*
Mr. and Mrs. Robert Auld, in honor of Dr. Josh Auld
Lydia Willits Bartholomew
Dr. Jill Beech
Mr. Perry Benson Jr., in honor of Sandy Sage
Mr. David Benway
Mr. Charles Bier
Raven Bier, Ph.D.
Ms. Clare Billett
Mr. and Mrs. Thomas Borecki
Janet L. Bowers
Mr. and Mrs. A. Michael Broennle
Michael and Katherine Bucklin
Susan S. Burchenal
Cheshire Hunt Conservancy
Mr. H. Nicholas B. Clark, in memory of Dick and Joan Stroud
William and Sara Corbishley
Terry and Richard Corkran
Mr. and Mrs. Leonard Cotton-Orlando
Mr. and Mrs. Richard W. Coyle
Kay Dixon*
Mr. and Mrs. Richard Doolan
Mr. and Mrs. Ford B. Draper Jr.
Sandy and Pete Drayer
Louise Lee Duncan – The Podge Fund
Dunwoodly Village Residents Association
Janet Ebert
Mr. and Mrs. J. Clifton Edgar
Drs. Scott H. Ensign and Michelle A. Duvali*
Dr. and Mrs. Leighton Everhart
Joan Fenza
Mr. and Mrs. Jack Fisher
Mr. and Mrs. Jeffrey Fralick
Mrs. Susan M. Garber and Mr. Ed Brown
GCFP Environmental School
Mr. and Mrs. W. Thomas Gehrt
Mr. John Gerbron, in memory of Nicholas Stroud
Dr. Susan and Mr. Garth Gill
Pete and Judy Goodman
Ms. Julianne Vicciardo Gordon
Mr. and Mrs. H. Barry Green
Libby and Ben Gregg*
Mr. and Mrs. Charles F. Gummey Jr.
Christina and David Hack
Mr. and Mrs. John J. Higgins, D.D.S.
Mr. and Mrs. Robert J. Holliday
Mr. and Mrs. J. David Hucker
Tuck and Heather Hunter
Dr. John K. Jackson*
Dr. and Mrs. Jinjun Kan*
Dr. and Mrs. Steve Kerlin*
Maurie Kerrigan
Susan and Bob Kissell
Ms. Frances Koblenzer
Ms. Carol Larson and Mr. Peter Compo
Ms. Laura Lynch
RC McCoy Family Fund
Mr. Paul J. Merluzzi
Hillary and Cintra Murray
Denis and Gail Newbold*
Prue and Art Osborn
Ms. Karen Owens, in memory of L. David and Barbara S. Reynolds
Robert and Elizabeth Peloso
Mr. Matthew Pinson
Wendy and Skip Powell
The Providence Garden Club of PA
David B. Reinfeld*
Mr. and Mrs. Alexander Roe
Mr. and Mrs. Roger M. Rohrer
Cecilia and Chris Ross
Mr. and Mrs. Rupert Rossetti
Nora Sadler
Sandy and Honor Sage
Lynnette Saunders, Ph.D.
Owen N. Sellar
Mr. and Mrs. Andrew A. Smith Sr.
Mr. Charles Soczek
Herbert Thal
Mr. and Mrs. P. Coleman Townsend
Mr. and Mrs. Michael Utley
Eva L. Verplanck, Ph.D.
Mr. and Mrs. Nate Wallace, in honor of Joan and Dick Stroud
Ware Presbyterian Village
Ms. Margaret Welsh, in honor of Cynthia Pizziketti
West Chester Garden Club
Mrs. Patricia Widner and Mr. Barry Stone
Drs. Tracy Wiegner and Josh Pierce
The William Penn Foundation
Mr. and Mrs. Matt Winters
Mr. Minturn T. Wright III

Up to $99
Anonymous (3)
Dr. Josh R. Auld and Mrs. Jan Lady-Auld
Mr. Carl Ballis
Susan Bara
John Bare
Ms. Mary Berger
Erika Bilger and Joe Meyer
Heather P. Brooks*
Mr. Alan Cheshire
Heather P. Brooks*
Erika Bilger and Joe Meyer
Ms. Mary Berger

Mr. and Mrs. Theodore Clattenburg Jr.
Ms. Marsha Cope
Ms. Susan Corkran
Ms. Marsha Cope
Mr. and Mrs. Theodore Clattenburg Jr.
Mr. Alan Cheshire
Heather P. Brooks*
Erika Bilger and Joe Meyer
Ms. Mary Berger

Mr. and Mrs. Theodore Clattenburg Jr.
Ms. Marsha Cope
Ms. Susan Corkran
Karen D’Agusto and Steve J. Bemasconi
Carol A.H. Davidson, in memory of Nancy Penn Smith Hannum
Laura de Ramel
Mr. and Mrs. Dave Dickens
Ms. Teri Reath Dignazio
Bruce and Lois DiVencenzo
Gerard and Jean Durdan
Ms. Jessica Duffy
Mr. Stephen Fagerstrom
Susan and John Fitzpatrick*
Mr. and Mrs. David H. Funk*
Ms. Valerie Fusco, in memory of Michael G. Fusco
Mr. Lamont Garber and Mrs. Marcella Hostetler*
John B. Hannum Jr., Esq.
Mercy Harris
Dr. and Mrs. Barry Kanofsky, in memory of Albert Catona Sr.
Mr. and Mrs. William B. Kelly
Ms. Dawn Knipmeyer
Amy Law
Mr. Tim Ligget
Ms. Maria McIver
Ms. Mari Markkula
Mr. and Mrs. Robert B. McKinstry
Arthur P. and Marjorie L. Miller
Vince and Pep O’Donnell*
Ms. Mary Ann Petrillo

Mr. C. Dilworth Pierson
Penny Preston
John and Rita Razze, in memory of Phyllis Wyeth
Sherman and Eleanor Roberts*
Mr. Christopher Robinson and Mrs. Ann Faulds
Ms. Susan Roche
Mr. George Seeds
Mr. and Mrs. Geoffrey Selling
Ms. Carolyn Dorph Shaw
SOLitude Lake Management
Richard Sperry
Linda and John Stapleford
Charles Walter Stewart
Shauna Stay
Toad & Co.
Ms. Alexia Vaughan
Anne Verplanck
Ms. Heather Warfel
Mr. and Mrs. Christopher H. Washburn
Mr. John Weaver
Matthew and Janet Weir
Dr. Candie C. Wilderman
Harold A. Wilkinson, M.D.

Special Gifts
Mr. and Mrs. Francis H. Abbott Jr., Girard College Education Program
Visionaries Documentary Project
David B. Arscott – Gift-in-kind: Pavilion Grill
Blue Yak Foundation: Infrastructure Support at the Maritza Biological Station in Costa Rica
Cabot Kjellerup Realty Trust: Visionaries Documentary Project
Crystal Trust: Education and Outreach Pavilion
The Davenport Family Foundation: Microscopes for the Pavilion
Dr. and Mrs. William L. Elkins: Research Grant for Buck and Doe Run Project
2019 John Deere Tractor

Fair Play Foundation: Lawrenceville School Project
Dr. and Mrs. John R.S. Fisher: ROZ Group Funding
Marilyn and Nathan Hayward: 2019 John Deere Tractor
Kennett Run Charities Inc.: STEM Girl Scout Program
Bert Kerstetter: ROZ Group Funding
Visionaries Documentary Project
John Lazarchich Foundation: Visionaries Documentary Project
Caroline Moran: Girard College Education Program
Margaret D. Strawbridge Foundation of PA:
2019 John Deere Tractor
Carol E. Ware through the Marian S. Ware 2003 Charitable Lead Annuity Trust:
Octoraro Watershed Restoration Project
Creek Critters Book Publication
Marshall-Reynolds Foundation: Restoration Buffer Maintenance
Mr. Rodman W. Moorhead III: Visionaries Documentary Project
PECO Energy Co.: Kennett After-The-Bell Education Program
Donna S. Queeney: Girls in STEM Education Program
Mr. and Mrs. Stephen M. Stroud:
Operational Funds for the Maritza Biological Station in Costa Rica
Penelope P. Wilson:
2019 John Deere Tractor
Yvonne and Brock Vinton:
2019 John Deere Tractor

Educational Improvement Tax Credit Program
The education department gratefully acknowledges these businesses for their support through Pennsylvania’s EITC program. These dollars are used specifically to subsidize costs associated with field trips from Pennsylvania public schools.
BB&T, now Truist
DNB First
First Citizens Community Bank
First Resource Bank
M&T Bank
PPL Corporation
Urban Outfitters/Fre People

The Future of Fresh Water Initiative is a special gifts program that is needed to strengthen Stroud Water Research Center’s ongoing work. Five major aspects have been identified, which created a $20 million endeavor.

We gratefully acknowledge the following individuals and entities that have supported the Future of Fresh Water Initiative from 2017 to date. Our remaining goal is $11 million and an investment in our mission is deeply appreciated.

Thank you!

“With all the pressures facing our environment, I am thrilled to have the Stroud Center in our midst. Their solid scientific research has positively affected fresh water initiatives in our community and far beyond. The educational opportunities they provide for all ages does give me great hope for our future.”

— DD MATZ
**The Future of Fresh Water Initiative**

**5 MAJOR ASPECTS OF THE INITIATIVE MAKE UP OUR $20 MILLION GOAL:**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Progress</th>
<th>Goal</th>
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<tbody>
<tr>
<td>1</td>
<td>RESEARCH</td>
<td>$8M</td>
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<tr>
<td>2</td>
<td>EDUCATION</td>
<td>$2M</td>
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<tr>
<td>3</td>
<td>RESTORATION</td>
<td>$4M</td>
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<td>4</td>
<td>BERNARD W. SWEENEY, Ph.D., EXECUTIVE DIRECTOR’S FUND</td>
<td>$5M</td>
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<tr>
<td>5</td>
<td>UNRESTRICTED PROJECTS</td>
<td>$1M</td>
</tr>
</tbody>
</table>

**$2,000,000 and More**

- Mr. and Mrs. Rodman W. Moorhead III – Director’s Challenge/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
  - Blue Yak Foundation – Research/Education
  - The Boudinot Foundation – Unrestricted
  - The Davenport Family Foundation – Education/Restoration
  - Nathan and Marilyn Hayward – Restoration/Director’s
  - The Leafglen Foundation – Restoration/Research/Education
  - Mr. and Mrs. Robert D. McNeil – Education
  - Caroline Moran – Unrestricted
  - Mrs. Elizabeth R. Moran – Research

**$50,000 to $99,999**

- Anonymous – Education
- Thomas P. Bentley Muddy Boots Fund – Education
- County of Chester – Unrestricted
- Crystal Trust – Research/Director’s
- Gerry and Marguerite Lenfest – Unrestricted
- The Laffey-McHugh Foundation – Restoration
- Mr. and Mrs. Frederick Meserve Jr. – Unrestricted/Director’s
- H. Donnan Sharp – Directors
- Mr. and Mrs. Ranney Moran – Restoration

**$20,000 to $49,999**

- Joan S. Blaine – Director’s/Research
- Cabot Wellington Foundation – Restoration
- David E. Davis III and The American Gift Fund – Education
- Dr. and Mrs. John R. S. Fisher – Unrestricted/Director’s
- Mr. and Mrs. Michael Matz – Director’s
- Dr. and Mrs. Bernard W. Sweeney* – Restoration
- Marian S. Ware 2003 Charitable Lead Annuity – Restoration

**$10,000 to $19,999**

- Anonymous – Education
- Maggie Brokaw – Research/Director’s
- Bessemer National Gift/24th Fund – Director’s/Restoration
- Herman O. West Foundation/West Pharmaceuticals – Education
- J. Renwick Kerr – Unrestricted, in honor of Rod Moorhead
- Bart Kerstetter – Unrestricted/Director’s/Research/Restoration
- Jane C. MacEe Foundation – Research
- The McLean Contributionship – Education
- Weglicki Family Foundation – Education

**$5,000 to $9,999**

- Dr. Dave and Yeda Arscott* – Unrestricted/Research/Director’s
- Jessie and Richard Benjamin – Director’s
- Michael and Katherine Bucklin – Director’s
- CRES – Education
- Mr. and Mrs. Bryan Colket – Education
- Mr. and Mrs. Charles Cruez – Education
- Charles and Karen Dow* – Unrestricted/Director’s

**$1,000 to $4,999**

- Anonymous (3) – Unrestricted
- Aqua America, Inc. – Education
- Mr. Bruce Balick and Ms. Claudia Schultze – Director’s/Restoration
- Dr. and Mrs. Thomas L. Bott – Director’s/Research
- Mary Sue Boyle – Education

**Phoebe A. Driscoll – Director’s Research**

- First NonProfit Foundation – Unrestricted
- Fog House Fund – Director’s/Education
- Global Tax Management – Education
- John B. Hannum Jr., Esq. – Unrestricted/Director’s
- Mr. Robert F. Johnston and Mrs. S. Francesca Orsini – Director’s
- Kristine and Jason Lisi* – Director’s
- Margaret D. Strawbridge Foundation of PA – Restoration
- George and Betsy McFarland – Restoration
- Mr. and Mrs. Ranney Moran – Restoration
- John and Mary Pepe* – Unrestricted/Research/Director’s
- MSB Cockayne Fund, Inc. – Director’s
- Rencourt Foundation – Education
- Barbara Cushing Riegel – Unrestricted
- Mr. Edgar Scott Jr. – Director’s
- The Roeomer Foundation – Unrestricted
- Mr. and Mrs. Robert Whetzel – Unrestricted
- The RJM Foundation – Unrestricted

**TOTAL:**

$666,000 remains of the $1 million challenge match generously sponsored by Rod and Alice Moorhead.
Comer Foundation Fund – Director’s
Matt and Andrea Ehrlart* – Restoration/Director’s
Dr. and Mrs. William L. Elkins – Director’s/Restoration
Robert and Marcy Fenza – Director’s
Anne and Matt Hamilton – Unrestricted
Patricia Kraus Holt – Research
Kristin Gamble – Unrestricted
Dr. John Jackson* – Unrestricted/Director’s
Dr. Steve and Betsy Kerlin* – Education
William Kronenberg III – Unrestricted
William and Maria LaFond – Director’s
Denis J. Lawler – Unrestricted
Susan LeGros, Esq. – Director’s/Unrestricted
Longwood Rotary Foundation – Education
Kathryn Kraus McClure – Research
Monomoy Fund, Inc. – Director’s/Unrestricted
Mark and Anna Myers – Unrestricted/Director’s
David B. Reinfeld* – Director’s/Education
Dr. Donald J. Rosato Charitable Foundation – Unrestricted
Mr. and Mrs. Charles P. Schutt III – Unrestricted/Director’s
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
Brook and Yvonne Vinton – Director’s/Restoration
W. L. Lyons Brown Foundation – Director’s
Peter Wellin – Director’s/Restoration
Mr. and Mrs. William R. Wister Jr. – Director’s

$500 to $999
Dr. Josh Auld and Mrs. Jan Lady-Auld – Unrestricted
Barboutown Foundation – Director’s
Claire Binney and Harry Orth – Director’s
David J. Callard – Director’s
Dr. Linda Carter and Patrick Hardesty – Director’s
Dr. Melinda and Mr. Robert Daniels* – Research/Director’s
Alexandra Dow – Director’s
Drs. Scott Ensign and Michelle Duval* – All Funds
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
Catherine Huston – Unrestricted
Dr. and Mrs. Jinjun Kan* – Unrestricted/Director’s
Mr. and Mrs. Robert C. McCoy – Director’s
Sally Peirson and John Baker* – Restoration/Director’s
Matthew and Jessica Provinski* – Unrestricted/Director’s
Mrs. Martha Ryan – Research
Charles P. Schutt Jr. – Director’s
Ira Glenn Stroud – Unrestricted
Ann Percy Stroud – Director’s
Octoraro Native Plant Nursery, Inc. – Director’s
Passive Capital Management, LLC. – Unrestricted/Director’s
The Redwoods Group Foundation – Education

$100 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
Michele Adams – Director’s
Judith Adler – Restoration
Thomas Allen – Research
Benevity Community Fund – Director’s
Dr. Jill Beech – Director’s
Thomas and Sharon Best – Director’s
Virginia and David Butters – Director’s
William Chase – Director’s
Mike and Emily College – Director’s
Cynthia and Patrick Conway – Director’s
Phyllis Copeland – Education
Daniel DePersia – Education
Dave and Eileen Dickens – Director’s
Dr. and Mrs. Robert M. DiFilippo – Director’s
Bruce and Lois DiVincenzo – Director’s
Kay Dixon* – Unrestricted/Director’s
The Honorable and Mrs. Calvin S. Drayer Jr. – Director’s
Michele and Jim Dulin – Director’s
Mr. and Mrs. Herman Fala – Director’s
John and Susan Fitzpatrick* – Director’s
Mr. and Mrs. David H. Funk* – Unrestricted/Director’s
Mr. and Mrs. Charles F. Gummey – Director’s
Richard and Ellen Hannum – Unrestricted
Ms. Lisa Hastings – Director’s
Lawrence and Bebe Hebling – Director’s
Dale Hendricks and Carol Curtis – Director’s
David and Mary Hess – Director’s
Mr. and Mrs. James Hicks – Director’s
Neal Howard – Director’s
Mr. and Mrs. M. Roy Jackson – Director’s
Ann Jones – Director’s
Mr. and Mrs. Harvey J. Journey – Director’s
John and Denise Kane – Director’s
Vicki and Wilson King – Director’s
Susan and Robert Kissell – Director’s
Di and Dallas Kraf – Education
William and Peggy Lang – Director’s
Carol Larson and Peter Compo – Unrestricted
Cathie and Michael Ledyard – Director’s
Mr. and Mrs. Gary Lernke – Director’s
Richard and Sally Lighty – Director’s
Virginia Logan – Director’s
Julia Loving and David Yates – Thomas – Director’s
Robert McCracken Peck – Director’s
Jim and Karla McGonigle – Director’s
James McPeak – Director’s
Karl and Dianne Mehn – Director’s
Holly A. Michael, Ph.D. – Unrestricted
John and Nancy Mohr – Director’s
Floyd and Joy Montgomery – Director’s
Hayden Murphy – Director’s
Joe Nangle – Director’s
Dr. Denis and Gail Newbold* – Unrestricted
Dave and Chris Nibours – Director’s
Dr. Diana Oviedo-Vargas* – Unrestricted/Director’s
Ted Passyn – Director’s
Kent and Karen Peterson – Research, in honor of Annie and Brook Stroud
Danielle Rice and Jeffrey Berger – Director’s
Gregg Robertson – Unrestricted
Diane and Robert Roskamp – Restoration
Sandy and Honor Sage – Director’s
Mr. and Mrs. Jesse D. Saunders – Director’s
Lynnette Saunders – Director’s
Karen Shal and John Sherman – Director’s
Mr. and Mrs. William M. Sharp – Director’s
Richard Shockey – Director’s
Bill and Cathy Siegel – Director’s
Sandra Sierzenski – Director’s Fund, in memory of Dorothy & Harry West
Charles and Patricia Sterling – Director’s
Mrs. Barbara Stewart and Richard Brown (The William K. Stewart Foundation) – Director’s
Mr. and Mrs. Henry Stoebenau – Director’s
Patricia Stroud and Alexander McCurdy – Director’s
Dan and Desiree Sweeney – Director’s
Kevin Sweeney – Director’s
Margot Taylor – Director’s
Maria Taylor – Director’s
Margot and Chris Teeter – Director’s
Meliora Design – Director’s
Brian and Allison Tester – Director’s
Collis and Catherine Townsend – Director’s
Upland Country Day School – Education
Randy and Shelby VonTill – Director’s
Eve and Nate Wallace – Director’s
Auston Wand – Unrestricted
Roberta and Dick Weber – Director’s
Robert Whitescarver – Director’s
Lydia Willits Bartholomew (National Bank of Malvern) – Unrestricted/Director’s, in honor of John B. Hannum Jr., Esq.
Wakefield Family Fund, Inc. – Director’s
Mr. William Wylie Jr. – Director’s
George Xakellis – Restoration

Please contact David Reinfeld, director of campaign programs and major gifts, 610-268-2153, ext. 314, or dreinfeld@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, 2019_

<table>
<thead>
<tr>
<th>REVENUES &amp; SUPPORT</th>
<th>EXPENDITURES</th>
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<td>Other Contributions &amp; Income</td>
<td>Information Services</td>
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<tr>
<td><strong>Total Revenues &amp; Support</strong></td>
<td><strong>Total Expenditures</strong></td>
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<td><strong>$7,629,404</strong></td>
<td><strong>$7,629,404</strong></td>
</tr>
</tbody>
</table>

**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 Gunnip & Company. Investment assets are managed by New Providence Asset Management and Passive Capital Management. 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.

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Your continued generosity through annual, endowed, and planned gifts is vital to our research, education, and 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

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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.

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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

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

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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.

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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.

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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 Director of Development Kristine Lisi at 610-268-2153, ext. 304, to learn about special giving opportunities.
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!

4th Annual Golf Invitational Fore Fresh Water

Volunteers
Marsha Antes
Amol Dhargalkar
Shelby Minka
Donnan Sharp
Matt Smith
Srinu Yalamanchili
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The Water’s Edge

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Anne Moran
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Rikki Saunders
Emily Scott
Trish Scott
Donnan Sharp
Andrea Spahr
Boo Stroud
Bonnie Van Alen

Lou Mandich, of Last Chance Garage, brought his Model T to the Road Rally. Photo Mitch Evans; Exelon helps out at our annual tree planting.

To learn how you can get involved, go to www.stroudcenter.org/volunteer.
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Hosted by Trail Creek Outfitters
We are grateful to the many sponsors, volunteers, and attendees who make this event so successful.

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Wild Birds Unlimited
Plus many individual volunteers for whom we are very grateful.

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*The Maritza Biological Station staff is employed by the Asociacion Centro de Investigacion 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) Diana Oviedo-Vargas, Ph.D., shares information about the Stroud Center’s research at the Stroud Preserve during Trails to Tailgates. B) Even though this impressive Rainbow Trout is non-native in our watershed, Stroud Center scientists work hard to protect and restore streams to provide ideal habitats for all aquatic life. C) The mark-recapture study is a lot of hard work, but even more challenging when our research techs are trying to tag slippery eels. The ones tagged in this study didn’t turn out to be big movers and were recaptured within 100 meters of where they were first tagged. Perhaps they’re saving all their travelling for that big trip to the Sargasso Sea to spawn. D) Joey George, a research tech in Fluvial Geomorphology, is taking stream bed sediment cores from a canoe. These cores will then be tested to see how much nitrogen they have in them. This is for a dam project, which will determine how much nitrogen dams can sequester. E) Clara Mendoza-Lera, a visiting scholar from Germany, sets up an experiment with the Ecosystem Ecology Group. Careful measurements of how bacteria, fungi, and algae affect stream chemistry are crucial for understanding how stream ecosystems respond to pollution. F) Entomology and Fisheries techs send a weak electric current pulse into the stream water to temporarily stun fish. The team collects them in buckets and fish are measured and weighed. They recover from their shock in a few minutes (or instantly in the case of eels) and are returned to the stream. G) Rachel Johnson works with students at the Independence School in Newark, DE to remove sensors from sediment that were buried from a storm event. Rachel took the opportunity to teach the students about sediment fluxes in streams.
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*At the December 2019 Board of Directors meeting, the Board acknowledged the many years of dedicated service of Anne Stroud, Peter Kjellerup, and Bill Kronenberg, and each were granted emeritus status.

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