

A woman with long brown hair, wearing a green shirt and a dark vest, is looking through a surveying instrument (a total station) mounted on a red tripod. The instrument has a teal-colored body and a small screen. In the background, another person wearing a yellow hard hat and a blue jacket is visible, standing near a red and white surveying pole. The scene is outdoors in a wooded area with bare trees and fallen leaves on the ground.

STROUD™

WATER RESEARCH CENTER

2016

Annual Report

A YEAR IN REVIEW

*Through a Scientist's Lens:
Training Citizens in
Freshwater Stewardship*

A | SCIENCE

SUEZ in Delaware has partnered with several entities to install streambank fencing and vegetated stream buffers on farms, and in 2016, Stroud Center scientists began studying how well these installations protect drinking-water sources from pollution. The researchers looked for several disease-causing microorganisms in collected streamwater samples, including *Cryptosporidium*, *E. coli*, *Enterococci*, and *Bacteroides*.

B | EDUCATION

In April, the Stroud Center's education department hosted a Brook Trout Release Day and Trout Adoption. Native brook trout populations have declined dramatically in the last 200 years, in large part due to the clearing of streamside forests. Children and their parents played educational games, drew pictures, hiked in the White Clay Creek Preserve, examined fish and macroinvertebrates from the stream, and released brook trout that were raised by Tara Muenz during the winter. *Photos: Tara Muenz*

C | WATERSHED RESTORATION

The Stroud Center was named Conservation Organization of the Year in 2016 by the Berks County Conservation District. Key to our conservation work is the assistance we provide to farmers and landowners to help them better care for our water resources by planting streamside forests and making other improvements on the land. Deep Roots Valley Farm, one of the farms in the Watershed Restoration Group's Farm Stewardship Program received the district's Farmer of the Year award. *Photo: Kay Dixon*

D | THE WATER'S EDGE

On the centennial anniversary of one of America's greatest treasures, the Stroud Center presented the 2016 SAFE Water Award to the National Park Service and its director, Jonathan Jarvis. The diverse areas managed by the National Park Service encompass more than 84 million acres and serve to preserve and protect freshwater resources throughout the United States.

Photo: The National Park Service

Back cover: Jan Battle collects macroinvertebrates on the Susquehanna River near Tunkhannock, Pennsylvania.

Cover photo: Kay Dixon

AT A GLANCE 2016



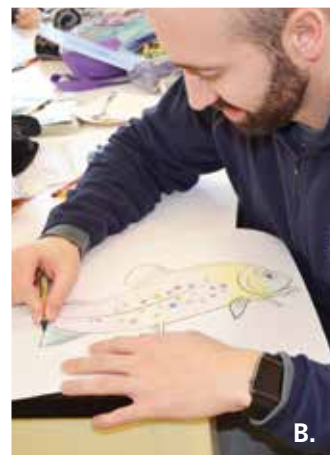
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MESSAGE FROM THE DIRECTOR

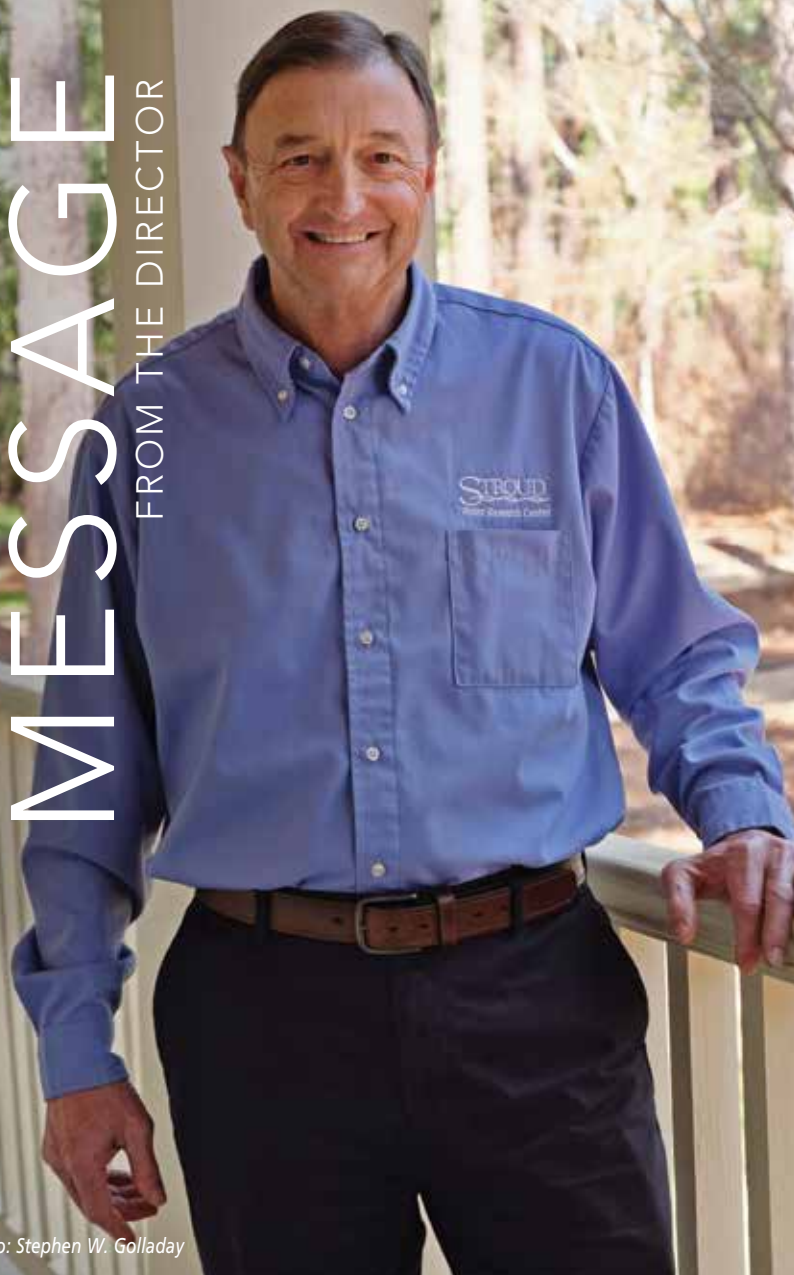


Photo: Stephen W. Golladay

“Over the past 50 years, we have come to realize that reaching out to engage people in science, educate them on environmental preservation, and help them restore damaged watersheds is critical to both achieving our mission and measuring our success.”

Mark Twain once said, “There is no such thing as a new idea,” only old ideas in “new and curious combinations.” Basic science surely progresses this way, expanding knowledge by building on strong foundations. The same applies to progress within scientific organizations. We move into the future sustained by the best of the past.

Our three feature stories in this report cover our new citizen science program, the expansion of our environmental education department, and the amazing breadth of our watershed restoration effort — three exciting programs that didn’t exist when I came to

Stroud™ Water Research Center in 1972. In fact, *citizen science*, *environmental education*, and *watershed restoration* were not even in our vocabulary.

We have always sought to engage citizens in science, educate people on the environment, and encourage the restoration of watersheds. Today, our mission is more robust, as we have defined the application and dissemination of our research more narrowly.

So the fact that this year’s annual report does not highlight science projects *per se* doesn’t mean that science is no longer the backbone of our mission. On the contrary, it will always be at the core of all that we do. Over the past 50 years, we have come to realize that reaching out to engage people in science, educate them on environmental preservation, and help them restore damaged watersheds is critical to both achieving our mission and measuring our success.

On behalf of all of us at Stroud Water Research Center, I hope you will continue to support our efforts to protect clean fresh water in all the streams in all the backyards here and around the world.

Making every drop count,

Burt A. Long

RESEARCH

With help and guidance from organizations like the William Penn Foundation, Stroud Water Research Center, the National Park Service, and The Nature Conservancy, it will be us, the citizens and citizen scientists, who will become the stewards of our air, land, and water.

— JEFF CHAMBERS





Citizen Scientists in Training:

VOLUNTEERS MONITOR THREATS TO WATER FOR 15 MILLION PEOPLE

By Diane M. Huskinson

"I've always been a bit of an environmentalist personally, doing what I could with the time that I had. Now I have more time on my hands," says Jeff Chambers, who retired from DuPont last year. A chemist by training, he is now one of more than a dozen volunteers learning how to monitor the health of streams in First State National Historical Park in Delaware through The Nature Conservancy's Stream Stewards Program.

"When I heard about this program, it seemed like a perfect match," he says.

Kim Hachadoorian is managing the program for The Nature Conservancy, in partnership with First State National Historical Park. She says volunteer training is just beginning and that more volunteers will be trained to monitor five of the eight streams that run into Brandywine Creek within the park. "The first step," she says, "is to collect baseline data, getting a good characterization of the water quality in those streams. The goal is to protect good water quality where we have it and improve degraded streams through land management." Although some of the volunteers, like Chambers, have science backgrounds, many do not. "Becoming a citizen scientist is a process," says Hachadoorian. "Training and evaluation are important to track the progress of volunteers as they learn how to follow the scientific method."

With a third of the park's land leased for farming, Hachadoorian expects a big part of the restoration effort will be to partner with farmers to improve cropland and farmyard management and install best management practices, such as streamside forests, that have been proven to protect and restore waterways. "After that,

we can continue with follow-up monitoring to determine the impacts those changes on the land are having on water quality. The great part about doing citizen science within the national park is that it's a welcoming space where the public can learn about how volunteers are protecting clean fresh water."

The William Penn Foundation is funding the Stream Stewards Program, and others like it, through its multimillion-dollar Delaware River Watershed Initiative (DRWI) that is supporting more than 50 leading nonprofits working together to reduce threats to water quality for the 15 million people — more than 5 percent of U.S. population — who get their drinking water from the Delaware River basin.

The initiative targets eight subwatersheds, or clusters, that make up 25 percent of the Delaware River basin and are of critical ecological value. A science-informed evaluation under the initiative showed that while these clusters face significant threats to water quality, the opportunity for successful intervention at these locations is great.

Stroud™ Water Research Center is helping guide the effort under a William Penn Foundation grant by working with DRWI partner organizations like The Nature Conservancy to grow their network of volunteers and enhance the quality and quantity of the data they collect.

One way the Stroud Center is doing that is through the "Watershed 101" workshops, which teach the volunteers about the physical, chemical, and biological processes that keep streams and rivers healthy. Chambers attended one of the three-day workshops and was struck



Citizen scientists attend a three-day "Watershed 101" workshop at Stroud Water Research Center. Photo: Dave Arscott

"TRAINING AND EVALUATION ARE IMPORTANT TO TRACK THE PROGRESS OF VOLUNTEERS AS THEY LEARN HOW TO FOLLOW THE SCIENTIFIC METHOD."

— KIM HACHADOORIAN, STREAM STEWARDS PROJECT MANAGER, THE NATURE CONSERVANCY DELAWARE CHAPTER

by the close relationship between land and water: "I've been learning how everything fits together in the environment we live in, how everything we do on the land affects our water resources, and how the bugs and fish you find in a stream can tell you about the health of that stream. The bugs get their food from the trees along the stream, and the fish eat the bugs, and it all fits together."

Hachadoorian says, "The volunteers come from diverse backgrounds. Some are retired. Some are young adults just starting out in their careers. But what they have in common is that they are all interested in a really meaningful volunteer experience. Yes, it sounds like fun to go out into the streams and collect data samples, but what they're really interested in is stewardship. They want to make a difference in their local communities, and with this program, we will be using the data they collect to better manage the land within the park."

"These trainings will help citizen scientists better understand what questions they should be asking and why," says Matthew Ehrhart, the Stroud Center's director of watershed restoration, "Plus they'll learn how to analyze and interpret the monitoring

data they collect so they can use it to guide future restoration and conservation work."

David Bressler, the Stroud Center's citizen science project facilitator, says that "Watershed 101" is a foundational workshop, and more specialized trainings on things like monitoring technologies are also being offered to the cluster groups and their volunteers.

Some of the volunteers are already learning to build and deploy do-it-yourself wireless environmental monitoring stations the Stroud Center recently developed. These inexpensive, customizable, and easy-to-use sensors are featured on EnviroDIY.org, an online community of enthusiasts who share ideas for environmental science and monitoring. (EnviroDIY™ is part of the WikiWatershed® online toolkit presented by Stroud Water Research Center.) With these devices, the citizen scientists will be able to measure water temperature, stream water level, electrical conductivity, water clarity, and more.



The William Penn Foundation's Director of Watershed Protection, Andrew Johnson, says, "The goal of DRWI citizen science is to, not only engage the public with conservation, but train and deploy volunteers to generate meaningful, professional-quality water data that can be shared more broadly across the watershed."

The data the citizen scientists collect will stream automatically to a web portal where they can easily visualize, analyze, and download the data they and their fellow volunteers throughout the Delaware River basin collect.

"In the years ahead," says Chambers, "I believe those of us who care deeply about our environment will increasingly turn to organizations like the William Penn Foundation, Stroud Water Research Center, the National Park Service, and The Nature Conservancy to protect our natural resources. With their help and guidance, it will be us, the citizens and citizen scientists, who will become the stewards of our air, land, and water."

Photos: Kim Hachadoorian (top), along with Shannon Hicks (bottom right), showed volunteers (right) who are learning to become citizen scientists through The Nature Conservancy's Stream Stewards program how to install wireless sensors that capture real-time water-quality data from streams.

Photos: Tara Muenz, with the exception of (center) David Bressler and (right) Kim Hachadoorian



"I'VE BEEN LEARNING HOW EVERYTHING FITS TOGETHER IN THE ENVIRONMENT WE LIVE IN, HOW EVERYTHING WE DO ON THE LAND AFFECTS OUR WATER RESOURCES, AND HOW THE BUGS AND FISH YOU FIND IN A STREAM CAN TELL YOU ABOUT THE HEALTH OF THAT STREAM. THE BUGS GET THEIR FOOD FROM THE TREES ALONG THE STREAM, AND THE FISH EAT THE BUGS, AND IT ALL FITS TOGETHER." — JEFF CHAMBERS

EDUCATION



“Many students and teachers informed me that this was one of the best field trips that they have ever been on, and I have to agree. I am delighted that we are continuing this partnership.”

— MICHAEL G. GARVIN, ASSISTANT PRINCIPAL, AVON GROVE INTERMEDIATE SCHOOL

The Stroud Center has been teaching Stream School to citizens across the country for more than 20 years. With new partnerships with the Master Watershed Stewards and Pennsylvania Forest Stewards, this training is preparing more citizens than ever before in Stroud Center history to become ambassadors for their watersheds. *Photo: Tara Muenz*

Sharing Stroud Science:

EDUCATION PROGRAMS REACH NEW AND BIGGER AUDIENCES

By Diane M. Huskinson

On a bright, clear morning in early October, first one, then two, yellow buses pull into a parking lot tucked within the forested countryside of Chester County, Pennsylvania. The buses have arrived at Stroud™ Water Research Center in Avondale. When the doors squeak open, dozens of schoolchildren, accompanied by teachers and parents, spill out and are greeted by educators who will lead them on a four-hour journey to investigate the health of White Clay Creek and learn how to protect their local streams.

The Stroud Center's education staff affectionately calls multiple busloads of schoolchildren, all arriving at the same time and buzzing with energy, a swarm. It's the same term scientists use to describe mayflies — a hallmark of healthy waterways — dancing above a stream.

In 2016, the Stroud Center engaged more children and adults in face-to-face programs than in any previous year: about 5,800, up from 1,800 in 2015.

Education Director Steve Kerlin, Ph.D., says, "Our goal is to engage about 10,000 children and adults in our programs on a yearly basis by 2020 and sustain that number into the future."

Working toward that goal, the education department added five part-time environmental educators last spring. In total, the education department's staff boasts more than 200 years of combined teaching experience.



Stream School Programs for Students

Bill Anderson, a retired high school advanced-biology teacher and an adjunct research associate, is among them: "In the last two years, especially in 2016, the number of students coming to the Stroud Center has skyrocketed. It seems like the parking lot is full every day with buses of students. I can't tell you how gratifying it is to see this part of the Stroud Center's mission becoming realized, especially with the new building. It's such a marvelous place for the kids to get hands-on experience in the stream with experts in watershed science."

The new building is the Moorhead Environmental Complex, a LEED Platinum green building and demonstration grounds for education and public outreach that opened its doors in 2012.

Anderson says, "Sometimes a parent or student will say, 'Thanks, mister. This is the best time we've ever had in school,' or something like that, and boy, you get a couple of those a month, and that's all you need!"

What makes the Stream School programs so appealing and engaging has a lot to do with connecting students to nature. Students typically rotate through four different learning modules. Anderson teaches the water chemistry module, where students learn about things like pH and dissolved oxygen.



Reaching thousands more students and adults than ever before with a variety of environmental science programs, the Stroud Center's education department grew from three to eight staff in 2016. They boast more than 200 years of combined teaching experience. *Photo: Kay Dixon*

"They can learn water chemistry in their school classrooms, but they won't come away with the same appreciation for their environment if the water sample they are testing is coming from the tap," he says. "When they come here, they're putting on rubber boots and carrying buckets to collect water directly from an actual stream."

The second module has the students going into White Clay Creek, the research stream that flows behind the Stroud Center, where they turn over rocks and look for critters they will later take back to the indoor education lab and put under microscopes to identify what species they have found. The third involves an exploration of stream habitat and flow during a nature walk.

"This is when they practice their observational skills," Anderson explains. "We ask them, 'What do you notice about the trees? How big are they? Do the trees come right down to the edge of the stream? Are there trees that have fallen over into the stream?'"

These questions help the students identify features scientists look for in streams that have good water quality and support native biological diversity.

Anderson says, "During the four hours they are here, we must capture their attention and their enthusiasm. As an educator, you have to be a bit of an entertainer to inspire them. It's challenging, but it's also rewarding and fun. If you are a career educator like me, you never turn down an opportunity to work with kids."

The last module is a guided tour of the sustainable building and grounds, including features such as constructed wastewater wetlands, rain gardens, vermiculture composting, a green (vegetated) roof, and geothermal and solar utilities. For many students, a highlight is also visiting the science labs, where

they see scientists at work and the kinds of research studies that are in progress. As part of the tour, they also walk through the streamhouse on the glass bridge that connects the research labs to the Moorhead Environmental Complex.

Reaching Beyond the K-12 Classroom

School groups aren't the only audience to benefit from the Stroud Center's knowledge about freshwater science. Within the last year, Kerlin and the education staff have expanded their efforts to reach more children and adults with a variety of fun programs. The Stroud Center now offers day and overnight programs for Boy Scouts and Girl Scouts, as well as trout-release programs for children and their families. Additionally, the education department is partnering with universities, the Chester County Intermediate Unit, and other Stroud Center staff to provide professional development workshops for teachers, watershed science education for undergraduate and graduate students, and training for citizen scientists and watershed professionals.

"In 2016, we began offering inquiry-based professional development for educators that includes webinars on WikiWatershed.org and the Leaf Pack Network[®]," says Kerlin. WikiWatershed[®] is an online toolkit redesigned and relaunched in 2016. "We've had dozens of educators from across the country participate, and with what they've learned, they will be able to use these tools in their own outdoor classrooms and communities."

Millersville University Professor Nanette Marcum-Dietrich, Ph.D., is helping to oversee the development of the new Watershed Education Training Institute at Millersville: "We wanted to bring in school groups and train teachers, but we don't have the manpower here to run the program, so we

Right: Educators learn to identify macroinvertebrates at a Leaf Pack Network workshop, one of several opportunities the Stroud Center offers to educators seeking professional development training and credits.

Photo: Tara Muenz

looked to Steve Kerlin at the Stroud Center and asked, 'Can you come in and fill this gap?'"

Marcum-Dietrich says she also had the opportunity to bring her own children to one of the trout-release days last spring. "My kids loved it. And my son was involved in the Stroud Center's first Cub Scout overnight trip. That was probably one of their favorite activities this year. To hear them talk about the eel they caught: 'It was the biggest one ever!' The exploring was so much fun for them. And they loved knowing that real scientists work there. They're not just reading about science in a textbook. That's the neat part about the education programs: the students aren't going to a nature center or a park; they're going to a research center where science is happening."

Watershed Science Goes High-Tech

While getting children and adults outside and into streams to learn watershed science is integral to the Stroud Center's education programs, so too is technology. "Technology, particularly mobile technology, plays an important role in science and how we gain knowledge about our environment. Plus children and adults enjoy using technology, so it's a win-win," says Kerlin.

One example is the Water Quality mobile app, which lets educators and citizen scientists create a digital lab report of stream data and then provides learning pop-ups to help users make sense of the data they collected. Previously, it was only available for Apple Devices. It is now available for Android tablets and smartphones too.

Another example: Model My Watershed®, one of the WikiWatershed web tools. "Last school year, we recruited about 75 teachers in five states to pilot a watershed curriculum that incorporates Model My Watershed,"

Kerlin says. The web tool developed by the Stroud Center and technical partners allows users to select any geographic area in the continental United States, choose from a variety of land-use changes, and then predict the impact on stormwater runoff and water quality.

"It's an exciting time. We're reaching more people than ever before with our watershed science and education, and we're not done yet!"

If there's one thing Anderson wants people to take away from an education experience through the Stroud Center, it's that the entire stream ecosystem should be treated as a living thing that is sensitive to outside forces: "It's like when you go to the doctor, and the doctor takes your vitals. Science tells you the vital signs of a stream. And more broadly, I hope we are teaching people to become more interested in their natural environment and giving them the knowledge and tools to make a positive impact in their schools and communities. Not everyone needs to be a scientist, but everyone needs to be a citizen scientist."



The Outdoor Classroom

Located just a short walk upstream, the Stroud Center's new outdoor classroom includes rustic-looking benches, lab tables, and an education kiosk that seem to naturally grow out of the woodland setting. The vision for the classroom came from Assistant Director of Education Tara Muenz, who saw a need to enhance the learning experiences for visiting students: "The classroom is all around us, but at the outdoor classroom, we can now provide infinite opportunities to learn and do real science within close proximity to the creek. It's a fun space that will continue to grow, and it's already a great model that other institutions are recreating." The innovative design of the education kiosk, which uses environmentally friendly materials, is the result of an Eagle Scout project by Payton Shonk of Boy Scout Troop 23 in Downingtown. Stroud Center Assistant Director Dave Arscott, Ph.D., crafted the benches and lab tables from cedar.



RESTORATION



“Our overall goal is to reduce the magnitude of flooding in the watershed by at least 40 percent! And we are trying to do this almost overnight — within two years — in fact.”



Hurricane Sandy Grant Funds Restoration on White Clay Creek

By Patricia McAdams

Stroud™ Water Research Center has been experimenting with a variety of methods to restore streams and rivers for decades, and one of the best examples of integrating multiple science-informed watershed restoration practices to make a greater impact is the Hurricane Sandy project.

Because of the flooding caused by Hurricane Sandy, the National Fish and Wildlife Foundation provided the Stroud Center with a \$3 million grant to reduce flooding downstream from White Clay Creek. The Stroud Center knew exactly how to proceed.

What is distinct about the Hurricane Sandy project is that it is unique in terms of scale, says Stroud Center director Bern Sweeney, Ph.D.

"It is a huge challenge — taking on our entire 1,800-acre White Clay Creek watershed — and hoping to get all 26 landowners to cooperate.

"Our overall goal is to reduce the magnitude of flooding in the watershed by at least 40 percent!" he says. "And we are trying to do this almost overnight — within two years in fact."



A newly constructed level-lip spreader captures runoff from the adjacent farm field. Photo: Stephanie Eisenbise

According to Sweeney, the Stroud Center's approach includes an unusual combination of both new and old best management practices (BMPs).

One unique BMP is cutting a conservation swale across a hill to catch all surface waters rushing down. This swale — called a level-lip spreader — allows waters to seep into the ground, where eroded soils can be captured and microbial processes occurring in the soils beneath the spreader can break down pollutants as waters travel gently toward the stream.

Another unusual BMP is placing woody debris into streams to slow waters moving downstream.

The project also seeks to achieve a streamside forested buffer of 100 feet. This is more than twice as wide as what had been asked of landowners in the past. But Sweeney is optimistic.

"We think we can demonstrate that if you can get landowners to work together as a team, and if you have good scientific protocol, you can reduce downstream flooding and better protect water quality in short order."



Erosion control matting is unrolled to stabilize the land on which a level-lip spreader was installed in summer 2016. Photo: Kay Dixon

Cover Cropping: Profitable and Better for the Environment

Within the context of the National Fish and Wildlife Foundation flood control project on White Clay Creek, Bern Sweeney received a grant from the U.S. Department of Agriculture to look at the effects of cover cropping on both the quality and quantity of water running off agricultural fields.

"With our big watershed project, we can create conservation swales and forest buffers and basically keep surface water from almost any activity uphill from running into the creek," he says.

"What we really want to do, however, is to change agricultural practices in such a way as to not produce surface water runoff in the first place."

According to Sweeney, the science behind continuous cover cropping means that at no time during the year is there ever bare

ground, nor is it tilled. Farmers abandon plowing and disking entirely. Instead, they plant eight to 10 species of plants carefully selected for distinct tasks. Some plants add nitrogen to the soil. Some control pests. Some create ways for water to infiltrate in a rainstorm. Properly done, farmers can reduce the expense of insecticides and pesticides and irrigating fields yet still grow the same amount of crops.

Sweeney is confident that he can demonstrate how things change with regard to the quality and quantity of water that either runs off the field or percolates down into the ground. He will demonstrate these differences using side-by-side fields — one with cover cropping and one without.

"And we can show farmers that they can make more money this way. Plus, it's better for the environment."

Working Together to Make a Difference

The idea of landowners working as a team is a key factor in the success of a project such as this, says John Jackson, Ph.D. Jackson, along with Melinda Daniels, Ph.D., is part of the science team working with the Stroud Center's Watershed Restoration Group, which includes Matt Ehrhart, David Wise, and Lamonte Garber.

Jackson understands that every mile along the stream counts, if one hopes to restore a watershed, a lesson he learned firsthand in 1999 when he led an experimental watershed restoration project in Lancaster County.

"This understanding helped to set the goals for this new project," says Jackson. "Recruit every farmer along a given stream where restoration and water quality and quantity improvements are targeted.

"The novelty with this project is that we are starting this conversation by looking at some of our rural and suburban landscapes and how they are contributing significantly to the downstream flooding, where property damage occurs." Jackson adds, "The intent with these resources is to address both water quality and quantity."

Building Upon Decades of Trust

Once the research design was in place, meeting with landowners and land managers was the next step.

"The three main questions we have to answer are: what, how, and why," Garber says. The "what" describes the BMPs requested for each property. The "how" comes down to

money, design, and who will make it happen, and when. The "why" answers landowners' questions about the reason for the considerable conservation practices necessary.

"We know we are asking a lot," Garber says, noting that BMPs for many properties include the installation of cropland terraces, grassed waterways, level-lip spreaders, 100 feet of streamside forests, and more.

Ehrhart credits the willingness of landowners to participate in this research directly to the trust developed over time between landowners and the Stroud Center.

"I've never seen anything like this happen at this scale before," Ehrhart says. "I'm still in disbelief a little bit."

Rebirth of the Streams

While her colleagues are up on the hill taking steps to reduce stormwater running into the stream, Melinda Daniels, Ph.D., is literally in the stream. Here, she and her team are lugging large fallen tree branches and other woody debris into the water.

Their objective is twofold: First, to control flooding downstream. Second, to improve the ecosystem's resiliency to all kinds of natural disasters.

"By adding wood to small streams and creeks, every 15 feet or so, we basically increase the roughness of the channel, slowing the water," Daniels says.

"Wood is a source of carbon too," she adds. "Thus, it serves as a slow-release food source in a stream ecosystem. Further, it adds habitat for macroinvertebrates and fish that prefer living on or among the wood deposits rather than on rocks."

Scientists are already analyzing the results of this robust restoration. Sensors attached to stakes driven into the bottom of the level-lip spreaders are recording water depth and temperature, which allows scientists to then calculate the volume of water that soaks into the ground during a single storm. Next to these sensors, passive samplers are collecting some of the water to be analyzed for nutrient and sediment content. Importantly, four monitoring stations deployed in White Clay Creek further enable a range of hydrologic and water-quality testing.

Stroud Center Distinct Among Research Labs

Dave Wise is incredulous at how quickly this project has been moving forward. Already, 9,000 two-year-old trees have been planted along 4.8 miles of White Clay Creek. This equals 58 acres of new or supplemental forest buffers restored, with just under a dozen species of native trees — including pin oak, river birch, red maple, sycamore, and other native trees.

In addition to restoring riparian forests, Wise says the Stroud Center installed 573 feet of grassed waterways and 17,247 feet of cropland terraces on farms to slow the movement of water cascading downhill in a storm. Finally, 14,706 feet of level-lip spreaders were installed farther down the hill to capture almost all of the storm runoff. An additional 8,859 feet of level-lip spreaders are proposed for summer 2017.

“Researchers typically have a year or two of monitoring data that is pre-restoration,” Wise says.

“But at the Stroud Center, we have four decades of pre-restoration data on this section of White Clay Creek! With this data, our ability to see what effects this restoration effort will have in this stream will probably be unmatched in Pennsylvania — and perhaps in the nation.”

The monitoring of White Clay Creek also includes sampling fish, and here Wise is especially positive. “This restoration project may result in brook trout being able to live in this stream again one day.”

New Horizons

Looking back, Sweeney remembers that when the national competition team first reviewed the Stroud Center’s application for the Hurricane Sandy flood grant they said, “Wow! This is a great idea. But can you really do it?”

“And we thought, ‘Well, why not try?’ And we are doing it!” he says. “And everyone can take credit for it — all the landowners, all the conservation people with whom we are

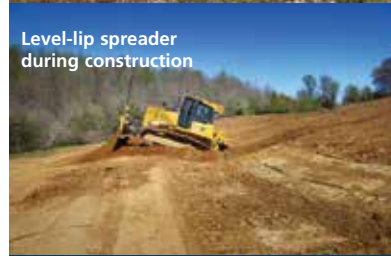
working, and our team at the Stroud Center. It’s a huge project, but with everybody working together, it is happening. Eventually, we hope to implement these practices nationwide.”



Location of level-lip spreader behind Stroud Water Research Center before construction



Level-lip spreader during construction



Level-lip spreader during construction



Level-lip spreader after construction

What Is a Level-Lip Spreader?

A level-lip spreader is a type of conservation swale designed to stop stormwater rushing into a stream.

“Picture a cornfield on a hillside,” says Bern Sweeney. “Then picture a heavy rainstorm with a flow of surface water cascading downhill into the stream.

“Now visualize on the hill toward the stream, a farmer builds a shallow trench across the entire field to catch this surface water. Importantly, this trench is on a contour, at the same elevation at one end of the field as at the other end of the field. Instead of the surface water running straight down the hill and into the creek, it runs into the trench — or level-lip spreader.”

The level-lip spreader catches virtually all the water for 90 percent of the storms. Specifically, the water stays in the swale for a day or two. Then it slowly seeps into the ground and moves toward the stream, underground, feeding streamflow later on when the weather is dry. Here, microbial processes can break down nutrients and other contaminants before they reach the stream.

In a big storm where all the water is not captured, the little that spills over does so slowly and gently across the entire width of the swale and into the forested buffer area.

“At no point do you have enough power for that water to create erosion or cause problems,” says Sweeney.

“One single level-lip spreader is a significant project to create, but it pays huge dividends in stopping most water from entering a stream,” he adds.

“And we did 18 last year!”

Research Projects

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

American Chestnut Foundation Leaf Feeding Study 2015–2016

Funded by: The American Chestnut Foundation

In an effort to restore chestnut trees to watersheds, blight-resistant varieties of American Chestnut have been developed over the last several years. This study uses the growth and survivorship of aquatic insects to test for differences in palatability and nutrition of leaves from several varieties of chestnut trees.

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

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

Funded by: Phoebe A. Driscoll

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: Bernard W. Sweeney and John K. Jackson

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

Funded by: Runnymede Sanctuary

The 1670-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



From left: Phoebe Driscoll, Matt Wilson, Kate McFadden, Sally Peirson, and Laura Borecki collect fish at Bennetts Run in Kennett Square, Pennsylvania.

Photo: Jan Battle

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: John K. Jackson and Matthew J. Ehrhart

Collaborators: Jinjun Kan, Melinda D. Daniels, David B. Arscott, and Anthony K. Aufdenkampe; The Nature Conservancy – Delaware Chapter

Characterizing Stream Connections and Physical, Chemical, Biological Influences on Downstream Navigable Waters

Funded by: U.S. Department of Justice

Drs. Dow and Arscott provided scientific expert services for the U.S. Department of Justice in the matter of Foster et al. v. EPA et al., No. 2:12-cv-16744 (S.D.W.V.). The scope of work was to characterize and provide testimony on the physical, biological, and chemical relationships between certain headwater streams located in Wood County, West Virginia, and downstream waters connecting to the Little Kanawha River and eventually to the Ohio River.

Principal Investigator: David B. Arscott

Collaborator: Charles L. Dow

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 Heirr-Stamm, Jason Bergtold, Aleksy Sheshukov, Martha Mather, and David Haukos (Kansas State University)

Collaborative Research: Coupled Geochemical and Geobiological Characterization of Dissolved Organic Matter Oxidation to Carbon

Funded by: National Science Foundation

As microbes process dissolved organic matter from leaves that fall into streams, they release CO₂ into the atmosphere. Scientists are studying stream networks from two different climatic regions to identify which molecules release high rates of CO₂ into the atmosphere from streams and rivers.

Principal Investigator: Louis A. Kaplan

Collaborators: Rose Cory (University of Michigan); Patrick Hatcher (Old Dominion 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.

Principal Investigator: Melinda Daniels

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

Delaware River Watershed Initiative — Monitoring, Evaluation, Scientific Support, and Capacity Building for Watershed Protection and Restoration Projects — Entomological and Fish Collections

Funded by: Academy of Natural Sciences of Drexel University (ANSDU) and William Penn Foundation

This project collected and interpreted data on macroinvertebrate specimens from 38 stream sites to provide a baseline for restoration 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: Roland Wall, Stefanie A. Kroll, Richard J. Horwitz, Jerry V. Mead, Donald F. Charles, and David J. Velinsky (Academy of Natural Sciences of Drexel University)



Sally Peirson and Lauren McGrath collect macroinvertebrates at the Runnymede Sanctuary.
Photo: Jan Battle

Delaware River Watershed Initiative — Protecting and Restoring Places of Ecological Significance (Brandywine-Christina and Middle Schuylkill Clusters)

Funded by: William Penn Foundation

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

Principal Investigators: John K. Jackson, Matthew J. Ehrhart, Bernard W. Sweeney, and William Eldridge

Collaborators: Berks Conservancy; Brandywine Conservancy; Brandywine Valley Association; Natural Lands Trust; Partnership for the Delaware Estuary; The Nature Conservancy of Delaware; University of Delaware

Delaware River Watershed Initiative — Protecting and Restoring Places of Ecological Significance (Schuylkill Highlands Cluster)

Funded by: Green Valleys Watershed Association and William Penn Foundation

This project monitored macroinvertebrates to establish a water-quality baseline at 10–16 selected sites associated with protection and restoration efforts for targeted watersheds in the Schuylkill Highlands cluster (i.e., Pigeon Run and French, Pickering, and Hay creeks) in the Delaware River Basin.

Principal Investigator: John K. Jackson

Collaborators: Green Valleys Watershed Association; Natural Lands Trust; French and Pickering Creeks Conservation Trust; Partnership for the Delaware Estuary; Audubon Pennsylvania

Ecotoxicity Study for Mayflies Exposed to Elevated Concentrations of Chloride

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 six mayfly species exposed to elevated chloride concentrations in water from three Exceptional Value streams in Pennsylvania as well as in White Clay Creek at the Stroud Center.

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

Ecotoxicity Study for Mayflies Exposed to Elevated Concentrations of Sulfate

Funded by: Pennsylvania Department of Environmental Protection

Across the United States, sulfate concentrations tend to be elevated in areas where acid rain or coal mining is present. This project measures responses of six mayfly species exposed to elevated sulfate concentrations in water from three Exceptional Value streams in Pennsylvania as well as in White Clay Creek at the Stroud Center.

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

Evaluating Potential Impacts on Groundwater of Passive Composting of Spent Mushroom Substrate According to Best Practices Guidelines

Funded by: Stroud Water Research Center and American Mushroom Institute

By installing monitoring wells for groundwater, soil-water samplers, and probes to measure the conductivity in soil and groundwater, researchers are testing whether Pennsylvania Department of Environmental Protection guidelines for passive composting of spent mushroom substrate are protecting groundwater.

Principal Investigator: Louis A. Kaplan

Experimental Streamside Forest Restoration to Improve Water Quality

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 600 trees and shelters on 2.1 acres of riparian land along Crum Creek in Paoli, Pa. The project was designed to test the effectiveness of 5-foot, coarse mesh shelters on seedling growth and survivorship.

Principal Investigator: Bernard W. Sweeney

Collaborators: Willistown Conservation Trust; Chester Ridley Crum Watersheds Association

Experimental Streamside Forest Restoration to Improve Water Quality

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



Sherman Roberts (on his birthday) and others collect fish in the West Branch Brandywine Creek near Honey Brook, Pennsylvania. *Photo: Kelly McIntyre*

This project involved an experimental planting of 300 trees and shelters on 0.7 acres of riparian land along Buck Run in East Fallowfield, Pa. The project was designed to test the effectiveness of various herbicide regimes on seedling growth and survivorship.

Principal Investigator: Bernard W. Sweeney

Collaborators: Dansko Co.; Cheshire Hunt

Experimental Streamside Forest Restoration to Improve Water Quality

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

This project involved two experimental plantings/installments of a total of 900 trees/shelters on 2.2 acres of riparian land along a small unnamed tributary of Buck Run in East Fallowfield, Pa. The project was designed to test the effectiveness of various herbicide regimes on seedling growth and survivorship.

Principal Investigator: Bernard W. Sweeney

Collaborators: Spring: Dansko Co.; Fall: Colonial Pipeline Co.; Exelon Co.

Improving Stream Water Quality and Reducing Runoff by Improving Farm Soil Health Through Permanent Cover Cropping

Funded by: U.S. Department of Agriculture

Scientists are studying how soil structure and soil ecosystem health improve farm fields over a three-year period after shifting from conventional tillage practices to cover cropping. They are also measuring changes in the amount of water, sediment, and nutrient runoff that result from the shift to cover cropping. At the conclusion of the project, watershed scaling models will be used to promote cover crops as a best management practice for mitigating pollution of streams and downstream estuaries.

Principal Investigator: Bernard W. Sweeney

Collaborators: Matthew J. Ehrhart, Anthony K. Aufdenkampe, and David B. Arscott

Installation and Maintenance Services for Two Wireless Stream Monitoring Stations Measuring Conductivity, Temperature, Depth, and Turbidity for London Grove Township, Pa.

Funded by: London Grove Township

To determine the extent of changes in water quality that may be related to land use, Stroud Center staff installed and maintained two real-time stations for monitoring water quality in a tributary of the East Branch of White Clay Creek to measure stream water level, temperature, specific conductivity, and turbidity in the creek.

Principal Investigator: Anthony K. Aufdenkampe

Integrated Data Management System for Critical Zone Observatories

Funded by: National Science Foundation EAR 1332257

The objective of the project is to develop a comprehensive, integrated data management system for the Critical Zone Observatory (CZO) program, called CZOData. The project's first goal is to support, empower, and broaden the impact of CZO science. The second is to maximize the return on investment of the CZO program by transforming capabilities to easily share, integrate, analyze, and preserve the wide range of multidisciplinary data generated within and across CZOs.

Principal Investigator: Anthony K. Aufdenkampe

Collaborators: Ilya Zaslavsky (University of California, San Diego); Kerstin Lehnert (Columbia University); Jeffery Horsburgh (Utah State University); Emilio Mayorga (University of Washington)

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)

Land Use Effects on Stream Thermal Regime

Funded by: USDA Forest Service

Stream temperatures are dramatically affected by land use in the watershed and riparian zone. In this project, we measure stream temperatures throughout a series of small watersheds with land use ranging from very urbanized to completely forested to develop a predictive model of stream temperature changes.

Principal Investigators: Melinda D. Daniels and Valérie Ouellet

Large Runoff Flux and Transformation of Particulate Nitrogen (PN) Following Large, Intense Storms: A Critical but Unexplored Component of N Cycling in Watersheds

Funded by: U.S. Department of Agriculture

Particulate nitrogen (PN) in stormwater runoff can increase dramatically with large storms, thus constituting a significant component of nitrogen cycling in watersheds. In this project, Stroud Center scientists apply a novel combination of approaches to monitor the flux and transformations of PN. The goal is to produce a comprehensive model for PN fate and transport in watersheds, especially in agroecosystems subject to climate variability.

Principal Investigator: Jinjun Kan

Collaborators: Shreeram Inamdar and Rodrigo Vargas (University of Delaware)

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

Funded by: National Science Foundation

Stream restoration in the United States is a multibillion-dollar industry. Yet long-term monitoring of its effectiveness is virtually nonexistent. 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: Bernard W. Sweeney, Anthony K.

Aufdenkampe, John K. Jackson, Jinjun Kan, and Melinda Daniels

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

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 Investigators: John K. Jackson and Bernard W. Sweeney

Metaecosystems and the Upstream Legacy: Influence of Dissolved Organic Matter on the Structure and Function of Streambed Bacterial Communities

Funded by: National Science Foundation DEB 1120717

Investigators explore how the quality of organic molecules changes with distance downstream and how those changes influence the composition of the communities of streambed microbes using that food resource. The research goals include advancing knowledge of stream ecosystems across drainage networks and forging a broad model of stream ecosystems in the global carbon cycle.

Principal Investigators: Louis A. Kaplan, Jinjun Kan, Tara Muenz, and Jennifer J. Mosher; Robert H. Findlay (University of Alabama)

Collaborator: David C. Richardson (SUNY New Paltz)

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: Anthony K. Aufdenkampe and David B. Arscott

Collaborators: Steven C. Kerlin; Robert Cheetham (Azavea, Inc.); Emilio Mayorga (University of Washington); David Tarboton (Utah State University)

Parthenogenesis (Virgin Reproduction), Hybridization, and Life History Plasticity in Mayflies

Funded by: Stroud Water Research Center

Scientists are studying a number of mayfly species in White Clay Creek as well as in streams throughout eastern North America to better understand virgin reproduction and hybridization in mayflies, confirm the biological integrity of species that are genetically distinct but have the same name, and develop valuable laboratory techniques for mating and rearing aquatic insects.

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

Pathogen and Water-Quality Monitoring at White Clay Creek

Funded by: United Water Delaware and Suez Environment

As part of a plan to meet new drinking water regulations, United Water Delaware (UWDE) applied best management practices at several dairy farms in the White Clay Creek and Red Clay Creek watersheds to reduce the amount of pathogens upstream of its Stanton plant. Scientists are monitoring water quality near and below these farms to measure the effectiveness of these best management practices.

Principal Investigators: Jinjun Kan and David B. Arscott

Collaborators: John K. Jackson; Kristen Jellison (Lehigh University); John Dyksen (United Water Delaware)

Physical, Chemical, and Biological Assessment of Streams and Rivers in Bhutan and Bangladesh

Funded by: Stroud Endowment for Environmental Research, W.B. Dixon Stroud Jr., Peter Kjellerup, and The Walker Fund of the University of Pennsylvania

Scientists continue to evaluate the water quality of streams and rivers flowing through the major districts of Paro, Thimphu, and Punakha in Bhutan, as well as the Sreemangal and Dholubari Tripura Para areas of Bangladesh. Three monitoring stations equipped with real-time sensors were established in 2015 on the Thimphu River in Bhutan and were operated continuously during 2016.



University of Pennsylvania graduate students Bryan Currinder and Naimul Islam collect aquatic macroinvertebrate samples in Bhutan. Photo: Nedup Tshering



How do aquatic biologists unwind after work? Kelly McIntyre, Katie Hughes, and Matt Wilson paddle on the Octoraro Reservoir. *Photo: Jan Battle*

Principal Investigator: Bernard W. Sweeney

Collaborators: Anthony Aufdenkampe; Beth Fisher (University of Minnesota); Bryan Currinder and Naimul Islam (University of Pennsylvania)

Restoring Flood Attenuation and Ecological Resiliency in the Mid-Atlantic Piedmont

Funded by: National Fish and Wildlife Foundation

For this project, scientists and watershed restoration professionals restore one headwater basin to reduce flooding downstream, improve water quality, and increase stream-ecosystem resiliency so that it will once again support a breeding population of native brook trout and other coldwater fish. Pre- and post-project measures of water quality, hydrologic regime, and biological communities will determine the project's effectiveness.

Principal Investigator: Melinda D. Daniels

Collaborators: Bernard W. Sweeney, David B. Arscott, Matthew J. Ehrhart, John K. Jackson, Tara Muenz, and Steven C. Kerlin

Scientific Software Integration (SSI): The Community-Driven BiG CZ Software System for Integration and Analysis of Bio and Geoscience Data in the Critical Zone

Funded by: National Science Foundation ACI 1332257

The goal of this project is to develop a web-based integration and visualization environment for joint analysis of cross-scale bio- and geoscience processes in the Critical Zone (BiG CZ), spanning experimental and observational designs. Collaborators include members of the Critical Zone science and broader communities, including natural resource managers and stakeholders. The BiG CZ Portal and Toolbox are built on foundations developed by the Model My Watershed® v2 and Observations Data Model v2 projects.

Principal Investigator: Anthony K. Aufdenkampe

Collaborators: Ilya Zaslavsky (University of California, San Diego); Kerstin Lehnert (Columbia University); Jeffrey Horsburgh (Utah State University); Emilio Mayorga (University of Washington)

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

Funded by: Starrett Foundation

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

Principal Investigator: Jinjun Kan

Spatio-Temporal Dynamics of Thermal Refugia in Streams: Consequences for Brook and Brown Trout Interactions

Funded by: Susquehanna University Freshwater Research Initiative

All species of trout are highly sensitive to stream temperature. Native brook trout are the most sensitive, needing colder temperatures than brown and other non-native species, making them most vulnerable to stream warming caused by land-use changes, such as deforestation, and climate change. This project tracked trout habitat use and stream water temperature in three headwater streams of the Loyalsock River, Pennsylvania, to evaluate how brook and brown trout compete for thermal refugia habitats.

Principal Investigators: Valerie Ouellet and Melinda Daniels

Supporting Citizen Science Within the Delaware River Watershed Initiative Cluster Team

Funded by: William Penn Foundation

The Stroud Center is working to expand and encourage higher-quality citizen-science monitoring and volunteer participation in the Delaware River Initiative cluster of streams. One- and two-day traveling workshops focus on general stream and watershed ecology, monitoring, and restoration. Remote sensors monitor water quality continuously and provide data for analysis. Efforts continue in the Circuit Rider program to facilitate cluster planning, coordination, project implementation, and monitoring, and to improve ongoing and future restoration project implementation.

Principal Investigators: Matthew J. Ehrhart, John K. Jackson, and David B. Arscott

Collaborators: Bernard W. Sweeney, Jinjun Kan, Melinda D. Daniels, Steven C. Kerlin, and Anthony K. Aufdenkampe

Threats and Opportunities in the Conservation of Native Pelagic Spawning Fishes in Kansas

Funded by: Kingsbury Family Foundation

This project documents how small dams have fragmented stream networks in the Central Great Plains region. Many fishes native to this region lay buoyant eggs that float downstream while developing. Juveniles then migrate back upstream to breed as adults. Using geographic information science, we are documenting fragmentation points (dams) that capture downstream drifting eggs as well as block maturing fish from returning to upstream portions of the stream network.

Principal Investigator: Melinda D. Daniels

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, Jinjun Kan, David B. Arscott, and Anthony K. Aufdenkampe

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 Creek National Wild & Scenic River

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

Education Projects

2016 Brandywine Treks at Point Lookout

Funded by: Point Lookout Foundation

The Brandywine Trek is a youth leadership and environmental awareness program that combines outdoor learning and physical activities over five days of hiking, canoeing, and camping along the Brandywine River. Trek activities are designed to build leadership skills, promote cultural and historical competence, and develop an understanding of watershed management and water resource linkages among our communities.

Project Lead: David B. Arscott

Collaborators: Tara Muenz and Steven C. Kerlin; Jarvis Berry (Coatesville Youth Initiative); Sky Prestowitz (UrbanPromise, Wilmington)

Collaborative Research: Introducing Critical Zone Observatory (CZO) Science to Students and Teachers

Funded by: National Science Foundation

The Critical Zone encompasses the external or near-surface Earth extending from the top of the vegetation canopy down to and including the zone of freely circulating groundwater. This project engages college students and teachers in a summer research internship studying two observatories: the Christina River Basin and the Susquehanna Shale Hills site. Participants engage in real-world, hands-on experiences examining and presenting on their particular research focus within the Critical Zone.

Project Leads: Aufdenkampe and Tara Muenz; Timothy S. White (The Pennsylvania State University)

Collaborators: David B. Arscott, Jinjun Kan, Melinda D. Daniels, and Heather Brooks; Holly Michael and Jim Pizzuto (University of Delaware)

Consortium for Scientific Assistance to Watersheds (C-SAW)

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

Stroud Center educators and scientists 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: David B. Arscott and Tara 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 Muenz

Collaborators: Shannon Hicks, Steven C. Kerlin, and Heather 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.

Project Leads: Marti Louw (Carnegie Mellon University); Tara Muenz

Collaborators: Steven C. Kerlin, John K. Jackson, Matthew J. Wilson, Michael C. Broomall, and Kelly C. McIntyre; John Morse (Clemson University); Lauren Allen (Carnegie Mellon University); John Wenzel (Carnegie Museum of Natural History)

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 at the Sacramento Waldorf School in California 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: Tara Muenz

Collaborators: Bernard W. Sweeney; Matt McTammany (Bucknell University)

Stream School for New Jersey Department of Environmental Protection (NJ DEP)

Funded by: NJ DEP

Stroud Center continues to provide expertise in two sets of two-day stream ecology trainings for AmeriCorps New Jersey Watershed Ambassadors and citizen water-quality-monitoring volunteers. NJ DEP utilizes volunteer data at the state level for assessing the health of its water bodies.

Project Lead: Tara Muenz

Stroud Stream 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 and Tara Muenz

Collaborator: Kristine C. Lisi



Tara Muenz shows eighth-graders from Patton Middle School how to monitor the health of a stream. Using a turbidity tube, the students measure how much dirt is in water collected from White Clay Creek, the research stream that flows behind the Stroud Center. Photo: Diane Huskinson



To educate the next generation of farm families about the relationship between land use and healthy streams, Lamonte Garber speaks to Mennonite school students in Lancaster County about watershed restoration projects the Stroud Center is working on in their community to improve water quality.

Photo: Tara Muenz

Stroud Water Research Center Streamside Classroom Project

Funded by: E. Kneale Dockstader Foundation

This project enhances our streamside classroom along White Clay Creek at Stroud Water Research Center with the construction of three educational kiosks and various interpretive signs and seating areas. Components of this infrastructure were built by a student seeking Eagle Scout rank with the Boy Scouts of America.

Project Lead: David B. Arscott

Collaborators: Steven C. Kerlin, Tara Muenz, Rebecca Duczowski, and William Milliken; Yeda L. Arscott (Arscott Architectural and Graphic Design)

Teaching Environmental Sustainability — Model My Watershed

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

Stroud Center educators and scientists are enhancing the Model My Watershed® application by integrating water-quality and terrain-analysis models. This work is being completed in partnership with the Concord Consortium, which will lead the curriculum development, and Millersville University of Pennsylvania, which will conduct research on learning. The geographic extent of this expansion will be the contiguous 48 states. Professional development for teachers will take place in California, Iowa, Kansas, Pennsylvania, and Virginia.

Project Leads: Melinda D. Daniels; Steven C. Kerlin; Nanette Marcum-Dietrich (Millersville University of Pennsylvania); Carolyn Staudt (Concord Consortium)

Collaborators: Anthony K. Aufdenkampe; Emilio Mayorga (University of Washington); Robert Cheetham (Azavea, Inc.)

Water Quality Mobile App for Android Devices

Funded by: Stroud Center Education Product Development

The Android version of the Water Quality app for tablets and smartphones was created to mirror the Apple Version. The Stroud Center now manages both versions and distributes the app as part of WikiWatershed.org.

Project Leads: Steven C. Kerlin and David B. Arscott

Collaborator: Chris Rider (Northern Kentucky University)

Water SCIENCE

Funded by: National Science Foundation, Innovative Technology Experience for Students and Teachers

The Stroud Center's education department is collaborating with the Concord Consortium on a project to introduce middle school students to engineering practices for water resources. This project targets schools in Boston; Kennett Square, Pennsylvania; and Phoenix/Tempe, Arizona. Millersville University of Pennsylvania is also involved.

Project Leads: Carolyn Staudt (Concord Consortium); Melinda D. Daniels; Nanette Marcum-Dietrich (Millersville University of Pennsylvania)

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. To date, the project has enrolled six farms implementing 52 best management practices, including about 3 miles of forested buffer averaging 50.5 feet on each side.

Project Lead: Matthew J. Ehrhart

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

Comprehensive Agricultural Stewardship in Lancaster County (DEP)

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

Stroud Center's Farm Stewardship Program provides technical and financial assistance to farmers and landowners to implement best management practices (BMPs) to protect water quality and improve stream health. In total, it has assisted 22 farmers to install more than 235 ag BMPs (including 85 acres of forested buffers on 11.3 miles of streambanks). This work leveraged roughly \$1.5 million in U.S. Department of Agriculture funds. In addition, the potential for farmers to engage in nutrient trading was also assessed on 231 farms. The intent was to see if income from nutrient trading could motivate and reward installation of ag BMPs. In most cases, work simply brought farmers up to baseline levels of conservation. In a few cases, tradable credits were generated.

Project Lead: Matthew J. Ehrhart

Collaborators: Red Barn Consulting, Inc.; TeamAg, Inc. Berks County Conservation District; Chester County Conservation District; multiple land trusts, conservancies, and others

Delaware River Watershed Initiative Circuit Rider for Technical Assistance to Grantees

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

This project provides technical assistance to grantees of the William Penn Foundation and the National Fish and Wildlife Foundation to develop and implement watershed restoration efforts and grants to monitor the impact of projects implemented in the Delaware River Watershed Initiative (DRWI) clusters. Stroud Center's efforts with DRWI partners will lead to better proposals and projects as well as improved assessment of the project outcomes.

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

Collaborators: Bernard W. Sweeney, Jinjun Kan, Melinda D. Daniels, and Anthony K. Aufdenkampe

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 ag best management practices (BMPs). 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

Demonstrating Low-Cost Methods for Reforestation

Funded by: National Fish and Wildlife Foundation

Four sites in New York, Pennsylvania, and Maryland demonstrated options for improving the cost-effectiveness of reforestation methods, including direct seeding, innovative fencing in lieu of tree shelters, live stakes, improved methods for managing herbivore competition, and more.

Project Lead: Bernard W. Sweeney

Collaborators: David S. Wise; Paul Salon (U.S. Department of Agriculture); Art Gover (private contractor); Andy Duncan (Pennsylvania Department of Conservation and Natural Resources); Natural Lands Trust

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

Whole-Farm Conservation Including Forested Buffers

Funded by: National Fish and Wildlife Foundation

This project expands the Farm Stewardship Program in Lancaster and Franklin Counties — the top two dairy counties in Pennsylvania. To address water-quality issues, whole-farm conservation with forested buffers is implemented. Farmers who install forested buffers receive incentives that can only be used to pay for other needed best management practices on the farm.

Project Lead: Matthew J. Ehrhart

Collaborators: Red Barn Consulting, Inc.; TeamAg, Inc.; others

Published Titles

Albertson, L.K., and M.D. Daniels. 2016. Resilience of aquatic net-spinning caddisfly silk structures to common global stressors. *Freshwater Biology* 61: 670–679.

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Photo: Dave Funk

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On May 13, 2016, Stroud family members flew from all over the world to participate in the dedication of the W.B. Dixon Stroud Courtyard in memory of the Stroud Center's founder. The event also unveiled a large bronze sculpture of mayflies floating above native wetlands, a gift to the Stroud Center from Cynthia Stroud. Photo: Yeda Arscott (left), Dave Funk (right)

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Mike Broomall*
Shannon Hicks*
John Jackson*
Kelly McIntyre*
Tara Muenz*
Matt Wilson*
Dave Zgleszewski

ADMINISTRATIVE VOLUNTEERS

Donnan Sharp
Martha Ryan (Dansko)
Bella Gallo, intern
Kathy Hornby (Dansko)
Beth LaMantia (Dansko)
Nick Welsh, intern

TREE-PLANTING VOLUNTEERS

Cheshire Hunt Conservancy
Colonial Pipeline
Dansko
Exelon Generation
Voya Financial
Plus many individual volunteers for whom we are very grateful!

Please join us for more fabulous events throughout the year. Go to www.stroudcenter.org/events to learn more. Photos (all except noted): Jessica Provinski



Photo: Diane Huskinson



Financials

OPERATING STATEMENT

for the year ended December 31, 2016

REVENUES & SUPPORT

Research Programs (Grants & Contracts)	\$ 3,608,747
Watershed Restoration Group Programs	1,774,006
Endowment	1,389,431
Annual Fund	536,242
Education/Public Programs	447,851
Other Contributions & Income	368,207

Total Revenues & Support	\$8,124,484
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EXPENDITURES

Research	\$ 3,460,885
Watershed Restoration Group	1,585,418
Facilities	1,090,876
Administrative	648,201
Education	475,485
Development/Outreach	409,305
Information Services	360,451
Communications	49,247
Other	44,615

Total Expenditures	\$8,124,484
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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.

SECURING THE FUTURE

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



CREDIT CARD

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



STOCK

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



WIRE TRANSFER

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



PLANNED GIVING

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



CORPORATE MATCHING GIFT

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



MEMORIAL AND HONOR GIFTS

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

Stroud Water Research Center Development Staff

Kristine C. Lisi, Director of Development, klisi@stroudcenter.org, 610-268-2153, ext. 304

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Jessica M. Provinski, Associate Director of Special Events and Corporate Relations, jprovinski@stroudcenter.org, 610-268-2153, ext. 288

Staff

2016

Administration

Bernard W. Sweeney, Ph.D.
*President, Director, and
Senior Research Scientist*

David B. Arscott, Ph.D.
*Vice President,
Assistant Director,
and Research Scientist*

John D. Pepe
Controller and Treasurer

STAFF

Rebecca Duczowski
Administrative Assistant

Jane Sowden
*Grant and Contract
Administrator*

Biogeochemistry

Louis A. Kaplan, Ph.D.
Senior Research Scientist

STAFF

Michael D. Gentile
Research Tech III

Sherman L. Roberts
Research Tech III

Communications

Diane M. Huskinson
*Communications Manager
and Editor*

Development

Kristine C. Lisi
*Director of Development
and Outreach and Secretary
to the Board of Directors*

STAFF

David B. Reinfeld
*Director of Campaign
Programs and Major Gifts*

Kay D. Dixon
*Associate Director
of Donor Relations*

Jessica M. Provinski
*Associate Director of Special
Events & Corporate Relations*

VOLUNTEER

Nick Welsh

Education

Steven C. Kerlin
Director of Education

Tara K. Muenz
*Assistant Director
of Education*

STAFF

William C. Anderson
Part-Time Educator

David R. Dickens
Part-Time Educator

Elizabeth S. Gregg
Part-Time Educator

MaryAnn Levan
Part-Time Educator

Jennifer R. Matkov
Part-Time Educator

Vincent P. O'Donnell
Part-Time Educator

Kelli E. Williams
Part-Time Educator

Entomology

John K. Jackson, Ph.D.
Senior Research Scientist

STAFF

Juliann M. Battle
Research Tech IV

Michael C. Broomall
Research Tech III

David H. Funk
Research Tech V

Catherine R. McFadden
Research Technician I

William L. Milliken Jr.
Field Assistant

Sally Peirson
Research Tech III

Kelly C. McIntyre
Research Tech II

Sherman L. Roberts
Research Tech III

Matthew J. Wilson
Research Tech III

INTERNS

Alaina G. Bertoline
West Chester University

Theodore V. Black
Bard College

Julia Boyer
Skidmore College

Luke T. Frankel
United States Naval Academy

Kara M. Grubb
University of Delaware

Trevor D. Hall
University of Delaware

Garrett W. Hoover
West Chester University

Amy E. Kochel
Juniata College

William F. Morrissey
University of Delaware

Thomas A. Oranzi
*The Pennsylvania State
University*

Maria D. Scarborough
Grand Valley State University

Jacqueline M. Smiler
Ursinus College

Christine M. Stephens
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Vassar College

Jenna M. Waite
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Peter A. Willard
Ursinus College

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Lynchburg College

VOLUNTEERS

Bryan Currinder
University of Pennsylvania

Lauren McGrath
University of Pennsylvania

Naimul Islam Moon
University of Pennsylvania

Facilities

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Director of Facilities

STAFF

William L. Milliken Jr.
Facilities Manager

Tonya Prigg
Housekeeping

Salomon Romero
Woodlot Tech

Javier Tinoco
Woodlot Tech

Fish Ecology

David B. Arscott, Ph.D.
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Laura K. Borecki
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Michael C. Broomall
Research Tech III

Catherine R. McFadden
Research Technician I

Kelly C. McIntyre
Research Tech II

Sally Peirson
Research Tech III

Sherman L. Roberts
Research Tech III

Matthew J. Wilson
Research Tech III

Fluvial Geomorphology

Melinda D. Daniels, Ph.D.
Associate Research Scientist



Stroud Water Research Center staff and interns outside the Moorhead Environmental Complex in June 2016. Photo: Dave Funk

STAFF

Sarmistha Chatterjee
*Ph.D. Candidate,
University of Delaware*

Jennifer R. Matkov
Research Tech II

David S. Montgomery
Research Tech III

Valérie Ouellet
*Post-Doctoral
Research Associate*

INTERNS

Emily L. Scott

Katie L. Hughes

Zarley A. Rebholz
Philadelphia University

VOLUNTEERS

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Cornell University

Frank Klein, Ph.D.
*Research Tech and
DuPont Chemist Retiree*

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*Director of Information
Services and
Research Scientist*

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Heather P. Brooks
Web Developer

Elizabeth S. Gregg
Systems Administrator

Maritza Station* Costa Rica

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*Station Manager and
Research Tech*

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Research Tech

Microbiology

Jinjun Kan, Ph.D.
Assistant Research Scientist

STAFF

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Research Tech III

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University of Delaware

Erin Johnson
University of Delaware

Organic Geochemistry

Anthony K. Aufdenkampe, Ph.D.
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Research Tech III

Shannon D. Hicks
Research Engineer III

Jennifer R. Matkov
Research Tech II

INTERN

Kwan Jin
West Chester University

Watershed Installations

David S. Montgomery
Manager

Watershed Restoration

Matthew Ehrhart
*Director of Watershed
Restoration*

STAFF

David W. Bressler
*Citizen Science Project
Facilitator*

Stephanie M. Eisenbise
*Watershed Restoration
Coordinator*

Lamonte Garber
*Watershed Restoration
Coordinator*

David Wise
*Watershed Restoration
Manager*

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Millersville University

Matthew A. Gisondi
Philadelphia University

Joseph P. Receveur
Millersville University

Research Scientists Emeriti

Thomas L. Bott, Ph.D.
*Senior Research
Scientist Emeritus*

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

Adjuncts

William C. Anderson
*Adjunct Researcher, Unionville
High School Teacher Retiree*

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

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

NSF Research Experience for Undergraduates and Teachers

EDUCATION DEPARTMENT RET

Jill Dunscomb
Rustin High School

FLUVIAL GEOMORPHOLOGY REUS

Nathan Watson
Cornell University

Emma Gibson
Missouri State University

MICROBIOLOGY REU

Kathleen Fisher
Villanova University

ORGANIC GEOCHEMISTRY RET

Dan Bondanza
Sun Valley High School

ORGANIC GEOCHEMISTRY REU

Peter B. Wise
Goshen College

UNIVERSITY OF DELAWARE REUS

Riley Brown
*California State Polytechnic
University*

Catherine Medlock
University of Delaware



Entomology staff with 2016 summer interns. Photo: Jan Battle

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



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**The Stroud Center gratefully acknowledges the service of Clay Smith who retired from the board in 2016 after many years of service.*

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35 trees preserved for the future



2 lbs. water pollutants not created



16,155 gallons water saved



1,081 lbs. solid waste not created



2,979 lbs. CO₂ of net greenhouse gases prevented



16,000,000 BTUs energy not consumed



1,629 lbs. of GHG emissions not generated



0.97 barrels of natural oil unused



995 miles not driven



11 trees planted

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OUR MISSION

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



Photo: Sherman Roberts