

A full-page photograph of two researchers in a field. In the foreground, a person in a white hooded sweatshirt and grey pants is using a hammer to drive a black metal rod into the ground. A small white electronic device is attached to the top of the rod. A blue flag is also attached to the rod. In the background, another person in a red vest and blue pants is holding a surveying instrument. The field is green with some dry grass in the foreground. The sky is blue with white clouds.

2019 Annual Report

A YEAR IN REVIEW

Growing Community Outreach

**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.

AT A GLANCE

2019



MESSAGE

FROM THE EXECUTIVE DIRECTOR



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!

A handwritten signature in black ink, appearing to read "David B. Aronson".

Executive Director, President, and Research Scientist

*“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

RESEARCH



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."

Left: Clockwise from top: Jinjun Kan hammers a stake into the sampling plot for monitoring soil health and water quality at the Stroud Preserve near West Chester, Pennsylvania; Diana Oviedo-Vargas and Melinda Daniels survey carbon stocks in Costa Rica streams on the slopes of Mt. Orosi; Marc Peipoch and other scientists seasonally float along a 5-mile stretch of the Brandywine Creek to measure how much and how fast algae can grow in the river. They float the river at the pace of the water and measure algal biomass and activity every minute for about 4-5 hours; John Jackson explains the ecosystem in the Guanacaste region where the Maritza Biological Station is located in Costa Rica.

"If farmers aren't engaged, change won't happen."



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

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."

"A river is not just a hydrosystem or an ecosystem; it's also a human system."



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

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.

"They just wanted to save money."



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

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.

"All water is connected."



– Jinjun Kan, Ph.D., Associate Research Scientist,
Microbiology Group

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."

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more

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EDUCATION



“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'ARCIPRETE, 6TH GRADE SCIENCE TEACHER,
STETSON MIDDLE SCHOOL, WEST CHESTER, PENNSYLVANIA



Left: Middle School students explore the local watershed to complete their field note books.

Right: High School students examine and identify aquatic macroinvertebrates for a stream health study.



Meaningful Watershed Education

A LASTING AND EXPANDING PARTNERSHIP WITH A LOCAL SCHOOL DISTRICT

By Paul Joyce, Ed.D., and Tara Muenz

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.



Expanding watershed education through collaboration and partnership

" THE PARTNERSHIP BETWEEN AND NON-FORMAL EDUCATION BUILDING EFFORTS STATEWIDE

2017

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.

1,000 WCASD fourth graders visit the Stroud Center for hands-on stream study programs which 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 Rodriguez, 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

WCASD AND THE STROUD CENTER HAS BECOME A MODEL FOR BUILDING FORMAL PARTNERSHIPS. WE CONTINUE TO SHARE THIS THROUGHOUT OUR CAPACITY- AND NATIONALLY." — STEVE KERLIN, PH.D., DIRECTOR OF EDUCATION, STROUD WATER RESEARCH CENTER

2018

The Stroud Center becomes an annual outdoor field experience for fourth graders across the district. A four-day mini-unit is crafted for fourth-grade students before and after their field trip.

Paul Joyce (WCASD) and Steve Kerlin (SWRC) submit an environmental education grant proposal to the DEP. The awarded grant now funds forest enhancement efforts and an outdoor water quality education center at Stetson Middle School.

2019

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120 eighth graders from WCASD visit the Stroud Center for field experiences.

WCASD high school biology teachers visit the Stroud Center gaining professional development during orientations to the WikiWatershed Toolkit, exposure to related freshwater learning tools, and shadowing of Stroud Center education programs.

Steve Kerlin (SWRC) and Paul Joyce (WCASD) collaborate to design and lead the first NOAA-funded Pennsylvania Environmental Literacy and Meaningful Watershed Educational Experience (MWEE) training for Pennsylvania school administrators.

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,

THE SHARED VISION OF BOTH PARTNERS: SYSTEMIC AND SCAFFOLDED K-12 EDUCATION THAT FOLLOWS STUDENTS AND STAFF THROUGH EVERY STAGE OF LEARNING.

gaining professional development during orientations to the WikiWatershed Toolkit, exposure to related freshwater learning tools, and shadowing of Stroud Center education programs for fourth-grade students. This reflects the shared vision of both partners: systemic and scaffolded K-12 education that follows students and staff through every stage of learning.

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 MWEE training for Pennsylvania school administrators in 2019. "We continue to share this model partnership throughout our capacity-building efforts statewide and nationally."

get
involved

Our educators have developed extensive resources for educating adults and students grades 4 and up about watersheds and their importance. On-site and off-site school and scout programs, professional development workshops, and community and family programs are just some of the available options.

Visit stroudcenter.org/education for more information

WATERSHED RESTORATION



“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

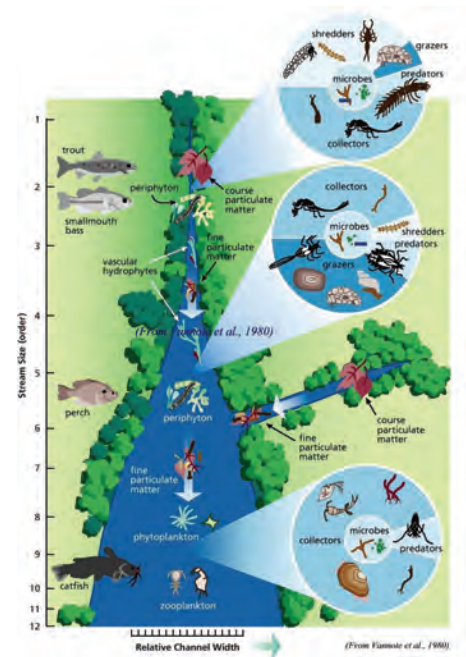


The River Continuum Concept was the first unified hypothesis about how streams and their watersheds work. It changed forever the world's understanding of freshwater ecosystems.

Source: *Stream Corridor Restoration: Principles, Processes, and Practices*, 10/98, by the Federal Interagency Stream Restoration Working Group (FISRWG).

Restoring the River Continuum Community

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



“FROM HEADWATERS TO MOUTH, THE PHYSICAL VARIABLES WITHIN A RIVER SYSTEM PRESENT A CONTINUOUS GRADIENT OF PHYSICAL CONDITIONS...WE REASON THAT PRODUCER AND CONSUMER COMMUNITIES CHARACTERISTIC OF A GIVEN RIVER REACH BECOME ESTABLISHED IN HARMONY WITH THE DYNAMIC PHYSICAL CONDITIONS OF THE CHANNEL.” — ROBIN VANNOTE, PH.D., *THE RIVER CONTINUUM CONCEPT* (1980)

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.](https://www.stroudcenter.org/restoration)

Mountains to the Sea

Restoring the River Continuum Community

"HE SAW THAT THE WATER CONTINUALLY FLOWED AND YET IT WAS ALWAYS THERE; IT WAS ALWAYS EVERY MOMENT IT WAS NEW."

— HERMAN HESSE, *SIDDHARTHA*

1 | Forests



3 | Healthy Soils



4 | Well-Managed Farms



5 | Riparian Forested Buffers



6 | Backyard Habitat



7 | Healthy Streams and Rivers



11 | Bays and Oceans



10 | Submerged Grasses and Salt Marshes



AND FLOWED,
THE SAME AND YET



2 | Wetlands and Meadows



8 | Green Infrastructure



9 | Woody Debris

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.

Photo: Stephanie Eisenbise

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. *Photo: M. Royer*

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. *Photo: City of Lancaster, PA*

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. *Photo: Chesapeake Bay Program*

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. *Photo: Chesapeake Bay Foundation*

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 Heirr-Stamm, Jason Bergtold, Aleksy 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)

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

Funded by: William Penn Foundation

This project collects and interprets data on macroinvertebrate specimens from stream sites to provide a baseline 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 represent an invaluable (and often neglected) tool to evaluate short- and long-term progress toward conservation priorities and goals. This project develops and implements



Entomology research technician, Sally Peirson, is collecting macroinvertebrates (aquatic insects) at Moselem Creek in Berks County, PA. Hundreds of streams like this one are being studied in an effort to protect and restore the Delaware River Watershed.



Drs. Denis Newbold, Diana Oviedo-Vargas, Clara Mendoza-Lera conduct an experiment in White Clay Creek to measure how algae moves in streams. The results are helping water managers distinguish water pollution from natural processes.

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

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

Funded by: William Penn Foundation

This project investigates how different agricultural management practices influence water quality and soil health. Using Rodale Institute's 37-year-old Farming Systems Trial and a 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 Octorara 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.

Project Lead: Marti Louw (Carnegie Mellon University)

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

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)

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.



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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



Dr. Dave Arscott explored the lower Cuyahoga River in Cleveland, OH via dragon boat (a 20-person canoe) with local high school students and teachers to learn how the river is being improved through stormwater management and stream stewardship.

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 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, and Melinda D. Daniels

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 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.

Stroud 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 are 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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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.

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Care has been taken to ensure the accuracy and completeness of this listing. We regret any omission and ask that you bring any corrections to our attention.

*Stroud Center staff †Deceased



Walt and Ellen Moore enjoy an evening out at The Water's Edge

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David B. Arscott – Gift-in-kind:
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Blue Yak Foundation:
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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.

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make a
difference

Learn how your business
can support our freshwater
education programs at
www.stroudcenter.org/eitc

**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:

PROGRESS 17% | GOAL \$8M

1 | RESEARCH

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

Achieved! \$50,000 Challenge Match Grant generously sponsored by Spurlino Family Foundation

PROGRESS 39% | GOAL \$2M

2 | EDUCATION

Enable educators to utilize technology to enhance and expand education beyond the classroom. Create, refine, and explore new education programs and associated curricula.

PROGRESS 93% | GOAL \$4M

3 | RESTORATION

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

PROGRESS 26% | GOAL \$5M

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

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

\$666,000 remains of the \$1 million challenge match generously sponsored by Rod and Alice Moorhead.

PROGRESS 93% | GOAL \$1M

5 | UNRESTRICTED PROJECTS

Affords institutional leadership the flexibility to apply funds where they are needed most, such as capital projects, conferences and meetings, and technology enhancements.

\$2,000,000 and More

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

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Cabot-Kjellerup Foundation – Restoration/Director's

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Anonymous – Research

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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

REVENUES & SUPPORT

Endowment	\$ 2,275,439
Research Programs (Grants & Contracts)	1,999,737
Watershed Restoration Group Programs	1,897,999
Education/Public Programs	611,079
Annual Fund	437,935
Other Contributions & Income	407,215

Total Revenues & Support	\$7,629,404
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EXPENDITURES

Research	\$ 2,618,513
Watershed Restoration Group	1,728,362
Facilities	1,153,955
Finance & Administrative	661,265
Education	533,842
Information Services	439,999
Development/Outreach	411,736
Communications	46,616
Other	35,116

Total Expenditures	\$7,629,404
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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.

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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



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.



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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.



CORPORATE MATCHING GIFT

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



MEMORIAL AND HONOR GIFTS

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

Please visit our website: www.stroudcenter.org or contact Director of Development Kristine Lisi at 610-268-2153, ext. 304, to learn about special giving opportunities.



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

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.

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
Peter Yee

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Science Seminar Series II: World Water Day Celebration

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Science Seminar Series III: Invasive Spotted Lanternfly

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Science Seminar Series IV: The Conestoga Study and the Woman Behind It

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Science Seminar Series V: Scientist on Tap

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The Water's Edge

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A special thank you to the Aller family and Lydia Willits Bartholomew for hosting this event.

Wild and Scenic Film Festival

Hosted by Trail Creek Outfitters
We are grateful to the many sponsors, volunteers, and attendees who make this event so successful.

Spring Tree Planting

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TREE PLANTING VOLUNTEERS

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

Administrative Volunteer Extraordinaire

Donnan Sharp



join
us!

Please join us for more fabulous events throughout the year.
Go to www.stroudcenter.org/events to learn more.

Clockwise from top: the Philly Eco Group toured the Stroud Center; Bob Huxter and Barbara Forney at The Water's Edge. Photo: Emily Scott; Voya Financial volunteered to help Restoration; Trail Creek Outfitter co-founders, Ed Camelli and Brian Havertine, at the Feb. 2019 Wild and Scenic Film Festival. (Brian Havertine has been dearly missed since his unexpected passing in Oct. 2019.)

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Rafael A. Morales
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Raven Bier, Ph.D.
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Laura K. Zgleszewski
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University of Delaware

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Daniel Warner
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Scientist Emeritus*

Adjuncts

Anthony K. Aufdenkampe, Ph.D.
*Adjunct Research Scientist,
LimnoTech*

Barry M. Evans, Ph.D.
*Adjunct Research Scientist,
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Nanette Marcum-Dietrich, Ph.D.
*Adjunct Education Faculty,
Millersville University*

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



A) 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.*



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