



2018 Annual Report

A YEAR IN REVIEW

Preparing for Extremes



A | THE WATER'S EDGE

American Rivers on its 45th anniversary and its president and CEO, Wm. Robert Irvin, received the Stroud Award for Freshwater Excellence on November 29, 2018 at Winterthur. In the previous year alone, the organization restored 407.5 miles of rivers, removed 2.58 million pounds of trash through their National River Cleanup, and granted \$1.24 million to local river conservation projects.

Photo: Gene Miller Photography

B | SCOUTS BENEFIT FROM MUDDY BOOTS FUND

As a result of a generous gift from brothers Greg, Barry, Keith, and Ray Bentley, the Chester County Council Boy Scouts of America and Stroud Water Research Center expanded their partnership to offer additional outdoor and environmental STEM programs.

C | RESEARCH

Scientists Jinjun Kan and Marc Peipoch ran an experiment using indoor flumes and stream water from White Clay Creek to learn about the formation and function of biofilms in streams. Armed with this knowledge, they can better understand how to encourage biofilm recovery after periods of flooding.

D | LAY OF THE LAND

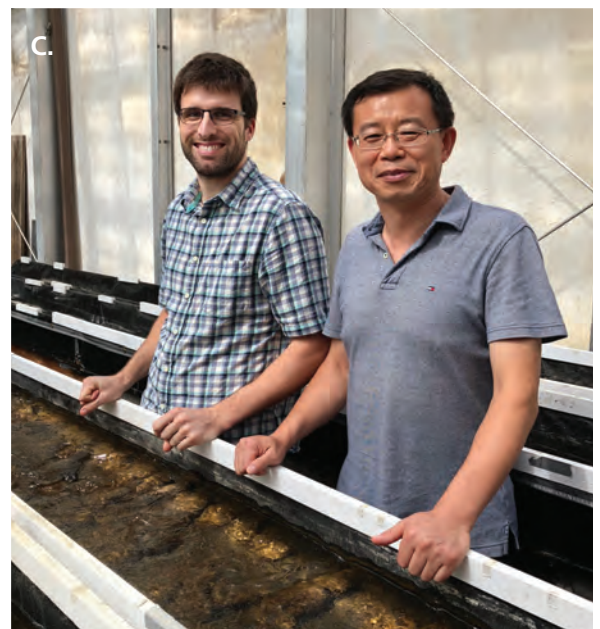
The 26-minute documentary film, "The Lay of the Land: Healthy Soil, Healthy Water," produced by Natural Light Films of Lancaster, premiered Thursday, October 11. The film tells the story of how local farmers are growing better crops while protecting water quality. It was produced in partnership with the Stroud Center, the Lancaster County Conservancy, and the Pennsylvania No-Till Alliance.

Cover photo: Carol Armstrong

Director's photo: Howard Sundwall

AT A GLANCE

2018



MESSAGE

FROM THE DIRECTOR



“Be prepared.” — ROBERT AND AGNES BADEN-POWELL, SCOUT MOTTO

Blistering heat and racing wildfires incinerated parts of California in 2018. As fire rained down, scorching the earth in biblical fashion, Paradise, it appeared, was lost. That was the West Coast. Meanwhile, here in Pennsylvania, we faced the second wettest year on record since 1949. Historic rain on the heels of Hurricane Florence brought devastating flooding to North Carolina. Then Michael, the strongest storm on record to hit the Florida Panhandle, caused an estimated \$4.5 billion in property damage, not to mention dozens of deaths.

Extreme weather is here, and so the question is, What are we going to do about it?

At Stroud Water Research Center, we are searching for answers. Much of our research explores solutions to the challenges posed by climate change.

On page 2, you can read about several of these projects and the potential benefits to landowners, communities, and their watersheds.

This year, we enhanced our award-winning web tool Model My Watershed with new features and expanded its use among students, teachers, and watershed professionals across the United States. You can read more about how this tool is making it easier for people to understand the impacts of land-use changes on water quality in their communities on page 6.

Our watershed restoration program is six years strong, and on page 10, we take a look at the progress made.

While 2018 was a year of many extreme weather challenges, it also provided opportunities to investigate how we can prepare for the future through research, education, and watershed restoration.

Lastly, I'd like to thank all of our friends of the Stroud Center for your generous support of our mission. We continue to put your support to work by enhancing existing projects, investing in novel and innovative research, education, and watershed restoration initiatives, and positioning ourselves to respond to future extreme conditions.

Yours in partnership,

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

RESEARCH



“There is a water crisis affecting both water quality and quantity...It is local, regional, and global in scale. The solutions are going to come from people rolling up their sleeves and trying to figure things out locally, while always keeping the bigger picture in mind.”

— BERN SWEENEY, PH.D., DISTINGUISHED RESEARCH SCIENTIST

Left: Stroud Center scientists measure flooding across Spencer Road after heavy rain. Right: Joey George and Raven Bier, Ph.D., take soil cores from one of the organic plots at the Stroud Preserve.



Going to Extremes

STROUD CENTER RESEARCH IN 2018

By James G. Blaine, Ph.D.

All across America, 2018 was a year of extremes in weather, temperature, and precipitation, most notably and tragically in California, where unprecedented summer heat, high dry winds, and the longest drought in its history produced massive and fatal wildfires. Conversely, in southeastern Pennsylvania it was “water, water everywhere,” as a total of 67.3 inches of rainfall made the year the second wettest in 70 years — only fractionally short of the 68.1 inches that fell in 2003. “The long-term trend is real,” said Denis Newbold, Ph.D., research scientist emeritus, whose analysis of data from Stroud Water Research Center and nearby NOAA stations “suggests that average annual rainfall has increased by six inches since 1949.” Yet unlike other years of heavy rainfall, 2018 had no major storms — the rain just kept falling. Among environmental scientists, there is little doubt that these weather extremes are related to changes in the earth’s climate.

Although water is one of the Stroud Center’s middle names, as well as its reason for being, too much of it can wreak havoc on its research projects — washing out experiments, intensifying runoff and erosion, and severely inhibiting the ability of its scientists to get onto the land and into the streams to do their work.

“It affects both the science you are trying to do and your ability to measure it,” said Senior Research Scientist John Jackson, Ph.D. “There was so much water in the Susquehanna River last year that we could not be in the river safely and get good data.”

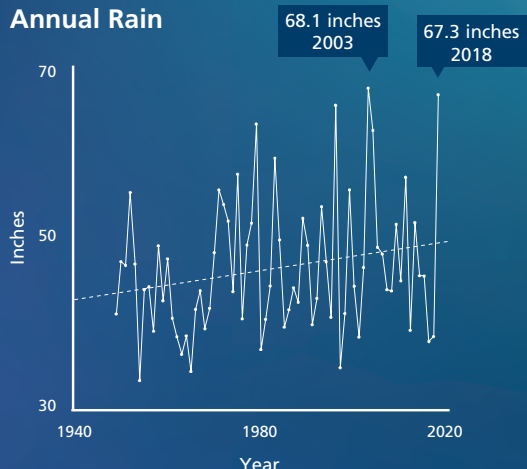
For the farmers who own and work the land on which many of the experiments take place, the effects can be worse: washing away seeds, delaying planting and harvesting, stranding equipment, and leaving crops rotting in the ground. “If this kind of weather pattern becomes regular in the northeast,” said Watershed Restoration Coordinator Lamonte Garber, “conventional best practices in agriculture and watershed restoration will have to shift dramatically.”

Stroud Center scientists are engaged in three significant research projects aimed at creating and testing new land-management practices to address many of the issues raised by increased weather extremes. Their collective goal is to help us learn how to best mitigate flooding hazards and protect clean water in a future that will be defined by the still-unfolding impacts of climate change. “The good news,” said Garber, “is that — thanks to the unusually heavy rains in 2018 — we got lots of runoff data.”

2018: A Year of Extremes

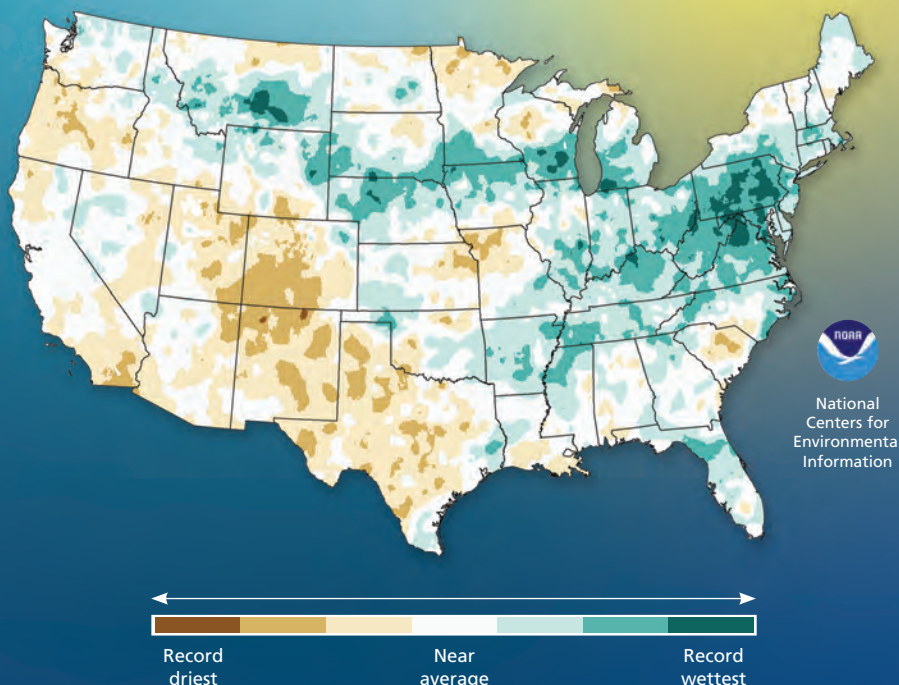
Unprecedented summer heat, high dry winds, and the longest drought in California history produced massive and fatal wildfires. Conversely, in southeastern Pennsylvania a total of 67.3 inches of rainfall made the year the second wettest in 70 years — only fractionally short of the 68.1 inches that fell in 2003.

Annual Rain



Total Precipitation Percentiles

January-August 2018 | Ranking Period 1895-2018



UNLIKE OTHER YEARS OF HEAVY RAINFALL, 2018 HAD NO MAJOR STORMS — THE RAIN JUST KEPT FALLING. AMONG ENVIRONMENTAL SCIENTISTS, THERE IS LITTLE DOUBT THAT THESE WEATHER EXTREMES ARE RELATED TO CHANGES IN THE EARTH'S CLIMATE.

Hurricane Sandy Project

The first project, known as the Hurricane Sandy Project, is funded by a \$3 million grant from the National Fish and Wildlife Foundation. Named for the devastating 2012 storm that caused almost \$70 billion in damage across the eastern United States and as far west as Wisconsin, the project's aim is to reduce flooding by 40 percent across the 1,800-acre White Clay Creek watershed, while simultaneously improving the ecological health of the stream's ecosystem. Now in its fourth year, the project has in place a number of flood mitigation best management practices (BMPs), including planting forest buffers along streams, creating floodplain wetlands, adding downed trees to stream channels, installing infiltration swales to capture field runoff, and terracing steep farm fields. Scientists are now in the process of comparing watershed flood responses before and after the BMPs were completed. "In addition to reducing flooding risk," said Melinda Daniels, Ph.D., the project's lead scientist, "these practices should contribute to cleaner and cooler water, as more precipitation will soak into the ground and take a slow, chilled underground route to the stream,

instead of flowing over the surface at air temperature. The net effect should be a cooler, healthier stream draining a watershed that produces lower magnitude floods during large storms."

Multi-Species Cover Cropping

The second project is a three-year Conservation Innovation Grant from the U.S. Department of Agriculture, which Distinguished Research Scientist Bern Sweeney, Ph.D., completed in December. He is seeking to determine whether converting conventionally tilled farmland to no-till, multi-species cover cropping can maintain crop yields, improve soil health, reduce runoff and erosion, and decrease the flow of nutrients and chemicals into streams. Preliminary results, said Sweeney, indicate that year-round cover cropping should help mitigate flooding because the improved soil structure will infiltrate and store rainwater longer, slowly releasing it through the ground, and ultimately into the stream. As a result, "there will be reduced runoff, and farmers will be less likely both to get their seed and soil washed away during rainstorms and need irrigation during droughts."

For these kinds of large-scale, long-term research projects to produce meaningful results, researchers have to collect, process, and compare data over several years, and the Prince Albert II of Monaco Foundation recently agreed to provide an additional three-year grant. Sweeney and his colleagues will add a new twist to the project by eliminating seeds coated with neonicotinoid pesticides on select fields. Because plants take up only about 5 percent of the pesticide coating, the vast preponderance goes into the soil, air, and water, which has substantially increased the amount of toxins in the environment. Sweeney's research will compare results between fields planted with neonicotinoid-treated seeds and those planted with organic seeds.

"What we're doing really isn't so new," he said. "Somehow we got away from cover cropping, something our ancestors learned 7,000 years ago through trial and error, and came to rely instead on large engineering and irrigation projects, on synthetic fertilizers and disruptive dams, which are expensive and environmentally destructive. Cover cropping is a form of infrastructure: it reduces flooding and makes farming more sustainable."

Healthy Soil, Clean Water

Finally, 2018 was the first year of a six-year, \$6 million project funded by the William Penn Foundation in which researchers at Rodale Institute and the Stroud Center have joined forces to evaluate the impact of farming practices on soil health, water quality, agricultural productivity, and profitability throughout the 8.7 million-acre Delaware River Watershed. With systems ranging from conventional to conventional no-till to organic to organic no-till, the project's goals, said Postdoctoral Researcher Raven Bier, are to "improve soil quality on the farms and water quality in the Delaware River watershed." The extremely wet summer created challenges for farmers, ranging from delayed planting to mired equipment to lost crops, moldy hay, and excessive weeds, and these in turn seriously hampered the scientists' efforts to gather background data. For example, said

Research Technician Joey George, "infiltrometer tests require pouring water on the soil to look at how quickly it percolates. But the soils were so saturated that nothing percolated."

In addition to research, the Stroud-Rodale project has programs for training farmers in the new techniques, engaging citizen scientists, and educating consumers.

All three studies seek to understand the impact of land-based activities, primarily by humans, on the quality and quantity of water and the life of streams. In doing so, they reinforce our understanding that all life is connected, and that what happens in one place has enormous — and often unintended — consequences for living beings and communities downstream. Like almost every other study in the Stroud Center's 51-year history, each had its origins in the East Branch of White Clay Creek, a small third-order stream that runs beside (and even through) the Stroud Center. And each embodies the recognition that the best solutions for almost all water crises are not to undertake massive engineering schemes but, instead, to put watersheds and their streams in a position to fix themselves and then get out of the way — to, said John Jackson, "let nature take its course."

"I call these 'good neighbor projects,'" added Jackson. "They are aimed at mitigating damage to downstream communities, estuaries, and the ocean by reducing inputs at the source." In years of unusual flooding, such as 2018, that becomes more difficult as the land gets saturated and the streams run high. With both the Stroud Center's data and global climate models pointing to a future of increasing rainfall, both farmers and scientists are preparing to cope with more extreme weather conditions.

"There is a water crisis affecting both water quality and quantity," said Sweeney. "It is local, regional, and global in scale. The solutions are going to come from people rolling up their sleeves and trying to figure things out locally, while always keeping the bigger picture in mind."

EACH STUDY EMBODIES THE RECOGNITION THAT THE BEST SOLUTIONS FOR ALMOST ALL WATER CRISES ARE NOT TO UNDERTAKE MASSIVE ENGINEERING SCHEMES BUT, INSTEAD, TO PUT WATERSHEDS AND THEIR STREAMS IN A POSITION TO FIX THEMSELVES AND THEN GET OUT OF THE WAY: "LET NATURE TAKE ITS COURSE."

— JOHN JACKSON, PH.D., SENIOR RESEARCH SCIENTIST

EDUCATION



“It is amazing to see how much more invested students become in these projects knowing that they are using real-world data to help solve real-world problems.”

— JAMES HOVAN, A 10TH THROUGH 12TH GRADE BIOLOGY TEACHER,
LANCASTER, PENNSYLVANIA

Creating Model Stewards by Modeling Watersheds

THE DIGITAL LEARNING TOOL FLOODING CLASSROOMS COAST-TO-COAST

By Mandy Nix

The energy in the room is electric as fingers skitter across keyboards and eyes run marathons over laptop screens. From the edges of chrome-and-plastic school chairs, students traverse hundreds of stream miles in a few mouse clicks, chasing their schoolyard creek in southeastern Pennsylvania past George Washington's famed crossing of the Delaware River in Trenton, New Jersey, and winding over the New York–Pennsylvania line to a headwater stream in the Catskills. Air conditioning buzzes overhead while students build cities, plant forests, install rain gardens, and try their hands at no-till agriculture. They make it rain, discover connections between land use and water quality, and model the watersheds of today for the stewardship of tomorrow.

This is Model My Watershed®, a professional-grade watershed modeling web app that enables students, citizens, and scientists alike to analyze real data and model water-quality impacts in watersheds across the lower 48 states. Stroud Water Research Center developed the tool in collaboration with LimnoTech, Penn State University, Utah State University, Drexel University, the University of Washington, Azavea, and Meliora Design.

"Model My Watershed puts at people's fingertips a quick, preliminary analysis of what's in their watershed and what human decisions and landscape features may be important

for water quality," says David Arscott, Ph.D., director of the Stroud Center and a key player in the web app's inception in 2009. "For anyone interested in learning anything about their stream, the very first place they should go is ModelMyWatershed.org."

James Hovan, a 10th through 12th grade biology teacher in Lancaster, Pennsylvania, says, "Model My Watershed allows students to quantify what sustainability looks like using real data to make compelling arguments for certain conservation practices in certain areas." He has used the tool to illustrate water-quality impacts and best management practices since 2015. "It is amazing to see how much more invested students become in these projects knowing that they are using real-world data to help solve real-world problems."



Left: Photo courtesy of the Pennsylvania Department of Conservation and Natural Resources

Accolades for Model My Watershed



- ★ A 2018 winner of Amazon's **City on a Cloud Innovation Challenge**.
- ★ Featured in a video in the NSF-funded **2018 STEM for All Video Showcase: Transforming the Educational Landscape**.
- ★ Finalist for the third annual **Excellence in Green Stormwater Infrastructure Awards** Ceremony in the Greater Philadelphia region.
- ★ Part of the **WikiWatershed®** toolkit that was awarded the 2017 Governor's Award for Environmental Excellence by the Pennsylvania Department of Environmental Protection.
- ★ Part of the **WikiWatershed** toolkit that was named by The Global Grid as one of the **Top 20 Civic Tech Websites for Urban Planners and City Makers of 2018**.

Hovan implements a place-based, problem-based watershed curriculum from the Teaching Environmental Sustainability: Model My Watershed project, a Stroud Center collaboration with Millersville University and Concord Consortium funded by the National Science Foundation. While actively engaging middle and high school students in watershed modeling and hands-on activities, the interdisciplinary curriculum promotes watershed stewardship, geospatial literacy, and systems thinking in science, technology, engineering, and mathematics (STEM).

More than 1,800 miles away in Gypsum, Colorado, STEM teacher Katie Lunde uses the curriculum to help her sixth- and seventh-graders critically analyze and understand the many environmental, economic, and social problems surrounding water.

"IT MAKES (STUDENTS) THINK, 'WOW, WE HAVE THE SAME ISSUES HERE IN EAGLE COUNTY AS KIDS IN INDIA AND AROUND THE WORLD. WE ALL HAVE POLLUTION. AND WE ALL NEED CLEAN WATER.'"

— KATIE LUNDE, STEM TEACHER, GYPSUM, COLORADO

"I don't think my students would typically walk around their schoolyard and think about soil, land cover, or conservation practices, or consider the impact of different types of pollution on the water near their own homes," confesses Lunde. "But this curriculum is an eye-opening experience that engages kids in a global issue — clean water. It makes them think, 'Wow, we have the same issues here in Eagle County as kids in India and around the world. We all have pollution. And we all need clean water.'"

Since 2016, 117 middle and high school teachers like Hovan and Lunde in eight states have completed training and classroom implementation of the curriculum. Hovan and Lunde shine among them as Model My Watershed Master Teachers, a coast-to-coast collective of 23 exceptional educators who lead the pack in implementing Model My Watershed in their own classrooms and spreading its delivery to others around the country.

Visitors to the online curriculum portal from 26 different states in 2018 indicate that its reach is only growing. Teachers are hungry for quality digital tools that support three-dimensional learning in the classroom while being free, fast, easy to access, and easy to use — boxes all ticked by the Stroud Center's cutting-edge web app.

Transporting Stewardship From the Screen to the Field

Perhaps the true power of Model My Watershed is not contained in a computer screen, but in the lasting lessons of action-based stewardship that follow students into the field. "Part of the original vision for Model My Watershed was to empower people not just to learn about their backyard, but to have the tools to understand problems and figure out how to fix them," recalls Arscott. "Now, we are eager to know, Has this tool led to action for anyone out there?"

Student action is a priority for Master Teachers hoping to equip students with the skills to analyze and solve complex environmental issues — from floods to drought. In the rolling farmlands of southern Pennsylvania, Hovan and his students are experiencing historically heavy rainfall and aberrations in the water cycle that he describes as "the new normal" in a state affected by climate change. "In the field, we have noticed much more riparian damage and channel shifting along the small streams we study than in previous years," says Hovan. "Since Lancaster County is the land of legacy sediment, this likely translates to much more sediment being transported downstream."

Model My Watershed's Site Storm Model has allowed Hovan's students to simulate large rain events that reflect current extremes in their watershed and discover best management practices that "effectively guard humans and the natural world from deluge and drought."

Meanwhile, in Colorado streams twisting below evergreen forest and chalk-white gypsum cliffs, Lunde's students have experienced shrinking snowpacks and extensive drought. "The last few seasons in Gypsum, we had absolutely no snow and hardly any precipitation," says Lunde of record drought in the state hailed the Mountain of Rivers. While 2019 has brought more precipitation to the region, the 2017–2018 water year in Colorado was the warmest and second driest in over 120 years of climate data. "Our rivers really ran dry, the waters were warm, and we observed a decline in macroinvertebrate and fish populations."

Endnote

Teaching Environmental Sustainability: Model My Watershed is funded by the National Science Foundation (grant DRL-1418133). The principal investigators are Steve Kerlin, Ph.D. (Stroud Center), Nanette Marcum-Dietrich, Ph.D. (Millersville University), and Carolyn Staudt (Concord Consortium).

WikiWatershed® and Model My Watershed were funded in part by:

- National Science Foundation (grants DRL-1418133, DRL-1417527, DRL-1417722, DRL-0929763, and DRL1433761)
- William Penn Foundation (grants 103-14 and 12-17)
- Stroud Water Research Center



SINCE 2016
117 teachers
IN
8 states

HAVE COMPLETED TRAINING
AND IMPLEMENTATION
OF THE CURRICULUM

Lunde embraces the weather extremes as teachable moments on the impacts of climate and human decisions on watershed health. Each year, her students become junior stream scientists while collaborating with their upstream neighbors in the ski town of Vail, where they collect and analyze aquatic macroinvertebrate and water chemistry data in Gore Creek and, more recently, plant native trees to restore streamside forests. At the least, the web app's curriculum is inspiring problem-solving, critical-thinking, and global-ready skills in her students, but at the most, it is jumpstarting their exposure and enthusiasm with STEM-related careers. "I have students who are aspiring for careers that they know, but I want them to be engaged in and aspire for careers they never knew anything about," said Lunde. "We need those global thinkers, those specialized careers in STEM and sustainability, and Model My Watershed is opening those doors for my students."

With impacts stretching 3,000 miles in classrooms coast-to-coast, the video gamelike interface of Model My Watershed is not an alternative to boots-in-the-water education; it is an enhancement and a revolution to the way we teach, understand, and conserve watersheds. "I would encourage anyone who wishes to impress the ecological, social, cultural, and economic value of a watershed on their students to give Model My Watershed a try," urges Hovan. "They will not be disappointed."

- Virginia Wellington Cabot Foundation
- The Danskø Foundation
- Generous donations from Peter Kjellerup and Mandy Cabot

WATERSHED RESTORATION



“Everybody’s connected to the land. Some less than others, but that’s what the general public gotta realize — hey, their food doesn’t come from a grocery store. There’s somebody out there raising it.”

— RANDY BALTHASER, FOURTH-GENERATION FARMER IN BERKS COUNTY, PENNSYLVANIA

Left: Balthaser's cows lazily graze on his farm. Right: Forest buffer planted along Northkill Creek on the Balthaser farm; Randy and Traci Balthaser.



Fifty Thousand Reasons Why the Watershed Restoration Program Is Six Years Strong

By Diane M. Huskinson

"Everybody's connected to the land. Some less than others, but that's what the general public gotta realize — hey, their food doesn't come from a grocery store. There's somebody out there raising it." Wise words from Randy Balthaser. He's a fourth-generation farmer in Berks County, Pennsylvania.

Living in a concrete city, as most Americans do, it can be hard to make that connection. Balthaser and his wife, Traci, both grew up on farms. They enjoy raising their kids on the farm and working as a family. They have 400 acres of corn, barley, soybeans, rye, and alfalfa and keep 125 cows.

Balthaser's connection to the land extends to managing the impacts his farming practices have on Northkill Creek. "We need to keep it clean. There's stuff we did. That's why I went to no-till," he explains. No-till is a method of farming that does not disturb the soil through

tilling, as is done with a plow. Studies have shown that it reduces erosion, increases microbial diversity in soil, and can even increase profits.

"The 40 acres here gets grazed just to keep everything green all the time. I know that helps [reduce] erosion." Balthaser adds, "Everybody lives downstream." What he understands is that any pollution from his farm, whether from fertilizer or erosion, that reaches the Northkill is a threat to water quality for everyone living downstream.

Stroud Water Research Center, the USDA Natural Resources Conservation Service, and the Berks County Conservation District helped Balthaser secure funding for best management practices (BMPs) installed on his farm, including manure storage away from the stream and a forest buffer planted last year.

A Distant Connection

More than 80 percent of Americans live in urban areas, eating food that travels between 1,500 and 2,500 miles from farm to table.



Robin L. Vannote Watershed Restoration Program Named in Honor of First Director



The Robin L. Vannote Watershed Restoration Program proudly recognizes the many years of Vannote's dedicated service, research contributions, and support to the Stroud Center. Robin Vannote, Ph.D., was a research scientist and the Stroud Center's first director and served in that capacity from 1966 until 1988, when Bern Sweeney succeeded him.

Under Vannote's leadership, the Stroud Center evolved from a dream to an institution at the forefront of freshwater research. With a creative mind, a voracious appetite for science, and boundless energy, Vannote was a scholar and a leader and remains a nationally respected expert on freshwater ecosystems. He conceived of and developed the River Continuum Concept, which remains today the most highly respected and cited paradigm in aquatic ecology.

The Stroud Center has benefited enormously from Robin Vannote's hard work, keen insight, and long-term scientific vision since 1966, and the naming of the Watershed Restoration Program is a fitting tribute.



From left: Lamonte Garber, Calen Wylie, David Wise, Matt Ehrhart, and Matt Gisondi.

SINCE ITS INCEPTION,
THE WATERSHED
RESTORATION TEAM
HAS WORKED WITH
121 farmers
TO IMPLEMENT
1,337 BMPs

The Stroud Center has long advocated for forest buffers, with Stroud Center scientists publishing studies on them in the 1970s and initiating experimental tree plantings as early as 1982. Our scientists know from years of research that streamside forests can reduce the amount of polluted stormwater that reaches streams. Then, in 2004, they learned that forest buffers also help streams to process the pollutants that do get into their waters by supplying shade and food and enhancing the quality and diversity of stream life.

In the last six years, the Stroud Center has planted nearly 50,000 trees for clean water and healthy streams. It's a pace that has steadily increased since the formation of the Watershed Restoration Group in January 2013 (now the Robin L. Vannote Watershed Restoration Program). Matt Ehrhart and David Wise helped launch the program as director and manager respectively. Lamonte Garber followed in 2014 to build relationships with landowners and restoration partners, followed by Calen Wylie in 2016, who is responsible for forest buffer care and evaluation.

Without financial assistance, making improvements can be a challenge for many farmers, including Balthaser, who notes milk prices are a concern for him.

"On the whole, farmers want to do the right thing. They think about their legacy and stewardship," says Ehrhart. "However, the cost of making barnyard improvements to keep cow manure out of streams, for example, can be prohibitive." Ehrhart and his team secure funding for best management practices (BMPs) through programs like the Pennsylvania Department of Environmental Protection's Growing Greener program. "In exchange, the farmers have to meet certain standards that will protect water quality and ultimately benefit the entire community. It's a win-win."

The team then connects farmers and landowners to conservation partners that help them implement BMPs. These can include a variety of improvements:

- The planting of forest buffers.
- Measures to manage barnyard runoff and capture and treat dirty water.
- Erosion control through cover crops, grass waterways, terraces, and no-till practices.
- Fencing and water systems to prevent overgrazing.

The Power of Partnership



Beyond the farm, the Stroud Center has engaged well over 15,000 conservation professionals, landowners, and farmers through educational field days, presentations, and workshop trainings. Many of them have attended thanks to partners like Rich Shockey, who works for the Pennsylvania Department of Conservation and Natural Resources. During the last 25 years, Shockey has helped organize more than 40 workshops involving over 1,600 conservation professionals.

The feedback Shockey has received from the students, farmers, engineers, biologists, and others who have attended the workshops has been positive. Because forest buffers are a relatively low-cost, low-tech method of protecting freshwater resources, many participants have made changes in their operations.



Right: Rich Shockey and his wife, Sue, kayaking during a beautiful fall afternoon.

One of those conservation partners, the Chester County Conservation District, has provided technical assistance on several Stroud Center projects, including the Hurricane Sandy project (see p. 4 to learn more about this project). Christian E. Strohmaier, the conservation district's director, explains that the Stroud Center's watershed restoration team was the first watershed-focused group to understand the importance of compensating the conservation district. The technical assistance his team provides is specialized and has value. It includes surveying land and acquiring permits for the construction of BMPs like wetlands or level-lip spreaders, as well as their design and construction.

Strohmaier says, "Stroud stepped up and basically said, 'You know what, if you want technical assistance from the conservation district, you're going to have to pay for it.' What that has allowed us to do is have someone on staff who has at least part of their time available specifically for this kind of work."

Since its inception, the watershed restoration team has worked with 121 farmers and more than a dozen partners to implement 1,337 BMPs. Some have gone on to win conservation awards. Deep Roots Valley Farm, a fifth-generation family farm run by Will and Kelly Smith were among four winners of the 2018 Clean Water Farm Award from the Pennsylvania Association of Conservation Districts. This came on the heels of a 2016 Farmer of the Year award from the Berks County Conservation District.

Empowering not just individual landowners, but the entire landscape of watershed professionals, is key, says Ehrhart: "The impact on our watersheds will be far greater when best practices become standard practices."

2018 by the Numbers

For a complete list of 2018
research, education, and watershed
restoration projects, go to
www.stroudcenter.org/projects.



164

volunteers planted trees
for healthier streams



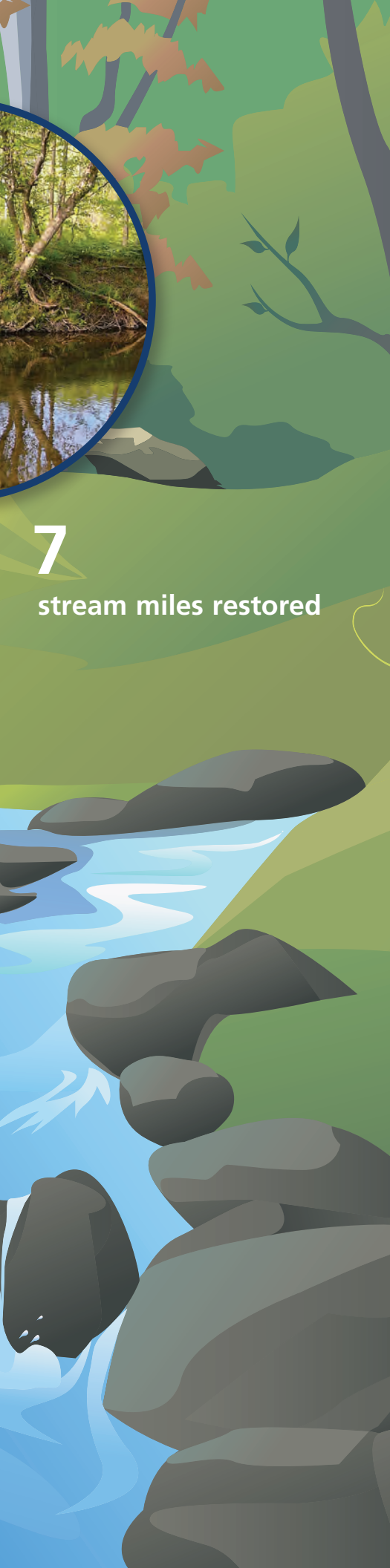
14,090

citizens learned about
freshwater science
and stewardship



363

stream sites studied



7

stream miles restored



104,407

macroinvertebrates identified to assess water quality and stream health



8

episodes of *Stories From the Streams* filmed for a WHYY series featuring Stroud Water Research Center and our partners



1

gold medal for the "Would You Drink the Water?" exhibit at the Philadelphia Flower Show



1,840

new users of Model My Watershed



7,562

total trees planted into

60.5

acres of streamside forest



2,353

water samples collected



1

Amazon Web Services award for Model My Watershed



236

best management practices installed and monitored on

24

farms



35

EnviroDIY sensor stations installed and monitored by

116

citizen science volunteers



30

peer-reviewed and scholarly articles published to share our knowledge about freshwater stewardship and build trust in our research findings



632

educators trained in watershed curricula, skills, and resources



5,000

fish collected



152

soil sites studied

Gifts and Contributions

We gratefully acknowledge the following 308 donors who generously contributed \$459,362 to our annual fund. These funds cover our operational expenses not supported by grants, and it allows us to continue and strengthen our work in freshwater research, environmental education, and watershed restoration. Thank you!

Gifts to the 2018 Annual Fund

\$25,000 and more

Meg and Dick Hayne
John Lazarich Foundation
The Leafglen Foundation
Mr. and Mrs. Rodman W. Moorhead III
The Willowdale Steeplechase

\$10,000 to \$24,999

Carol Atterbury
Amanda C. Cabot and
Peter Kjellerup
First Cornerstone Foundation
Jane C. MacElree Family Foundation
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\$5,000 to \$9,999

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honor of Alice and Rod Moorhead
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\$1,000 to \$4,999

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Evie Scott, Cuyler Walker, and Dolly Fisher at The Water's Edge to honor American Rivers. Photo: Gene Miller Photography

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 Mr. and Mrs. Robert Powelson,
 National Association of Water
 Jess and Matt Provinski* *in*
memory of Kathee Rengert



Rich Crosby and Nancy Wood shared a fun night out with Billy and Lisa Knox at The Water's Edge. Photo: Gene Miller Photography

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 David B. Reinfeld*
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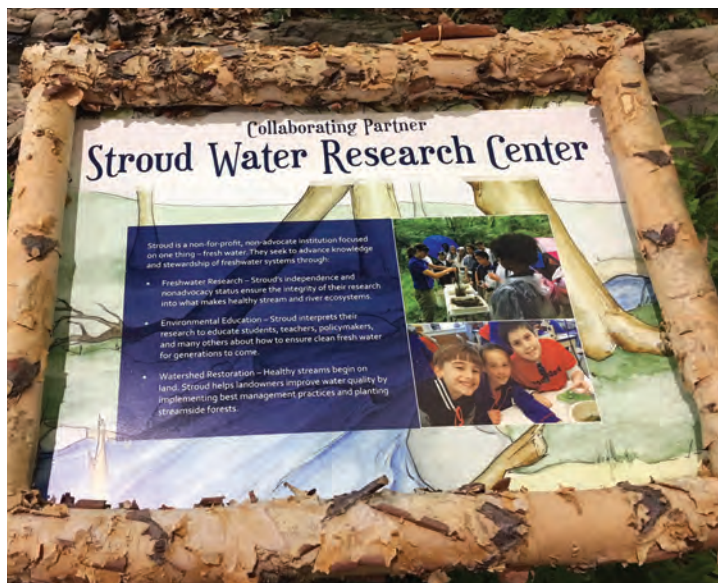
Up to \$99

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in memory of Bill Anderson
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Joseph Schmidt
 Tara Muenz* *in honor of the*
Muenz Family

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.



Stroud Water Research Center collaborated with horticulture students from Williamson College of the Trades on their Philadelphia Flower Show exhibit titled "Would You Drink the Water?" The exhibit featured flowing streams and highlighted ways to improve water quality. It won a Pennsylvania Horticultural Society Gold Medal and the Pennsylvania Landscape and Nursery Association Trophy for showing the most effective use of plants and best use of design in the education category.

Cintra and Robert Murray
 Mr. Dean Neely *in honor of*
Judy and Jamie Ackerman
 Mr. and Mrs. Thomas Noga *in*
memory of Doris Sweeney
 Vince and Peep O'Donnell*
 Diana Oviedo-Vargas, Ph.D.*
 Mr. C. Dilworth Pierson
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Sarah Plowman
 Denise M. Polk, Ph.D.
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 Mr. Christopher Robinson and
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 Dave and Cindy Rominger
 Nora Sadler
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 Mr. and Mrs. Geoffrey Selling
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 Mrs. Frances Levinson
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 Mr. and Mrs. Christopher H. Washburn
 Mr. John Weaver
 Matthew and Janet Weir
 The Wells Family
 Wynne and Sam Wharry
 Dr. and Mrs. Robert Whitlock
 Sandy and Hal Wilkinson



Special Gifts

The Auman Family Charitable Fund:
 education programming
 Axalta Coating Systems:
 education programming
 Bernardon — Gift-in-kind:
 architectural services
 Peco Energy Co.:
 education programming
 Mr. and Mrs. Gregory Perry:
 education program
 Sigma Aldrich/Millipore Sigma:
 barcoding research
 The Starrett Foundation:
 funds to support continuation of
 scientific research in the
 Red Clay Creek
 Mr. and Mrs. Stephen M. Stroud:
 funds to support operations at
 the Maritza Biological Station in
 Costa Rica
 Rittenhouse Builders — Gift-in-kind:
 construction services



Rittenhouse Builders provided vital renovations of the outdoor isotope laboratory as a generous gift-in-kind donation.

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.

Bryn Mawr Trust Company
 DNB First
 M&T Bank



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

5 MAJOR ASPECTS OF THE INITIATIVE

RESEARCH

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

\$50,000 Challenge Match Grant generously sponsored by Spurlino Family Foundation to benefit Research

EDUCATION

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

RESTORATION

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

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

Provide funds for critical centerwide initiatives. This fund will honor the legacy of Bern Sweeney's more than 40-year career and dedication to research, education, and watershed restoration for decades to come.

\$1 million Challenge Match Grant generously sponsored by Rod and Alice Moorhead to benefit the Bernard W. Sweeney, Ph.D., Executive Director's Fund

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.

The Future of Fresh Water Initiative

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.

Collectively, since December 2016, the following individuals and entities have contributed more than \$8.82 million of the \$20 million goal. They have our deepest gratitude.

OUR GOAL
**\$20
million**

\$2,000,000 and More

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

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

Meg and Dick Hayne – Restoration

\$500,000 to \$999,999

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Research

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– Unrestricted/Director's

Robin L. Vannote – Director's/
Restoration

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Anonymous – Research

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Education

The Boudinot Foundation –
Unrestricted

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Gift Fund – Education

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Restoration/Director's

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Restoration/Research/Education

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Caroline Moran – Unrestricted

Mrs. Elizabeth R. Moran – Research

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

Morris and Boo Stroud – Director's/
Research

The Marjorie P. Kraus Freshwater
Fund – Research

Welfare Foundation – Research

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Unrestricted/Restoration

H. Donnan Sharp – Director's

Spurlino Family Foundation –
Research/Research Challenge

\$20,000 to \$49,999

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Cabot Wellington Foundation –
Restoration

Crystal Trust – Research

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Dr. and Mrs. Bernard W. Sweeney –
Restoration

Marian S. Ware 2003 Charitable
Lead Annuity – Restoration

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Oxford Area Foundation –
Education

Rittenhouse Builders – Research

Carol E. Ware, Ph.D. – Restoration

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Research/Director's

Bessemer National Gift/24th Fund
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in honor of Rod Moorhead

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The Roemer Foundation –
Unrestricted

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Unrestricted

The RJM Foundation – Unrestricted

\$1,000 to \$4,999

Anonymous (3) – Unrestricted

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Stewart Huston Charitable Trust –
Education

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Director's

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\$500 to \$999

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\$100 to \$499

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Up to \$99

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 Mr. and Mrs. David Wise – Director's
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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, 2018

REVENUES & SUPPORT

Research Programs (Grants & Contracts)	\$ 3,365,060
Endowment	1,829,228
Watershed Restoration Group Programs	1,538,475
Education/Public Programs	545,620
Annual Fund	459,362
Other Contributions & Income	381,048

Total Revenues & Support \$8,118,793

EXPENDITURES

Research	\$ 3,622,795
Watershed Restoration Group	1,356,906
Facilities	1,125,042
Finance & Administrative	606,038
Education	504,061
Information Services	410,827
Development/Outreach	399,527
Communications	49,947
Other	43,650

Total Expenditures \$8,118,793

Financial Information

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

Privacy Statement

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

SECURING THE FUTURE

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



ONLINE

Visit www.stroudcenter.org/donate



CASH OR CHECK

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



CREDIT CARD

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



STOCK

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



WIRE TRANSFER

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



PLANNED GIVING

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



CORPORATE MATCHING GIFT

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



MEMORIAL AND HONOR GIFTS

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

Stroud Water Research Center Development Staff

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

Volunteers from Lincoln University (left) and Exelon Generation (right) were just a few of the many who helped us plant more than 7,000 trees for clean fresh water.

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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!*

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Yo'r So Sweet



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



Clockwise from top: Philadelphia Eagles safety Chris Maragos joined Axalta's All-Pro teachers for an educational adventure in White Clay Creek; Attendees at the Tip Your Hat to Bern Sweeney Retirement Party; Some winners at the 3rd Annual Fore Fresh Water Golf Invitational; Bern at his Tip Your Hat to Bern Sweeney Retirement Party; Road Rally for Fresh Water winners; 3rd Annual Fore Fresh Water Golf Invitational at Bidermann Golf Club.

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* 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.



From left to right, top to bottom: Volunteer Carol Armstrong maintained a sensor station in Pickering Creek in Phoenixville, Pennsylvania; Kevin Roth with Pennypack Ecological Restoration Trust collected a grab sample for analysis at the Stroud lab; Kelly McIntyre made some new friends on the Brandywine Creek; Jeff Chambers, a volunteer leader with The Nature Conservancy's Stream Stewards Program measured discharge with Matt Gisondi on Rocky Run as it flowed into First State National Historical Park; Dave Arcsott, Ph.D., and Jess Provinski celebrated Super Bowl LII Champions, the Philadelphia Eagles, at an Axalta Coating Systems event in Philadelphia; Stroud Center educators geared up for the fall season of environmental education programs during a professional development training day; Jan Battle spread her wings for the Wild-and-Scenic-themed holiday party; Jan Battle (Stroud Center) and Kim Hachadoorian (The Nature Conservancy) collected aquatic insects in First State National Historical Park; Denis Newbold, Ph.D., research scientist emeritus, was named a fellow by the Society for Freshwater Science and recognized at the annual meeting. Fellows are leaders, at national and international levels, of their areas of freshwater science.

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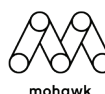
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