

Stream Stewards:

A Guide to Watershed Stewardship through Community Science and Youth Engagement

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Contents

Introduction

- Stream Stewards Program
- Community Science
- Strategic Partnerships

Community Science

- Data Collection with a Purpose:
Research Questions & Monitoring Strategy
- Cultivating Community: Volunteer
Recruitment, Training & Retention
- Story: A Pandemic Planting Project

Youth Engagement

- Alliance for Watershed Education (AWE)
Fellowship
- Green is For Teens (GIFT)
- Story: A Pick-up Truck of Pots

Program Sustainability

- Evaluating the Impact
- Story: Getting the Message “Just Right”
- Planning for the Future





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Introduction

Stream Stewards Program

Since 1951, The Nature Conservancy (TNC) has worked to protect the lands and waters on which all life depends. Throughout North America we're using nature-positive strategies to create healthier and more resilient human and natural communities. In northern Delaware, the Brandywine Creek flows through the heart of Wilmington, providing residents with drinking water and abundant recreational opportunities.

The Brandywine is also a crucial ecosystem that supports a wealth of native plants and animals, including migratory fish. The Stream Stewards program, launched in 2016, was created to build a constituency of support for the protection and

management of this vital resource. Based on a partnership between TNC and First State National Historical Park (FRST) and The Stroud Water Research Center (Stroud Center), the program aims to involve a wide range of people in caring for and managing watersheds through community science, education, and youth engagement.

The program harnesses the power of dedicated adult volunteers who contribute to science-based freshwater conservation through monitoring and restoration activities and provides education and professional development opportunities for local teens to raise awareness about green jobs pathways and the importance of clean water.

Introduction

Community Science

Community science (also called citizen science or public participatory science) engages people who are not professional scientists in research projects designed to study questions through scientific investigation. There are three main types of community science programs: contributory, collaborative and co-created.

With contributory programs, the primary role of volunteers is data collection. The collaborative model provides deeper engagement opportunities for volunteers who are also involved with data analysis and communication, often working in partnership with professional scientists. Co-created programs are those where volunteers are involved in every aspect of the project, starting with the project's goals, developing research questions, and implementing practices and recommendations that stem from their investigation (Bonney, Ballard et al., 2009).

The Stream Stewards program follows the collaborative model of community science. Volunteers participate in an extensive training program to learn about watershed ecology and the importance of water quality monitoring in managing freshwater resources. They learn how to collect data that will contribute to science-based conservation efforts.

Strategic Partnerships

Stream Stewards is based on a partnership between TNC and FRST, with the goal of creating a place-based program at the Park's Brandywine Valley unit while also providing valuable data to assist with natural resource management. As a relatively new national historical park, FRST was interested in building awareness and engaging visitors.

Since TNC's Delaware preserves are located in the southern part of the state and far from Delaware's largest city, the partnership with FRST provided an opportunity to grow our urban conservation program in Wilmington. With this partnership in place, and a plan starting to take shape for initiating a community science water quality monitoring program, the Stroud Water Research Center agreed to provide technical expertise to develop research questions, a monitoring strategy and state-of-the-art water quality sensor stations and equipment.

The Stroud Center is also invested in community science as a way of increasing public scientific literacy and building capacity for data collection with the goal of understanding, improving and protecting fresh water.

Community Science

Data Collection with a Purpose: Research Questions & Monitoring Strategy

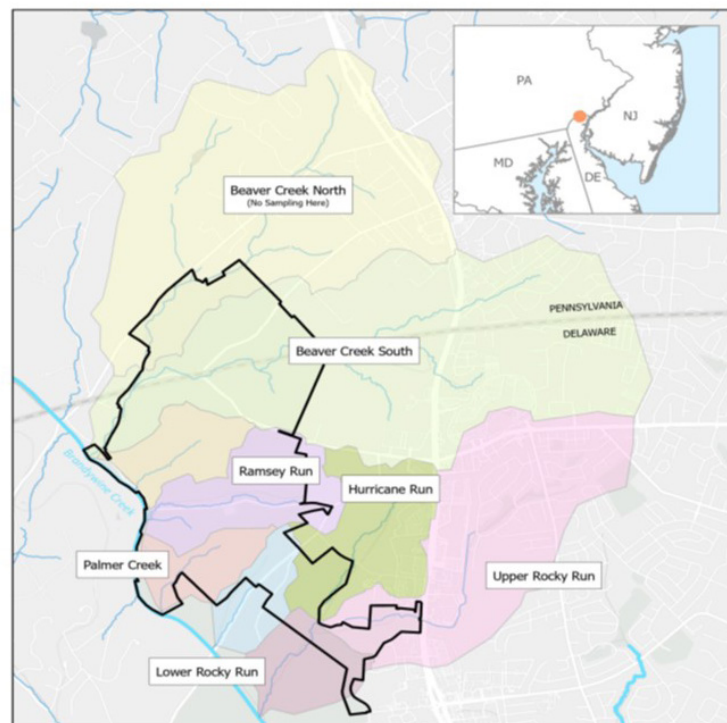
The Stream Stewards program was designed with the intention of collecting data for a specific purpose: to protect and improve water quality in Brandywine Creek through land management activities in the Brandywine Valley unit of First State National Historical Park. The data collection was guided by this purpose and the water quality monitoring activities were designed to answer questions that would help to achieve this goal.

The data collection was also intended for a specific audience: the national park staff who manage the land surrounding the streams. By defining a specific purpose and target audience for the data collection from the outset, TNC and FRST avoided a common pitfall of community science programs that engage volunteers in data collection and then struggle to find a meaningful application or identify an appropriate end user to validate the data collection and provide a sense of worth to the volunteer efforts.

The first step towards achieving the purpose was to develop a better understanding of how the various land uses within the ~1,350 acre park unit were impacting the water quality in the tributary streams that flowed through the park and into Brandywine Creek.

With guidance from the scientists at the Stroud Center, a monitoring strategy was designed to answer these questions. Six monitoring stations were installed on the banks of streams in the park that were surrounded by a variety of land cover types including forests, agricultural fields, residential and commercial development. With the goal of protecting and improving water quality in mind, the monitoring strategy was designed to provide data that would inform land management decisions in FRST and identify priorities areas for restoration.

This map shows the six stream monitoring locations and below is a brief description of the land cover types within each watershed (land that drains into the stream).



Beaver Creek:	Residential and agricultural impacts upstream of the park boundary
Ramsey Run:	Agricultural impacts inside park boundaries
Palmer Run:	Forested watershed completely contained within the park
Hurricane Run:	Development, including a college campus, upstream of park
Rocky Run:	Two monitoring stations on this stream. Headwaters in heavily developed residential and commercial area upstream of the park boundary. The "Upper Rocky Run" monitoring station is located just downstream of this development. The "Lower Rocky" station is located further downstream after Rocky Run joins with Hurricane Run.

Community Science

At each monitoring station two in-stream sensors were installed. One sensor measures turbidity which is an indicator of how cloudy or clear the water is and is determined by the amount of suspended solids in the stream. Suspended solids are particles, like soil particles that do not dissolve in the water. The other sensor measures three things: conductivity, temperature and depth. Conductivity is a measure of how well the water can conduct electricity and is determined by the amount of dissolved ions, or charged particles, in the water. These ions derive from materials that dissolve in the water, like salts. For example, table salt (sodium chloride) will dissolve into a positively charged sodium ion and a negatively charged chloride ion. A stream that has a high input of salt will have a correspondingly high conductivity. These in-stream sensors take readings every five minutes. The sensors are connected by cables to a logger board powered by a solar battery and protected by a waterproof box mounted on the streambank. The data are transmitted to a website and backed up on a memory card.



Left: The two in-stream sensors

Below: The stream sensors are connected to a data logger device



This is what each parameter tells us about water quality and stream health:

Turbidity: Very high turbidity can be a sign of excessive erosion or discharge. Large amounts of particles suspended in the water can negatively impact the stream habitat by preventing sunlight from penetrating the water, and clogging fish gills.

Conductivity: High conductivity is usually a sign of pollution entering the stream in the form of run-off from surrounding land. These pollutants can include road salt, and nutrients like nitrate and phosphate that can derive from fertilizers running off lawns and agricultural fields. High levels of these nutrients can cause algal blooms and a subsequent drop in dissolved oxygen levels which can lead to fish kills.

Temperature: High water temperature can negatively affect the stream habitat in many ways. Warm water does not hold as much oxygen as colder water and is therefore unable to support many native fish species, like Brook trout. Warm water also leads to higher levels of bacterial growth which can make recreational activities like swimming unsafe for people.

Depth: Water depth measurements can show how a stream reacts to large precipitation events. This can be an indicator of a stream's health based on the condition of the stream channel and banks. Natural stream channels with vegetated banks are more resilient during big storms, whereas streams with concrete channels and hardened banks are susceptible to flooding.

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Community Science

Cultivating Community: Volunteer Recruitment, Training & Retention

After the overall program goals and strategies were developed, it was time to begin the process of recruiting volunteers to be trained as community scientists. The plan was to recruit and train enough people to have teams of two or three volunteers for each of the six monitoring stations.

The main activity for each team would be to work together to schedule a monthly field visit to their designated sensor station to: conduct a visual survey (taking note of the land and water conditions, looking for signs of bank erosion, and indicators of pollution); conduct maintenance of the sensor station (clean sensors, ensure proper functioning of equipment, download data); and, take field measurements using pocket meters and test kits (measuring conductivity, pH, phosphate and nitrate).

Starting in 2016, a new cohort of volunteers was recruited to complete a training program consisting of four separate four-hour training sessions that served to introduce volunteers to the partner organizations and overall program goals, and to learn the monitoring protocols and gain hands-on experience in how to maintain the equipment and take field measurements.

Once fully trained, volunteers were organized into teams and assigned to monitoring stations. While the monitoring work was conducted in small teams, there were several opportunities throughout the year for the entire Stream Stewards volunteer team to gather. Quarterly meetings, attended by all volunteers and FRST staff, take place each season to share updates and review the quarterly data report to discuss water quality issues and trends.

Activities and events like bird walks, canoe paddles and an end of the year celebration provide opportunities to recognize and thank volunteers for their dedication to the program and for the volunteers to come together as a cohesive community.

In addition to the monthly monitoring activity, several other potential volunteer roles were developed to allow volunteers to bring their passion and expertise to the program. These include data analysis and visualization, public outreach and education with park visitors, working with youth, helping to train and mentor new volunteers, and working on restoration projects designed to protect and improve water quality. The following is a story that describes a project to add native trees and shrubs to Ramsey Run, to provide benefits for water quality, habitat and park visitors.



Community Science

Story: A Pandemic Planting Project

"To plant trees is an act of faith" – Robin Wall Kimmerer

In the early spring of 2021, following the long year of COVID lockdown, we were yearning to go outside, be together, and do good work. Over the course of several days that April, staff from First State National Historical Park, Stroud Water Research Center and The Nature Conservancy, along with several Stream Stewards volunteers, safely gathered at the park's Brandywine Valley unit for a project designed to use a natural solution to protecting clean water. We planned to plant native trees and shrubs along a section of Ramsey Run, one of the streams we monitor, that flows into the Brandywine Creek—the sole source of drinking water for residents of Wilmington, Delaware.

To comply with COVID safety measures we needed to limit the size of our group and practice social distancing while still working together as a team to plant and install protective barriers around 250 trees and shrubs. Following TNC's safety guidance, I wrote up a plan, had it approved, and assembled a group of staff and volunteers who were determined to not let a global pandemic stand in the way of watershed stewardship.

We chose to focus on a section of Ramsey Run where the stream is bordered on one side by a road, and on the other side by a large, mowed field that was being proposed as a parking site at the time (and has since been used for that purpose). This part of the stream was mostly unshaded with only a few large trees and was overgrown with invasive plants like multiflora rose that created impenetrable brambles with minimal value to local wildlife.

We wanted to replace these low-value species with fast-growing Silver Maple trees, whose broad leaves would shade the stream and make it a better home for animals like fish who need cool water because it holds more oxygen. We decided to add Button Bush to provide food for pollinators like bees and butterflies. All the plants we would put in the ground that day would bring many benefits as they grew into the future years and decades. They would help to prevent erosion by holding soil in place with their roots; they would protect clean water in the stream by filtering out pollutants; and they would create a beautiful and peaceful scenic backdrop for park visitors to enjoy as they hiked along the creek trail.



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Community Science

Story: A Pandemic Planting Project

Over two days we planted 250 trees and shrubs along the banks of Ramsey Run. It was hard work. We had to dig holes for every plant, spread mulch around the base and install a tube around every tree and a wire cage around every shrub to protect the tiny seedlings from being eaten by the hungry deer that we knew would be roaming the park by early evening. Had it not been for the pandemic we would have assembled a larger team for this project, but our small group of volunteers and staff from our three partner organizations happily labored side by side... well six feet apart for COVID safety! We smiled broadly at one another from under our masks.

Three years later, most of the trees and shrubs we planted are thriving. Several groups of volunteers and high school students have contributed to the maintenance of the planting by helping to clear away invasive vines and other non-native species from the planting area. This will give the native trees and shrubs a better chance to get established and get their fair share of resources like water, sun and space.

This project demonstrates the power of partnership. Non-profit partners, volunteers, and local youth groups working together have enhanced this natural system in their national historical park. In addition to wildlife and water quality benefits, this planting project creates an opportunity to raise awareness about the importance of protecting clean water and the ways that we can all help to be stewards of our local natural resources.



Youth Engagement

Alliance for Watershed Education (AWE) Fellowship

Through the partnership with FRST, TNC participated in The Alliance for Watershed Education (AWE) of the Delaware River from 2016-2023. AWE is a network of environmental education centers in New Jersey, Pennsylvania, and Delaware working to collectively increase and enhance constituent appreciation, knowledge, and stewardship of the Delaware River watershed. As an AWE member, TNC participated in the Watershed Fellowship program by hiring a summer intern from the local community to work on engaging residents in watershed stewardship through a variety of activities and programs.

This work as a Watershed Fellow exposes young people to environmental career pathways and provides professional development opportunities. Fellows become part of a cohort of Fellows working at centers throughout the watershed and get to learn about jobs and organizations throughout the watershed. After their Fellowship ends, they keep in touch with each other and staff from the centers through the Alumni network. Since the program's inception, many Fellows have been hired into full-time positions with member centers and other organizations within the watershed.

As part of the program, Fellows work on a capstone project designed to connect people to their local waterways. The capstone is an opportunity for Fellows to bring their passion and creativity to their work by designing a project that allows them to practice and explore skills in community engagement, education and youth development. Some examples of capstone projects led by our Fellows include building an educational model to demonstrate how urban stormwater runoff contributes to the pollution of streams and rivers; creating interpretive signage about the migration of American Shad in Brandywine Creek; developing programs for summer campers and teens about the mental health benefits of spending time in nature; and leading stream health investigations with teens in the Green Jobs summer employment program managed by the City of Wilmington Parks Department and the University of Delaware Water Resources Center.



Youth Engagement

Green is for Teens (GIFT)

The Green is for Teens (GIFT) curriculum grew out of a partnership with The Teen Warehouse, a community-based organization that provides employment and professional development for teens in Wilmington, DE. GIFT was created as an externship opportunity for teens to learn about green jobs and explore career path options, including jobs in water quality monitoring, urban forestry, green stormwater infrastructure, and advocacy. As part of the externship, teens participated in field trips hosted by program partners and heard from a variety of guest speakers. The goal was to expose teen participants to potential green career pathways that they might not have considered otherwise, and to highlight how these job skills could help them prepare for future employment that would contribute to a cleaner, greener future.

The following is a summary of feedback received from the eight high school students who participated in the GIFT program at The Warehouse in the Fall of 2022. Feedback was collected using a weekly reflection form that each student completed by answering three questions about that week's topic of study (stormwater management, urban forestry, advocacy, etc.). The three reflection questions were based on the Head, Heart, Hands Evaluation framework. Each week students were asked to write about what they learned (Head), how they felt (Heart), and what actions they intended to take (Hands) based on that week's lessons and activities.

What was Learned

The teen participants reported that they learned about the impacts of runoff on streams and rivers and how this source of pollution can be managed with green stormwater infrastructure. They wrote about the benefits of trees for people and nature, especially in cities. And they said that they learned how to use their voices through advocacy and public speaking.



"Something I learned this week is that when you have houses closer together it can help with water management. I thought this was interesting because I never really found the good in houses being close together, but on our field trip this week I learned that it creates more room for other things, like gardens, ponds, and plants that helps water runoff control."



"Something I learned this week is trees in cities make the temperature cooler, clean and soak up the rainwater, and clean out the air."



"Something that I learned this week is that advocacy is fighting for what you believe in... fighting for clean air and water for everyone."

Youth Engagement

Green is for Teens (GIFT)

How Participants Felt

The teens wrote about having fun and being engaged, especially during field trips and hands-on experiences, when they got in the water to do water quality testing and macroinvertebrate sampling. Staff from The Nature Conservancy and partner organizations came to The Warehouse as guest speakers and hosted the teens at off-site locations. The participants enjoyed hearing from guests about their career paths and learning about jobs in stormwater management and urban forestry.



"I liked when we went... inside the water to collect little bugs and we measured the water to see how good the water is and how cold it was."



"One thing that was fun was learning about jobs inspecting drains and I used the magnet crane to replace a storm drain cover."



"One thing I found fun was the planting trees we did on Wednesday. Another thing I enjoyed was learning about the different trees around The Warehouse on our walks."

What actions were inspired:

Participants were interested to learn more about the green jobs career pathways that were introduced in this program. They were also inspired to share what they learned with others in their families and their communities.



"I want to continue to look into careers that have to do with nature, it's something I've been gaining interest in since I was little. Something I want to learn more of is other tools to help with storm water management."



"I hope to learn if I see a tree we talked about to see if can remember what it's called...I hope to take (what I learned) and teach people in the real world about it."

Youth Engagement

Story: A Pickup Truck of Pots

"You are not honored for the fruit you pick, but for the trees you plant."
Matshona Dhliwayo

When I asked Kesha and Taryn, with the Delaware State Forest Service, if they would partner with me to provide programming for the teens at The Warehouse, as part of the GIFT externship, they were very happy for the opportunity to help teach teens about jobs in urban forestry. As part of our week together, they talked to the teens about why trees are important, especially in cities, and all the ways they help people including cleaning our air and water and providing shade during hot weather. The trees take care of us, and in return we must take care of the trees. The concepts became more tangible when we walked around the neighborhood together and saw examples of healthy trees as well as examples of trees that needed better care. But the most impactful experience that week was when Kesha and Taryn showed up at The Warehouse with a pick-up truck filled with bags of soil and bare-root seedlings in need of being potted.

At first, the teens were a bit reluctant. "We're going outside? It's cold out!" But once everyone put on jackets and work gloves and understood the task at hand, they really "dug into" the work. The students took great care to place the seedlings properly in the pots and add just the right amount of soil to support the baby trees in an upright position. They would bring their pots to me or Kesha or Taryn and ask, "Does this look good?" before moving on to the next. We all laughed as we worked out of the bed of the pick-up truck in the parking lot of The Warehouse as the sun went down in the late afternoon sky.

Once all the seedlings were potted up and arranged neatly in the truck bed, and we were walking across the parking lot to go back inside The Warehouse, one of the teens asked me "That's something people do as a job?" "Yes!" I said, "You can get a job at a nursery doing work like that." She looked at me skeptically "You mean like...with babies?" "No, not that kind of nursery." I thought for a minute and said "Well, it is working with babies, but not human babies—you work with plant babies!" She nodded thoughtfully: "OK, I like that." The experience of potting seedlings opened up the possibility of a green career path, and the sense that helping plants grow was something she enjoyed.





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Sustainability

Evaluating the Impact

TNC worked with an evaluation consultant to better understand the impact the Stream Stewards program was having on participants including the water quality monitoring volunteers, youth program participants, and local residents who we interacted with at public events like watershed clean-ups. Through a variety of evaluation tools, including focus groups, interviews, surveys and embedded assessments, TNC gathered information about the ways the program was succeeding and ideas for how to continue to improve it. TNC learned that volunteers appreciate being part of a community, and knowing their efforts were contributing to a watershed-wide effort to protect clean water. TNC heard from participants that they felt a stronger connection to their watershed by engaging in hands-on data collection that led to a sense of ownership and responsibility for “their stream.” Youth participants shared that their experiences inspired them to talk to their friends and family about what they learned and that they could explore environmental careers

in their future. The Stream Stewards program revealed the ability of community science to empower people to be educators and advocates, and the value of public clean-up events to inspire people to take action for clean water. An embedded assessment is one example of an evaluation tool that provided valuable information about the program’s impact. Embedded assessments offer a way to evaluate participant performance by integrating assessments into regular project trainings and program activities. The assessments are, in a sense, “invisible” to the participants, in contrast to a tool like a survey, that calls itself out as an evaluative method. Embedded assessments are particularly helpful in understanding how well participants are gaining skills necessary for achieving program goals. The following is a story describing how we used this tool to understand how well volunteers were communicating with park visitors about their work.

Sustainability

Story: Getting the message “Just Right”

“She tasted the large bowl and said, “This porridge is too salty!” She tasted the medium bowl and said, “This porridge is too sweet!” She tasted the small bowl and said, “This is porridge is just right.” She ate it all up.” – Goldilocks and the Three Bears

When Stream Stewards volunteers are out conducting water quality monitoring activities in the streams that flow through the National Park, it is not uncommon for park visitors to stop and inquire about what they are doing. These interactions provide the perfect opportunity for volunteers to serve as ambassadors for the program and to help educate the public about science-based conservation and watershed stewardship, which is one of the goals of the program.

To assess our progress towards this goal, it is important to understand how well volunteers are conveying the purpose of their work in a way that makes sense to the average passerby. To that end, we worked with our evaluation consultant, President of Two Roads Consulting Rachel Becker-Klein, to develop an elevator pitch embedded assessment that would help us understand how effectively volunteers were communicating about the program. We asked volunteers to practice a real-life experience that they would likely encounter—someone in the park comes up to you while you in the stream collecting data and says, “Hey, what are you doing?” How would you answer them? We asked this question of our volunteers during a training session and video recorded their responses.

The ways that volunteers answered this hypothetical question varied greatly. One volunteer responded: “We’re doing water quality measurements on this stream.” Short and sweet, but maybe not quite sufficient to satisfy the curiosity of the questioner. Another one said: “We measure the flow. We have a sensor that’s continuously monitoring water quality parameters: conductivity and turbidity, and we take monthly samples of nitrates and phosphates.” A lot more information in that answer, but maybe a tad too technical and not relatable to the questioner’s experience or understanding.

Another volunteer responded with this: “We’re monitoring the health of all the streams that flow into the Brandywine, which is Wilmington’s drinking water.” This response seems “just right” as it simply explains what she is doing, why it was important, and how it relates to people’s lives. This Embedded Assessment revealed the importance of “just right” messaging and the need to train our volunteers how to communicate effectively so that we can succeed in spreading the word and getting people invested and involved.



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Sustainability

Planning for the Future

Stream Stewards is a successful watershed stewardship program that provides a model for accomplishing the goals of community science, youth engagement and public education by providing opportunities for people to learn about and engage with their local waterways. The partnership between The Nature Conservancy, First State National Historical Park (FRST) and Stroud Water Research Center provided the foundation for the growth and development of Stream Stewards into a sustainable program with a largely self-sufficient team of dedicated volunteers who conduct water quality monitoring, assist with public education at events in the park, and act as advocates for clean water in their communities.

One of the main goals of the Stream Stewards program was to create a place-based program in FRST's Brandywine Valley unit to build awareness and visitor engagement in the relatively new national park. Since the program's inception in 2016, FRST has continued to add staff and programming at the Brandywine Valley unit and now has the capacity for administering a full range of volunteer roles, managing natural resources, and providing educational and youth programs. In addition, the park is now supported by Friends of First State, a Friends Group that helps to provide the park with funding and resources. FRST is now well positioned to take on full oversight of the Stream Stewards program and ensure its sustainability into the future.

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