EnviroDIY in the Delaware River Basin
Where have we come from and where are we going?

2021 Watershed Congress, Thursday September 23, 2021, 4:30-5:30p
David Bressler, Stroud Water Research Center
Main Point today: Stroud Center is supporting EnviroDIY in the DRB – how it’s happening, who’s involved, what’s being learned, what’s happening, and how can others get involved.
Today more specifically

- Overview of EnviroDIY
- Overview Monitor My Watershed
- Overview of “EnviroDIY in the DRB” program past, present, future; including:
  - History, for context
  - Case studies of how stations/data can be used
  - Resources for users
  - Options for how individuals/groups can get involved
EnviroDIY is “a community for do-it-yourself environmental science and monitoring. EnviroDIY is part of WikiWatershed, a web toolkit designed to help citizens, conservation practitioners, municipal decision-makers, researchers, educators, and students advance knowledge and stewardship of fresh water.” (from EnviroDIY.org)
What is EnviroDIY?

Join a community of do-it-yourself enthusiasts sharing open-source ideas for environmental science and monitoring.

Visit EnviroDIY

Discover what aquatic insects can tell you about your stream’s health by performing a simple leaf pack experiment.

Visit Leaf Pack Network

Identify common freshwater macroinvertebrates with this resource designed for citizen scientists.

Visit Macroinvertebrates.org

Enhance stream study and monitoring activities for students and citizen scientists. Available for Apple and Android devices.

Learn More
What is EnviroDIY?

- EnviroDIY is focused around the Mayfly Data Logger

The EnviroDIY Mayfly Data Logger is a powerful, user-programmable microprocessor board that is fully compatible with the Arduino IDE software.

Designed by Shannon Hicks, Stroud Center engineer
What is EnviroDIY?

- Lots of possibilities

Building a Low-Cost Electrical Conductivity Sensor Using the Mayfly Platform

The “Frankenlog” Network: A Forest Floor Ecohydrology Sensor Network Using the Mayfly Data Logger

By David Lutz on 2021-02-05

Building a Continuous Temperature Logger with the EnviroDIY Mayfly

By Robert S on 2020-05-11

No Comments

In the stream, sensors were mounted on standpipes and, later, on a boom extending over open water.
EnviroDIY globally

EnviroDIY monitoring stations across the world
EnviroDIY in the U.S.

Most stations are in the eastern U.S.
EnviroDIY in the U.S.

Greatest density of stations is in the Delaware River Basin
The Standard EnviroDIY Station

- Stroud Center’s standard EnviroDIY Monitoring Station

**EnviroDIY in the DRB**

Also designed by Shannon Hicks
The Standard EnviroDIY Station
The Standard EnviroDIY Station, Logger Box and solar panel
Features of the EnviroDIY Mayfly Data Logger

- microUSB port
- Bee Module Socket (Xbee/WiFi/Cell)
- FTDI programming port
- Power switch
- MicroSD/SPI connector
- User-defined pushbutton
- MicroSD socket (horizontal)
- 20-pin header for analog pins and 2 UART ports
- Auxiliary 16-bit, 4-channel Analog-to-Digital Converter
- Grove digital ports
- I2C port
- Solar panel connector & charging circuitry
- Red & Green LEDs
- LiPo battery connectors
- DS321 Real Time Clock with battery backup
- 20-pin header for digital pins
- 5V boost converter
The Standard EnviroDIY Station, Cell Board

4G/LTE cell board – transmit data to Monitor My Watershed
The Standard EnviroDIY Station, Sensor Bundle
The Standard EnviroDIY Station, Sensors

- CTD Sensor (Meter Hydros 21)
- Turbidity Sensor (Campbell OBS 3+)
The Standard EnviroDIY Station, microSD card

microSD card files are generally the most secure data.
### Data points collected every 5 minutes

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The Standard EnviroDIY Station, MonitorMW data portal

- Data sent in real-time to Monitor My Watershed data portal via cell signal
What is EnviroDIY?

- Model My Watershed: Analyze geospatial data, model storms, and compare conservation or development scenarios in a watershed. Learn more.
  - Launch the App

- Monitor My Watershed: Discover and map monitoring data from multiple sources. Share and compare your monitoring data with the world. Learn more.
  - Launch the App

The Standard EnviroDIY Station data points:

- EnviroDIY: Join a community of do-it-yourself enthusiasts sharing open-source ideas for environmental science and monitoring.
  - Visit EnviroDIY

- Leaf Pack Network: Discover what aquatic insects can tell you about your stream’s health by performing a simple leaf pack experiment.
  - Visit Leaf Pack Network

- Macroinvertebrates.org: Identify common freshwater macroinvertebrates with this resource designed for citizen scientists. Learn more.
  - Visit Macroinvertebrates.org

  - Learn More
Monitor My Watershed

- Monitor My Watershed is where you access and see the data

http://monitormywatershed.org/
Monitor My Watershed

Clickable map with color legend provides quick view of station online status
Monitor My Watershed

Clickable site and then click “View data for this site” to get to site’s homepage
Site home page contains site info, station owner, deployment date, etc., along with 72hr data panels with real time feed.
Monitor My Watershed

Data panels provide real-time (most recent) readings

Easy to access on a smart phone
Monitor My Watershed

Time Series Analyst (TSA) graphs provide ability to see past data trends, multiple parameters, multiple sites.
Stream ecology concepts in MonitorMW

Seasonal and day/night (diel) patterns in stream water temperature

Pickering Creek, Phoenixville
Stream ecology concepts in MonitorMW

Dilution of stream water during storms – conductivity decreases as depth increases

Naylors Run – urban watershed, high conductivity and lots of dilution during storms
Stream ecology concepts in MonitorMW

Spikes in conductivity during/after winter storms – flushes of road salt/de-icer

Tributary to Cobbs Creek in Philadelphia area
Stream ecology concepts in MonitorMW

Data signals of unknown source – pollutant, sensor fouling, malfunction?

Palmer Run, a heavily forested stream in First State National Historical Park, DE
Stream ecology concepts in MonitorMW

Increased turbidity during storms

Valley Creek at Ecology Park
Where have we come from and where are we going?

Overview of “EnviroDIY in the DRB” program past, present, future; including:

- History, for context
- Resources for users
- Case studies of how groups and schools are using the data
- Options for how individuals/groups can get involved
Where have we come from and where are we going? Vision

- Vision: make it increasingly easier for people to
  - Monitor water using EnviroDIY
  - Understand, analyze, apply data for management, education, outreach
- *This DRB work is a pilot of sorts for what is starting to happen more broadly*
Where have we come from? Stroud Center Perspective on EnviroDIY in DRB

- Primary Goal
  - Support Station owners, managers, and volunteers
  - Use stations for local purposes

- Secondary Goal
  - Analyze basin-wide data set
  - Develop tools to characterize and contextualize watersheds
Delaware River Watershed Initiative (DRWI)

https://4states1source.org/

4States1Source
The Delaware River Watershed Initiative

Working across four states to protect one shared source of clean water
What is C-SAW?

The Consortium for Scientific Assistance to Watersheds (C-SAW) is a team of specialists who provide free organizational and scientific technical assistance to Pennsylvania-based watershed and conservation organizations.

C-SAW does not conduct watershed monitoring or assessments. Instead, C-SAW helps watershed organizations do a better job with their own monitoring and assessments.
Who is “we”?  

- Watershed groups, schools, and universities using EnviroDIY monitoring stations in the Delaware River Basin (DRB) with Stroud Center support via the Delaware River Watershed Initiative (DRWI)
Who is “we”?  

Abby Weinberg, OSI  
American Littoral Society  
Angelica Creek Watershed Association  
Bartrams Gardens  
Berks County Conservation District  
Berks Nature  
Berks Nature; DCNR; Nolde St Forest  
Brandywine River Museum  
Brodhead Watershed Association  
Darby Creek Valley Association  
Deerpark Rural Alliance  
Delaware Riverkeeper  
East Stroudsburg University  
Easter DE Co. Stormwater Coal., Villanova-WPF  
Great Marsh Institute  
Green Valleys Watershed Association  
Independence School  
Lake Committee, Somerset Lake Community  
Lawrenceville School  
Lopatcong Creek Initiative; NJ Highlands Coalition  
Master Watershed Stewards, Berks Co.  
Musconetcong Watershed Association  
Natural Lands Trust, Woodstown High School  

Pennypack Ecological Restoration Trust  
Perkiomen Creek Trout Unlimited  
Poconos-Kittatinny Cluster/East Stroudsburg University  
Primrose Creek Watershed Association  
PSU MWS, Aquashicola/Pohopoco Watershed Conservancy  
Schuylkill River Greenways  
Silver Lake Nature Center  
South Jersey Land & Water Trust  
Stroud Water Research Center  
The Land Conservancy for Southern Chester County  
The Schuylkill Center for Environmental Education  
The Watershed Institute  
TNC/FSNHP  
Tookany/Tacony-Frankford Watershed Partnership  
Trout Unlimited  
Trout Unlimited, NJ  
Valley Forge Trout Unlimited  
Wallkill River Watershed Management Group  
West Chester University  
White Clay Wild and Scenic  
Wildlands Conservancy  
Willistown Conservation Trust  
Wissahickon Trails  

And growing – ongoing need for capacity building among groups and collaborative support for the network
Where have we come from? Technology

- How is it that Stroud Center was able to provide this resource?
  - Technology development by Shannon Hicks for 20+ years
Where have we come from? Technology

- How is it that Stroud Center was able to provide these stations?
  - DIY tech development by Shannon Hicks for 20+ years
Where have we come from? Technology

- Fortunately, ~2015-16 Shannon’s technology was ready for standardization and public availability
Fortunately, ~2015-16 Shannon’s technology was ready for standardization and public availability.
Where have we come from? EnviroDIY.org

- Anthony Aufdenkampe (LimnoTech) and Shannon Hicks (with Stroud Center support) started EnviroDIY.org
  - Open Source access to technology, code (via GitHub)
Where have we come from? Data portals

- Dreamhosters was the original data portal
Where have we come from? Data portals

- Monitor My Watershed – this is the long term data portal for EnviroDIY, ongoing development, plans for upgrades
Where have we come from? Timeline

- 2017-2018, Station grants
  - ~60 EnviroDIY monitoring stations granted to groups in DRB, 1yr contract
  - Developing resources – temporary data portal, workshops/classes/trainings
  - Everyone learning
Where have we come from? Timeline

- **2018-2019, Transition**
  - Updated tech and guidance (operations manual, field data sheets videos, guidance materials, workshops, on-site assistance)
  - Resources page: [https://wikiwatershed.org/drwi/](https://wikiwatershed.org/drwi/)
Where have we come from? Timeline

- 2019-21, Stabilization and planning
  - Standard EnviroDIY CTD build workshop, comprehensive manual, video tutorials
  - Monitor My Watershed fully functional, planning for upgrades
  - Building out resources

*Stroud Center technical support throughout the process*
Where are we now? Support

- **2017-2021 support materials summary**
  - Field Visit Data sheets w online entry and storage
  - EnviroDIY and MonitorMW manuals and Quick Guides
  - Videos
  - Workshops
  - Resources page ([https://wikiwatershed.org/drwi/](https://wikiwatershed.org/drwi/))
  - Online group – station troubleshooting updates
  - **Ongoing assistance and troubleshooting**
Now, 2021, lots of stations, lots of groups

- Over 100 stations across DRB
- Owned by over 50 groups
- \(~\text{Median watershed size} = 10 \text{ km}^2\) (much smaller than USGS watersheds)
Number of stations installed each year in DRB

- 2017 – 55 stations
- 2018 – 35 stations
- 2019 – 25 stations
- 2020 – 12 stations
- 2021 – 4 stations
- TOTAL – 131 stations deployed
Where are we now? Stats

- **Numbers of data points**
  - 840,000 data points per station per year
  - Stations installed in 2017: 136,000,000
  - Stations installed in 2018: 56,000,000
  - Stations installed in 2019: 20,000,000
  - Stations installed in 2020: 14,400,000
  - >227,000,000 data points

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Where are we now? Stats

Number of EnviroDIY station sites by organization

- Wissahickon Valley Watershed Association
- Willistown Conservation Trust
- Wildlands Conservancy
- White Clay Wild and Scenic
- West Chester University
- Wallkill River Watershed Management Group
- Valley Forge Trout Unlimited
- Trout Unlimited, NJ
- Trout Unlimited
- Tookany/Tacony-Frankford Watershed Partnership
- TNC/FSNH
- The Watershed Institute
- The Schuylkill Center for Environmental Education
- The Land Conservancy for Southern Chester County
- Stroud Water Research Center
- South Jersey Land & Water Trust
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- Primrose Creek Watershed Association
- Poconos-Kittatinny Cluster-East Stroudsburg University
- Perkiomen Creek Trout Unlimited
- Pennypack Ecological Restoration Trust
- Natural Lands Trust, Woodstown High School
- Musconetcong Watershed Association
- Master Watershed Stewards, Berks Co.
- Lopatcong Creek Initiative; NJ Highlands Coalition
- Lawrenceville School
- Lake Committee, Somerset Lake Community
- Independence School
- Green Valleys Watershed Association
- Great Marsh Institute
- Easter DE Co. Stormwater Coal., Villanova-WPF
- East Stroudsburg University
- Delaware Riverkeeper
- Deeppark Rural Alliance
- Darby Creek Valley Association
- Brodhead Watershed Association
- Brandywine River Museum
- Berks Nature; DCNR, Nolde Forest Env Ed Center
- Berks Nature
- Berks County Conservation District
- Bartram's Gardens
- Angelica Creek Watershed Association
- American Littoral Society
- Abby Weinberg, OSI
Where are we now? Stats

- **Station maintenance**
  - >3000 site maintenance visits by groups/volunteers since July 2018
  
  - ~900 Quality Control efforts conducted since July 2018
  
  - >350 troubleshooting site visits by Stroud Center in 2019-2020
Where are we now? Support

- Support resources
  - https://wikiwatershed.org/drwi/
  - http://monitormywatershed.org/ (help tab)
  - https://www.envirodiy.org/
Where are we now? Examples of station usage

- **Examples of work being done** (see https://wikiwatershed.org/drwi/#project-updates):
  - Musconetcong and NJ TU – flow/WWTP effluent; temperature and brook trout
  - DE TNC/First State NHP – pollution into national park
  - East Stroudsburg Univ – DRWI PKC cluster; class work
  - Watershed Hydrological Analysis Team – stormwater and sediment
  - White Clay Wild Scenic – working with municipalities
  - Wallkill and Lopatcong – Watershed Characterization collaboration, local decision makers
  - TNC NJ – Paulins Kill temperature and sediment from dams
  - Deerpark Rural Alliance – Dragon Springs development pollution, Basha Kill monitoring
  - Brodhead Watershed Assoc – salt sleuthing and municipal infractions on Forest Hill Run
  - West Chester Univ – salt from WCU and WC borough
  - Primrose Creek Watershed Assoc – quarry monitoring
Case Studies

- Monitoring of the streams in First State National Historical Park by The Nature Conservancy (DE/PA) Stream Stewards
Case Studies

- Monitoring of the streams in First State National Historical Park by The Nature Conservancy (DE/PA) Stream Stewards

Identification of severe road salt/de-icer pollution events
Case Studies

- Monitoring of the streams flowing into First State National Historical Park by The Nature Conservancy (DE/PA) Stream Stewards

Sleuthing out and fixing sources of the elevated conductivity – working with New Castle Co and the mall
Case Studies

- Pickering Creek Montgomery School, investigation of patterned conductivity spikes (unknown upstream inputs)
Case Studies

- Pickering Creek at Montgomery School, investigation of patterned conductivity spikes

5-15 minute spike duration – challenging to coordinate upstream measurements
Case Studies

- East Stroudsburg University – longitudinal monitoring of Cherry Creek, DRWI Poconos-Kittatinny Cluster

Stream gets warmer going downstream, with some exceptions…why?
Case Studies

- East Stroudsburg University – integration of station management and data into classes and labs

Dr. Paul Wilson

Engaging
And Getting Real Data

Building the Water Conservation Infrastructure of Tomorrow

- Professionals
- Community Leaders
  - Watershed associations
- Community Connections
  - Friends
  - Family

Unifying
- Students
- Community
- Teachers
  - Non-teaching roles
  - Teaching roles
- Mentorship
  - Mentoring students
  - Mentoring faculty

Two Course-tasks
- Setting
  - National
  - Local
- Making
Case Studies

- West Chester, PA – Patty Haug (MWSteward), George Seeds (MWSteward), and Elisabeth R (Conestoga High School)
Case Studies

- West Chester, PA – Patty Haug, George Seeds (Master Watershed Stewards)

Variability in pollution status of local streams, new knowledge of these streams

Streams that drain the most developed/paved areas of West Chester show the highest conductivity levels – freshwater salinization
Case Studies

- West Chester, PA – Patty Haug, George Seeds

Winter storm conductivity data show different timing and duration of events
Case Studies

- Longitudinal sampling to determine sources and extent of contamination – Elisabeth Ruschmann, Conestoga High School
Case Studies

- Longitudinal sampling to determine sources and extent of contamination – Elisabeth Ruschmann, Conestoga High School
Case Studies

- Paulins Kill at Sussex County Community College, Watershed Characterization

**Upper Paulins Kill**

Water Quality Report
2020

Collaboration between Walkill Watershed Management Group (Kristine Rogers), New Jersey Highlands Coalition, and the Stroud Center

This water quality report was produced by the Walkill River Watershed Management Group and Stroud Water Research Center as part of a Delaware River Watershed Initiative citizen science effort funded by the William Penn Foundation. The report begins with an Executive Summary that reviews New
Case Study, Watershed Characterization

Water temperature in relation to state trout criteria

[Graph showing water temperature trends from June 2 to September 8, 2019, with temperature values ranging from 16°C to 28°C, and key temperature points indicated for NJ DEP Trout Maintenance daily maximum, NJ DEP Trout Production daily maximum, and Ideal trout temperature maximum.]
Case Study, Watershed Characterization

Water temperature in relation to local forested “reference” sites
Conductivity (and chloride) in relation to state criteria
Conductivity (and chloride) in relation to local forested “reference” sites
Where are we going? How to get involved

- **Ways to get involved**
  - Build a station
  - Help manage a station
  - Use the data
  - Attend monthly meetings/workshops/trainings
  - Support others, collaborate
Where are we going? How to get involved

- **Build and Deploy a station, Methods:**
  - Via EnviroDIY Build Workshop
    (https://www.envirodiy.org/event/virtual-workshop-building-envirodiy-monitoring-station/)
    - *Next workshop is planned for early 2022 – contact Dave Bressler if you’d like to be added to the early access list*
  - Via EnviroDIY Monitoring Station Manual
    (https://www.envirodiy.org/mayfly-sensor-station-manual/)
  - Via Video Tutorials
    (https://www.envirodiy.org/videos/)
Where are we going? How to get involved

- **Build and Deploy a station**, Supplies:
Volunteer to help manage a station

1. **Management oversight** – ensure functionality (below tasks completed), data usage, pay cell plane, etc.
2. **Desktop monitoring of station function** – On check station function and data readings on MonitorMW **daily**
3. **Maintenance** – clean sensors **once a week**
4. **Quality Control** – do data cross checks **quarterly**
Where are we going? How to get involved

- Volunteer to help manage a station
  - Desktop monitoring of station function – check station function and data readings daily
Where are we going? How to get involved

- Volunteer to help manage a station
  - **Maintenance** – clean *once a week* (or as needed)
Where are we going? How to get involved

- Volunteer to help manage a station
  - **Quality Control** – do data cross checks *quarterly* (or as needed)
Where are we going? How to get involved

- **Use the data and resources**
  - For outreach
  - For education

Use available lesson plans, make your own, or do informal class work

**MonitorMW Online Data Analysis Lab Series – Student DRAFT**

**Understanding Temperature Patterns in Our Watersheds**

**Overview**

In this lab we will use data from Mayfly Data Logger Board™ Sensor Stations installed in rivers and streams to learn more about the patterns of temperature in nature. These Sensor Stations measure and transmit important data to the Monitor My Watershed® web portal that can be accessed by scientists, educators, students, and various organizations interested in understanding and monitoring watersheds in our area. Throughout these activities, you will learn how to use the portal to view and interpret data collected at the sensor stations, investigate significant events, analyze the information, and create new understandings about the dynamics and interactions of variables in your local waterways. As you go through the activities, be sure to record the data and your analyses on your lab sheet.

**Learning Objective:**

By the end of this lab you will explain temperature patterns in watersheds and develop analytical and reasoning skills by accessing and interpreting real world data.

**Introduction**

What do you think of when you hear the word “temperature?” Write your definition for temperature below.
Where are we going? How to get involved

- **Learn**
  - Attend EnviroDIY-DRWI Monthly Meetings (virtual via Zoom) – every third Thursday of the month, 2:30-3:30p; recordings: [https://wikiwatershed.org/drwi/#user-group-meetings](https://wikiwatershed.org/drwi/#user-group-meetings)
  - Attend workshops/trainings, examples in following slides
Where are we going? How to get involved

- **Support others**
  - Different groups have different resources
  - Consider opportunities to collaboratively build/install/manage a station for a specific purpose
Where are we going? Support Resources

- Stroud Center EnviroDIY support
  - MEETINGS: Monthly EnviroDIY-DRWI meetings (contact dbressler@stroudcenter.org to be added to list)
  - DIRECT SUPPORT: On-site assistance and training
  - TECHNOLOGY: Updated Mayfly data logger, cell boards, sensors, supporting code; Monitor My Watershed upgrades
  - EQUIPMENT: EnviroDIY Monitoring Kits via EnviroDIY shop and other new inventions by Shannon
  - WORKSHOPS:
    - EnviroDIY build workshops (e.g., Feb 9-10, 2020 Build Workshop)
    - Support workshops (e.g., troubleshooting workshop June 23, 2020)
  - CERTIFICATIONS?: For managing high priority stations
  - GUIDANCE MATERIALS: Manual, Quick Guides, Videos, etc ongoing development, https://wikiwatershed.org/drwi/
Where are we going? Infrastructure

- Longer term planning
  - Developing ways to summarize continuous data for rapid assessment of stream conditions
  - Developing mechanisms to apply data for management
  - Building out Monitor My Watershed to include
    - Data correction/Quality Control
    - Metadata
    - Key statistics (metrics) and thresholds
    - Rating curves (e.g., apply equations to convert depth to discharge, conductivity to chloride)
Lessons Learned

- Get very familiar with the Mayfly data logger and sensors
- Using Monitor My Watershed to track station function daily is IMPORTANT
  - Become fluent in MonitorMW usage
- Cleaning sensors and doing QC is the only way to ensure good data
- PEOPLE are important! Reliable individuals to perform specific tasks ensures good station function (and good data)
  - Having a schedule/roles/responsibilities has been effective for many groups
Lessons Learned

- Ongoing dialogue on station function with Stroud team can help ensure sustained collection of good data
- Backup funds are important to replace broken or malfunctioning parts
- Before putting stations out know exactly how you will use the data
  - “What to do with all this data?” is a big question for some
  - Know what the data can and can’t tell you before getting started
  - Define your goals for the data and for the station’s usage
This is all new – new inventions, new technology, new guidance materials

Tools and resources becoming more accessible, those who want to get involved, get in touch!
Staying in the loop

- If you’d like to be on the EnviroDIY in the DRB email distribution list contact dbressler@stroudcenter.org
  - EnviroDIY-DRWI monthly meeting updates/reminders
  - Workshop updates
  - General updates
Thank You! Questions?

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- Christa Reeves, christa@musconetcong.org, 908-537-7060

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