Seneca Valley Trout Unlimited

Webinar hosts: Seneca Valley Trout Unlimited

A tale of two programs:

Watershed Restoration and Whole Farm Stewardship

Citizen Science using Open-Source DIY Technologies

Building an EnviroDIY Monitoring Station Workshop (#260000)

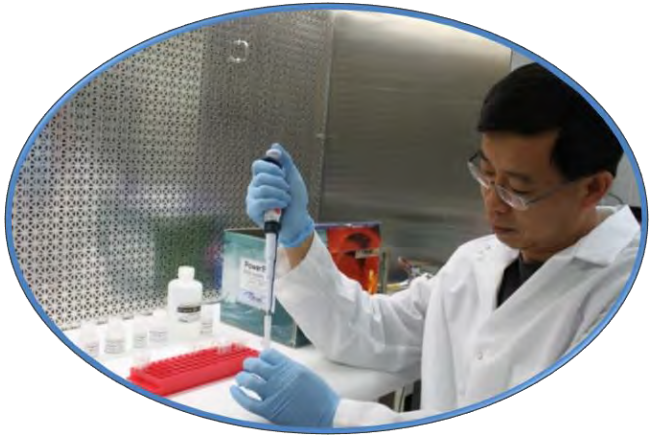
EnviroDIY Mayfly Data Logger Board and Starter Kit (Pack of 5)

8 March, 2021

Dave B. Arscott, Executive Director

STROUD WATER RESEARCH CENTER

ADVANCING KNOWLEDGE & STEWARDSHIP OF FRESHWATER SYSTEMS THROUGH GLOBAL RESEARCH, EDUCATION, AND WATERSHED RESTORATION



Est. 1967
Avondale, Pennsylvania

STROUD WATER RESEARCH CENTER

Stroud Water Research Center

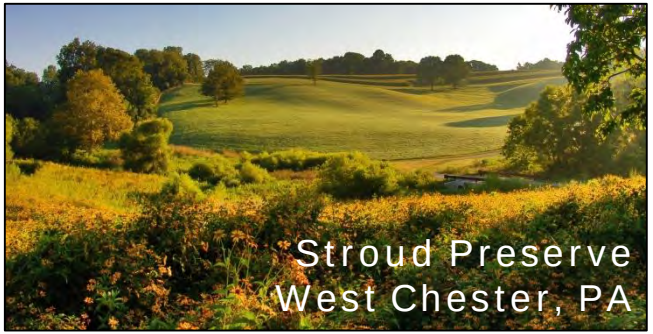
An independent, third party, non-advocacy, 501(c)3 non-profit

Staff

- ~50 full-time employees
  - 10 Ph.D. scientists/educators
- +10 part-time employees
- 20-30 undergrad interns annually
- Volunteer corps

STROUD WATER RESEARCH CENTER

Our Flagship Research Sites



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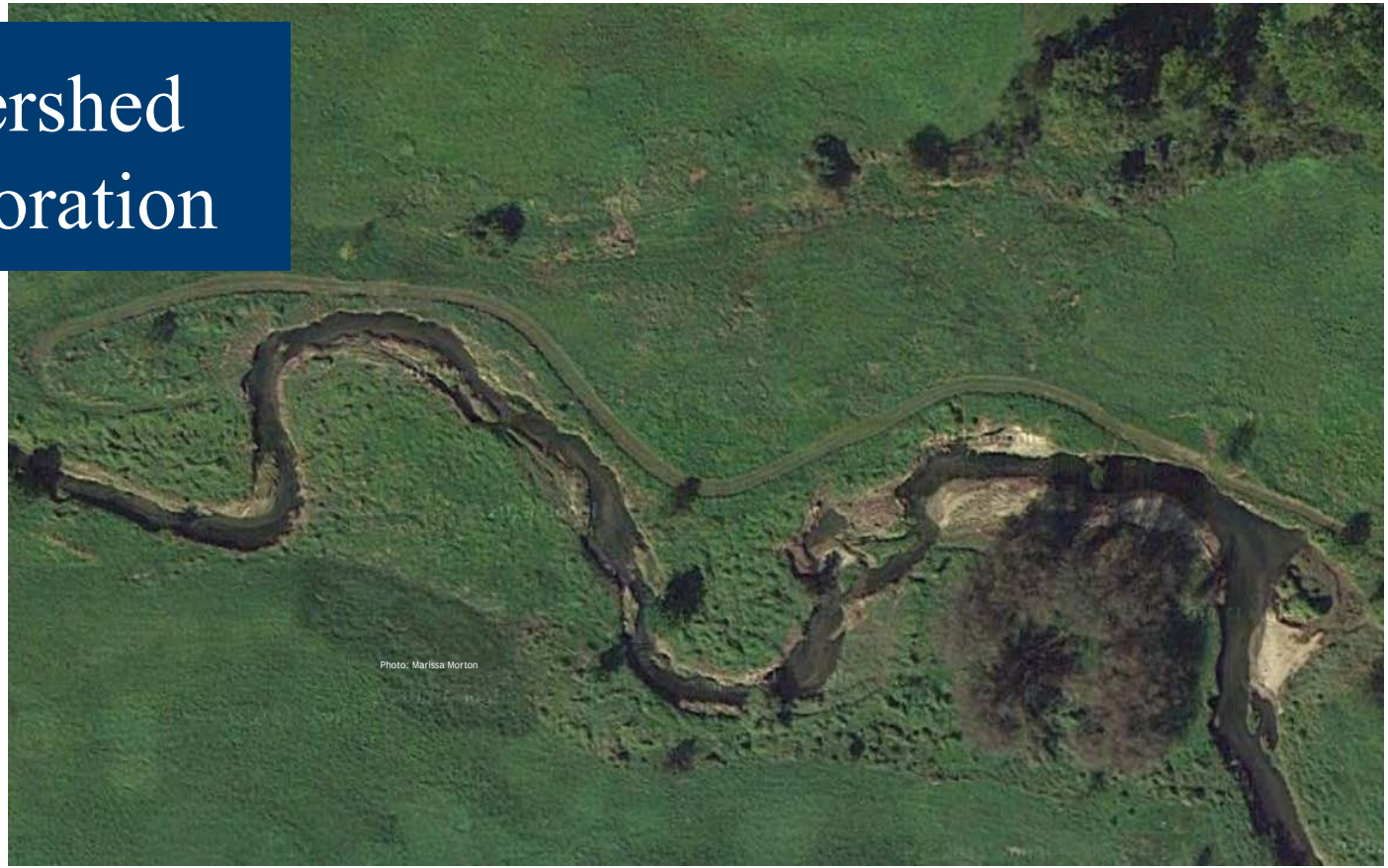
Watershed Restoration



Aims to re-establish normal rates and magnitudes of physical, chemical, and biological processes that create and sustain river and floodplain ecosystems

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Watershed Restoration

Channel and reach focus not producing the desired recovery of ecosystem functions and biodiversity (e.g. Bernhardt et al. 2005; Palmer 2009)

Fundamental disconnect between watershed science and restoration practice

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To Get Cleaner, Healthier Waterways:

We Need To Reduce:

- Stormwater runoff & flooding
- Sediment
- Pathogens
- Nitrogen and phosphorous
- Other “stuff” coming off of our landscapes
- Water temperature

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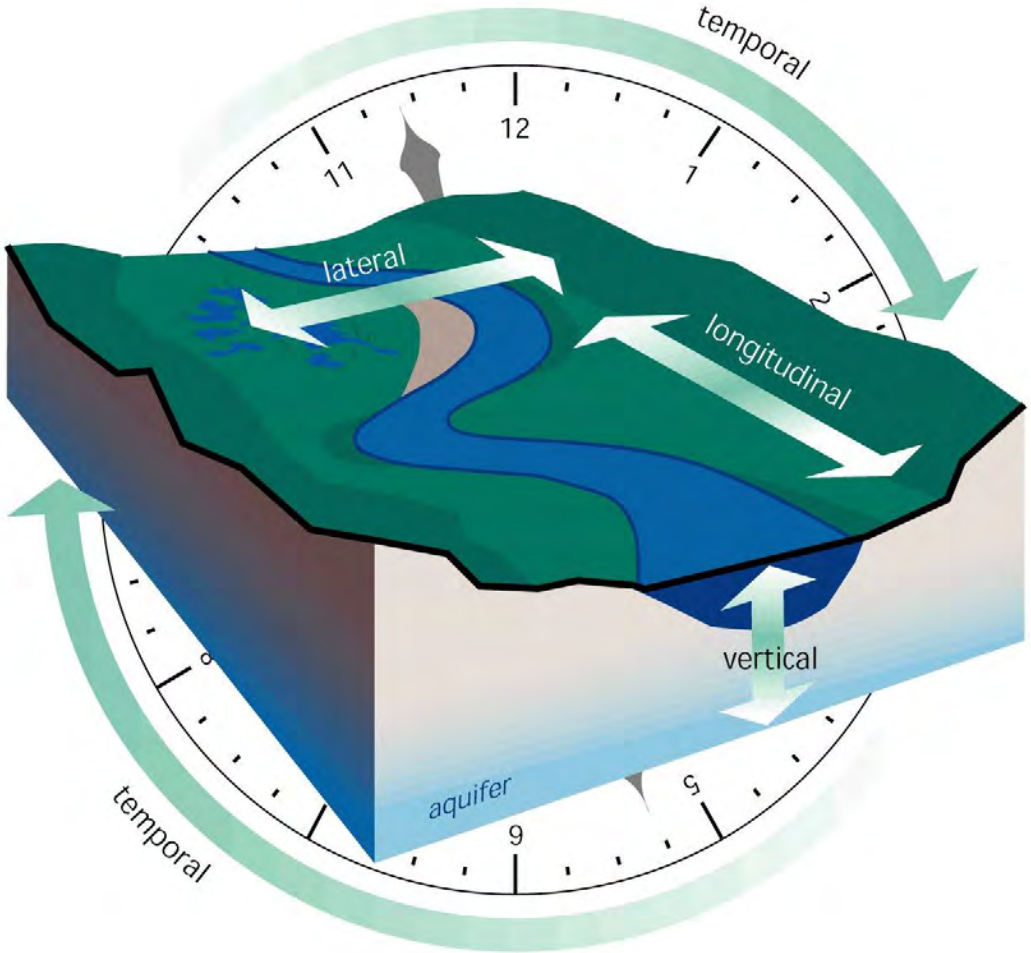
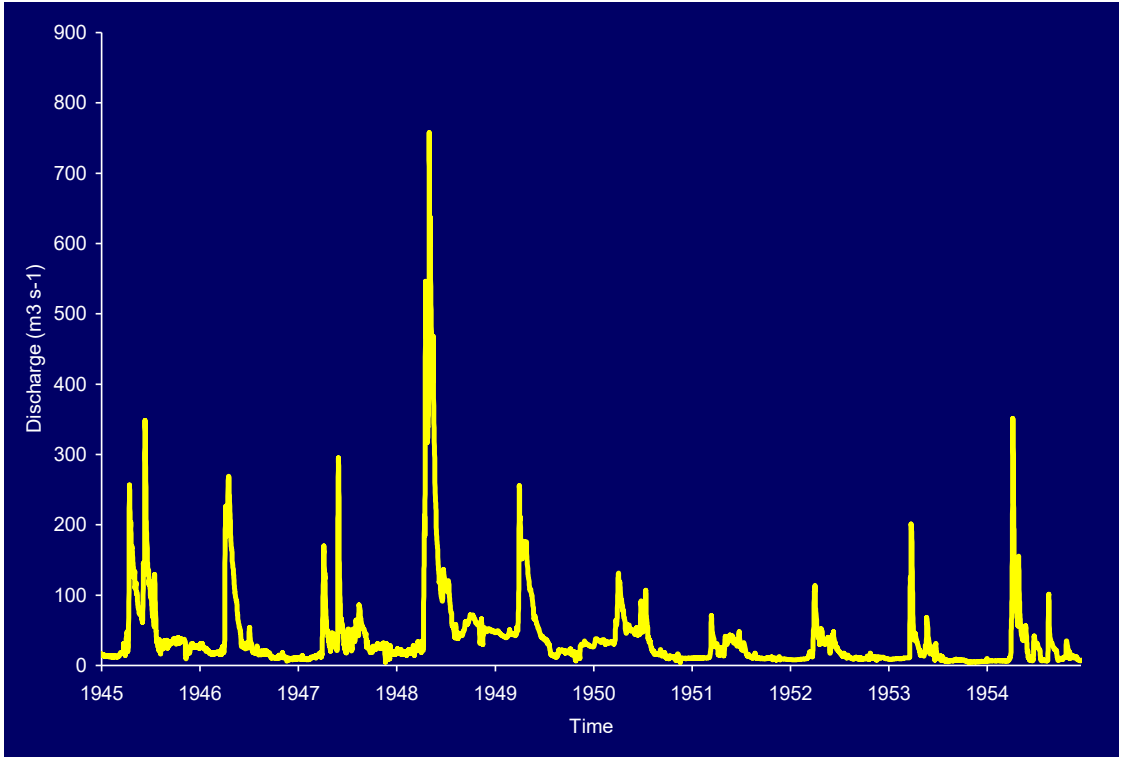
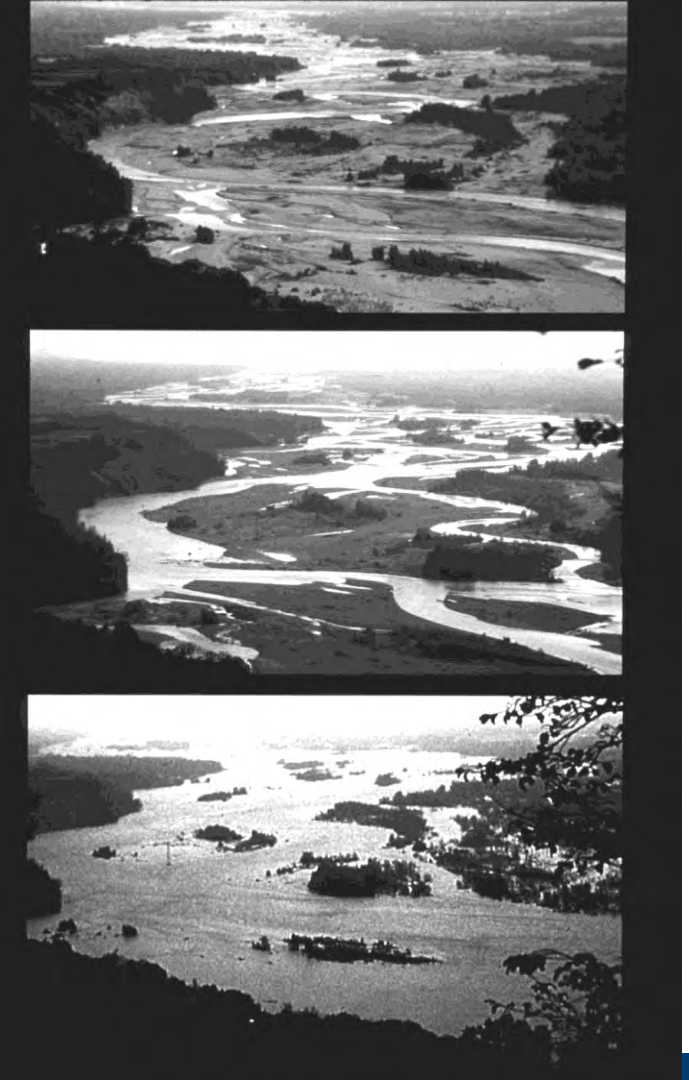
Watersheds are dynamic in 4-dimensions



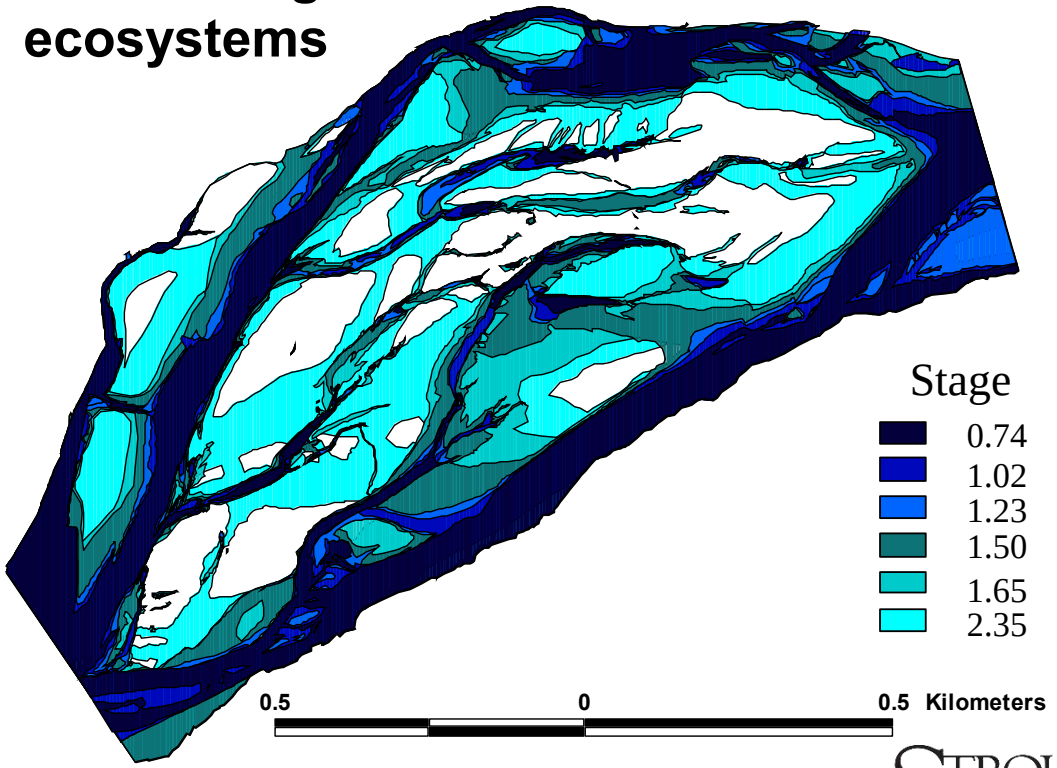
Climate and weather drive variations through time

Hydrology (and weather) dominates our perspectives of temporal dynamics (but people and biology matter too)





Flood plains are expanding and contracting ecosystems



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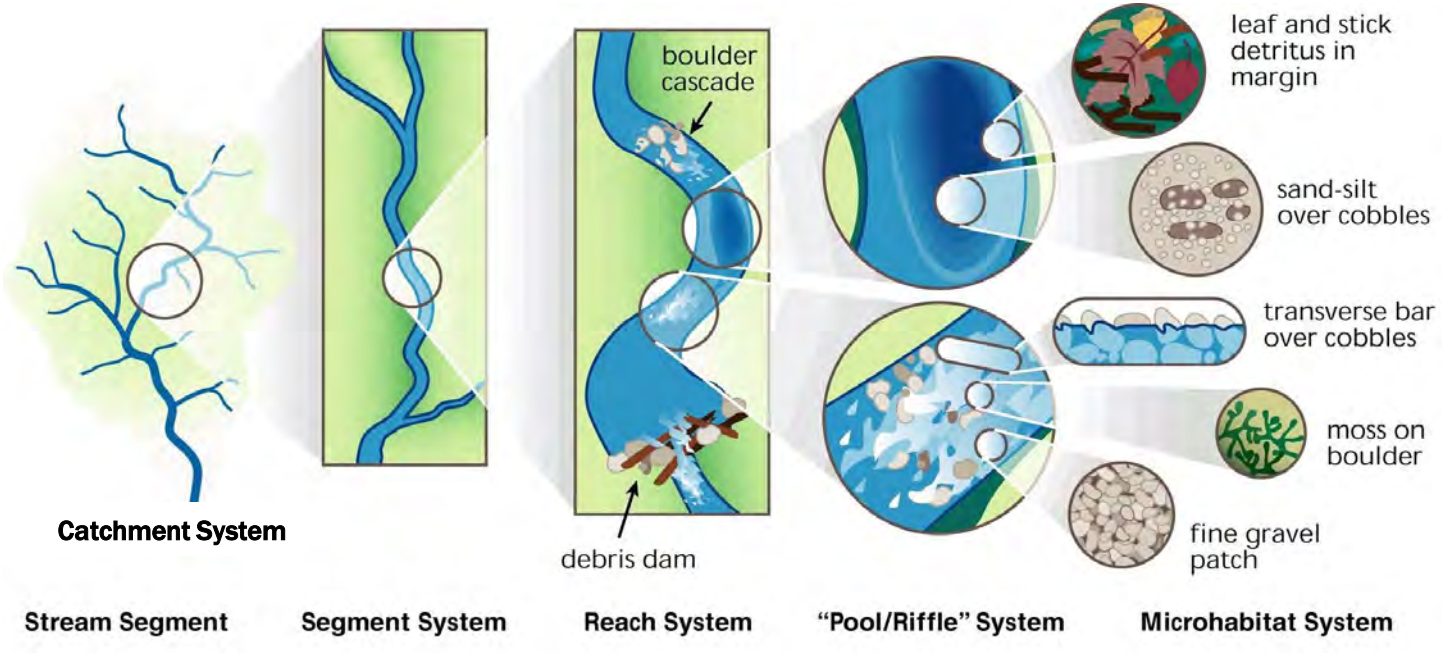
Recognizing the importance of scale in understanding river and watershed ecology



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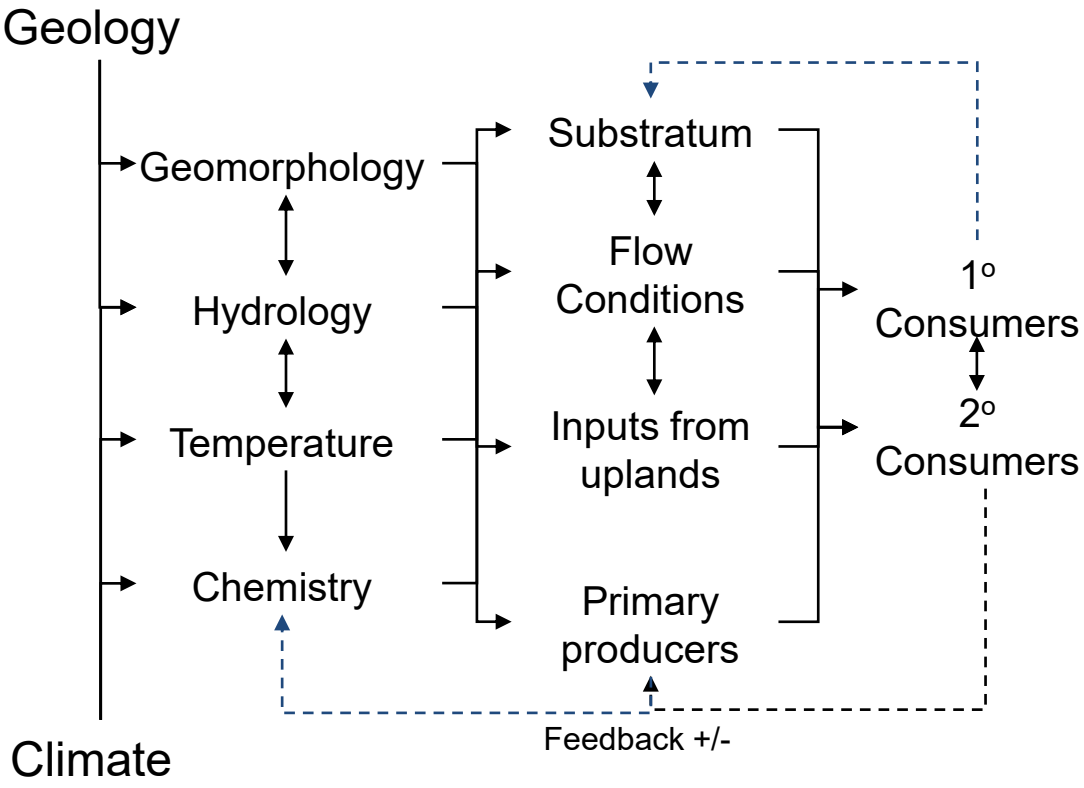
The Riverine Habitat Template

Dimensions
Longitudinal
Lateral
Vertical
Temporal

Scale
Macro to micro
Coarse to fine
Broad to narrow



Humans can influence all of these components

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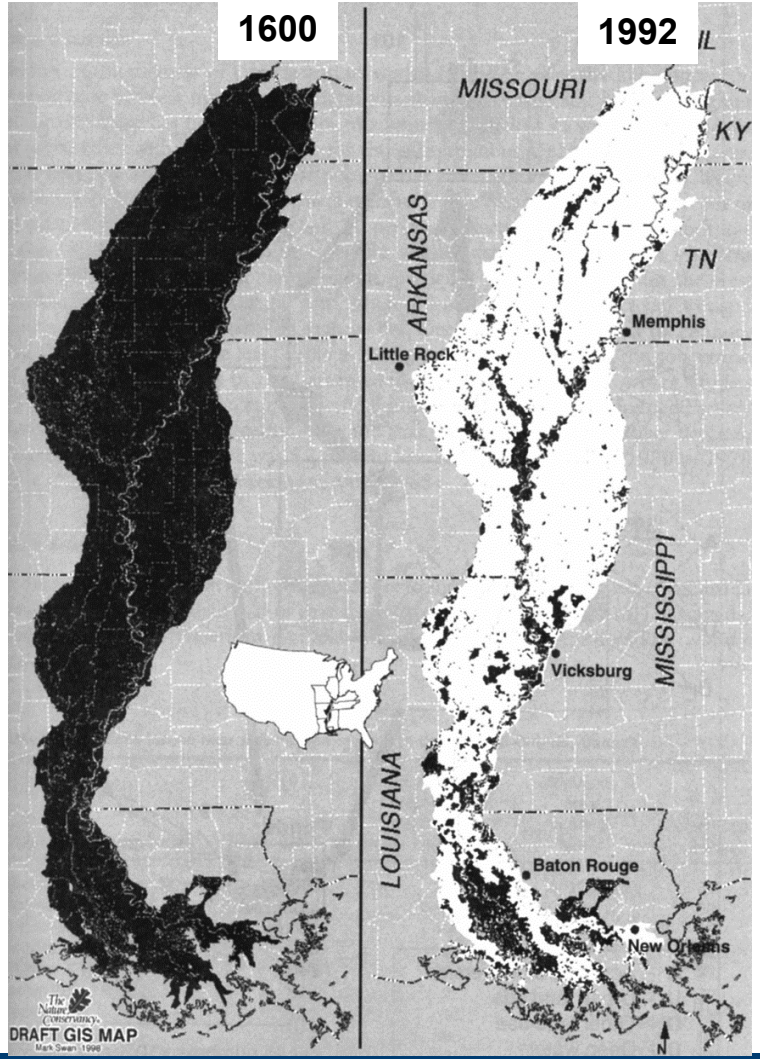
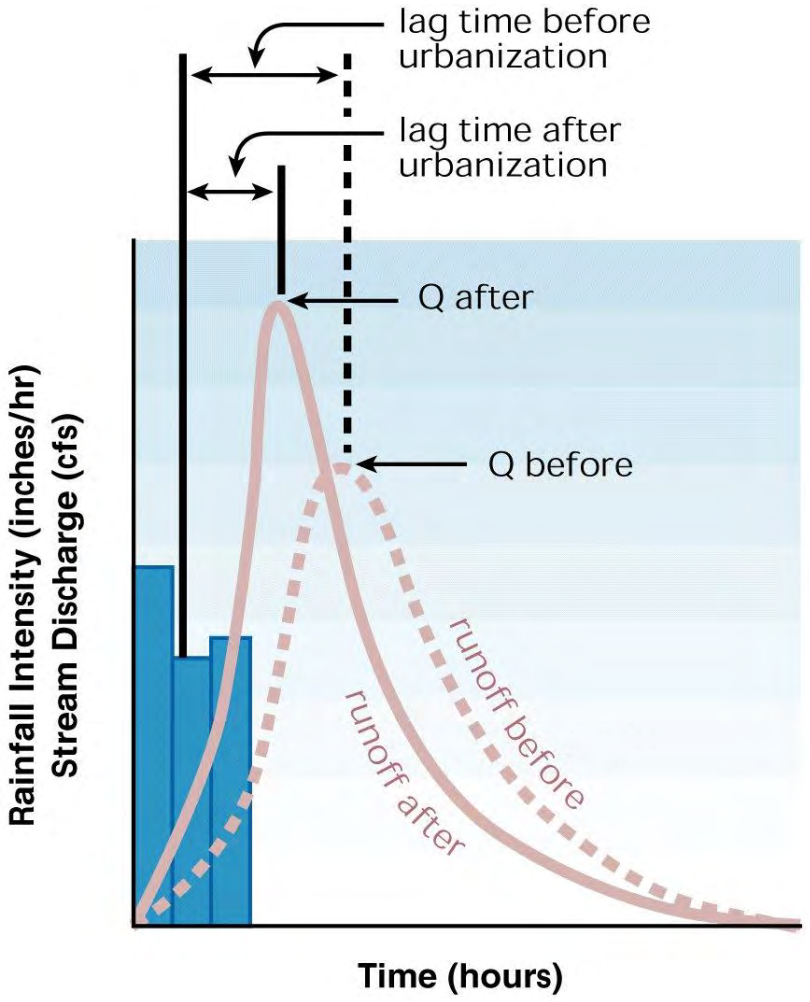
Mississippi Floodplain Loss



Bottomland wetland forests in the Mississippi River floodplain

Land Use Impacts on Hydrograph



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Balancing watershed production of water and sediment with dynamics of stream geomorphology

Changes in the watershed that lead to more runoff and stream discharge or more sediment delivery will result in stream channel adjustments

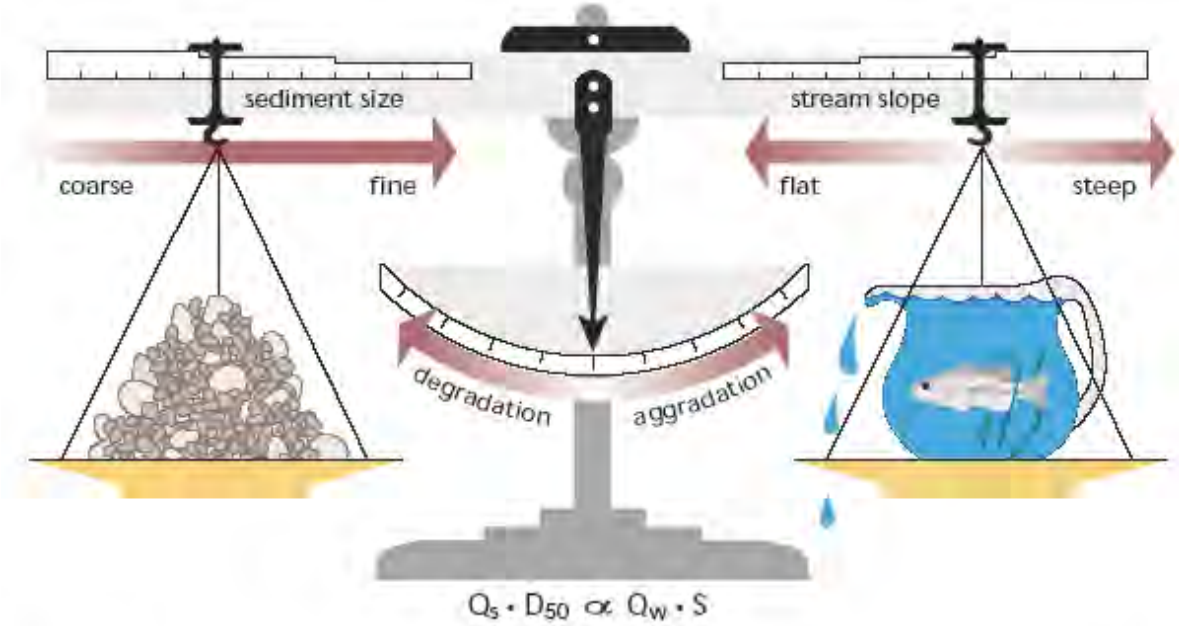
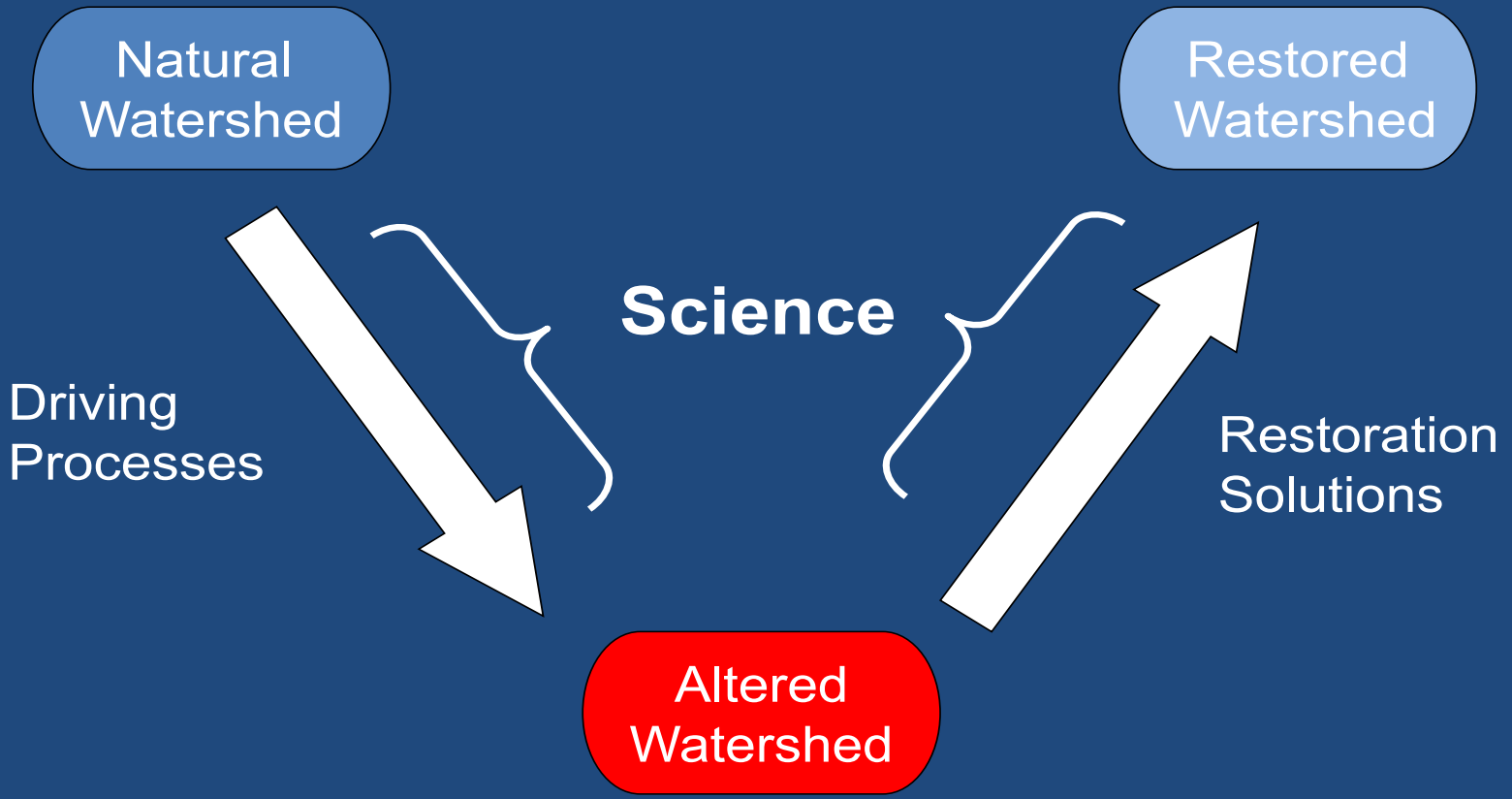


Figure 1.13: Factors affecting channel equilibrium. At equilibrium, slope and flow balance the size and quantity of sediment particles the stream moves.

Source: Rosgen (1996), from Lane, *Proceedings*, 1955. Published with the permission of American Society of Civil Engineers.

Watershed Restoration



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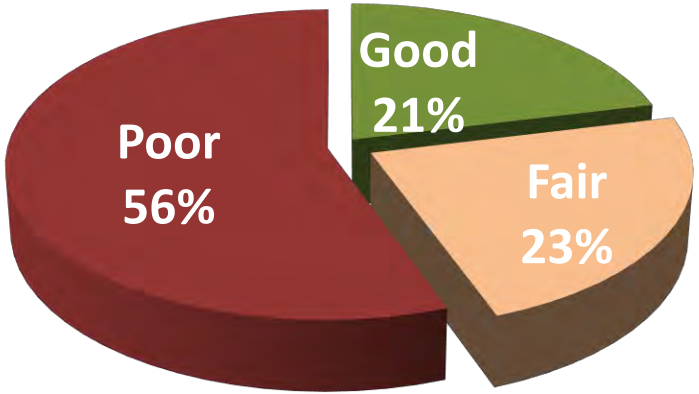
National Rivers and Streams Assessment 2008-2009 Report

- 56% of the nation's river and stream miles do not support healthy populations of aquatic life



WHY?

Chemical stressors

Total phosphorus, total nitrogen, salinity, acidification,

Physical stressors

Excess streambed sediments, in-stream fish habitat, riparian vegetative cover, riparian disturbance

US EPA – https://www.epa.gov/national-aquatic-resource-surveys/national-rivers-and-streams-assessment-2008-2009-results

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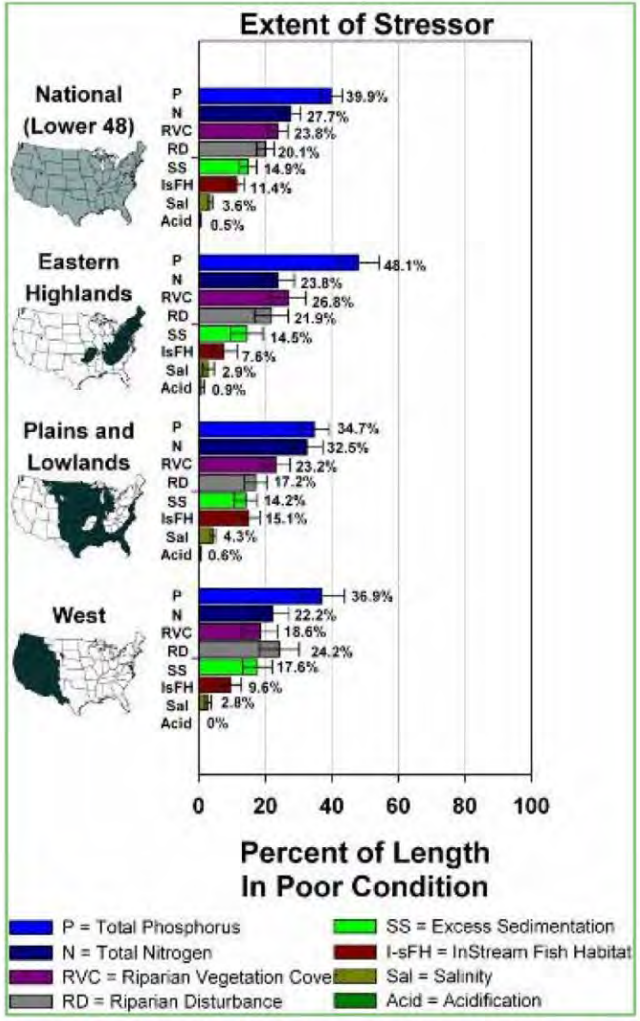

Figure 19. Relative extent of stressors in the nation's rivers and streams (EPA/NRSA).

Leading problems (from 2012-13): nutrient pollution and habitat degradation

- 40% of miles w/ high phosphorus
- 27% with high nitrogen
- 24% poor vegetative cover
- 20% high levels of human disturbance nr stream banks
- 15% have excess levels of streambed sediments

- All can be addressed by riparian buffer restoration, soil health improvements, and whole farm management plans (to varying degrees)

US EPA –Report: National Rivers & Streams Assessment 2008-2009

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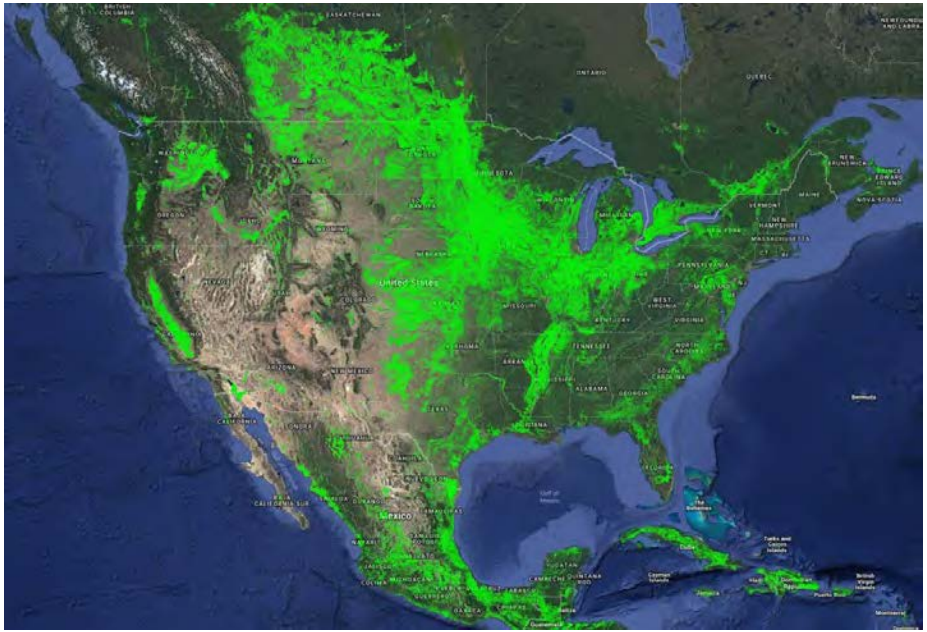
To Get Cleaner, Healthier Waterways:

We Need To Reduce:

- Stormwater runoff & flooding
- Sediment
- Pathogens
- Nitrogen and phosphorous
- Other “stuff” coming off of our landscapes
- Water temperature

Land cover/use in United States (2017)



https://www.usgs.gov/media/images/map-croplands-united-states

U.S. croplands in a nominal 30-m resolution derived primarily with Landsat imagery for the year 2015. The United States has 166 million hectares of net cropland area and is ranked second in the world after India, which has 180 million hectares of croplands.

Land type	Land use (%)	Land area
Forests	27%	842,400 mi²
Shrubland	24%	748,800 mi²
Agriculture	17%	530,400 mi²
Grasslands and Pasture	17%	530,400 mi²
Wetlands	5%	156,000 mi²
Other	5%	156,000 mi²
Open Space	3%	93,600 mi²
Urban Areas	2%	63,400 mi²
Total	**100%**	**3,120,000 mi²**

https://www.visualcapitalist.com/america-land-use/

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Stroud Center's Farm Stewardship Program

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Thus, farms are a great opportunity for:

- scale of work
- pace of work
- impact of work

Many Partners!

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Replace Near-Stream Pollution with Forest

[building buffer zones also may treat pollution from upland areas]

Before

After

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Before

After

Planted Apr 2007
Photo Aug 2008

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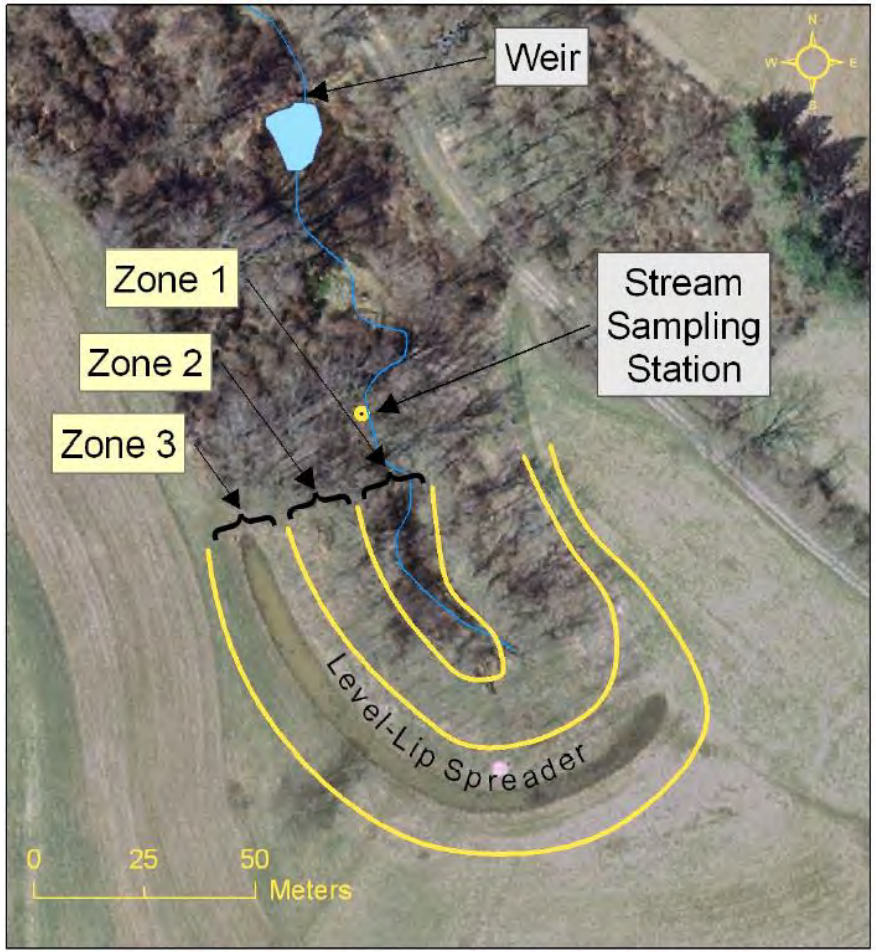

Figure 2. Morris Run (treatment) stream and the riparian forest buffer system with a level-lip spreader in April 2005.

Buffer Effectiveness Results (1998-2006)

(Newbold et al 2009)

Nitrogen: 26% removed

Suspended sediments: 43% removed

Total phosphorus reduction was inconclusive…

- 22% reduction in particulate P, but buffer released compensating quantity of dissolved P (likely after decomposition of particulate material)

Results required 10 yr minimum

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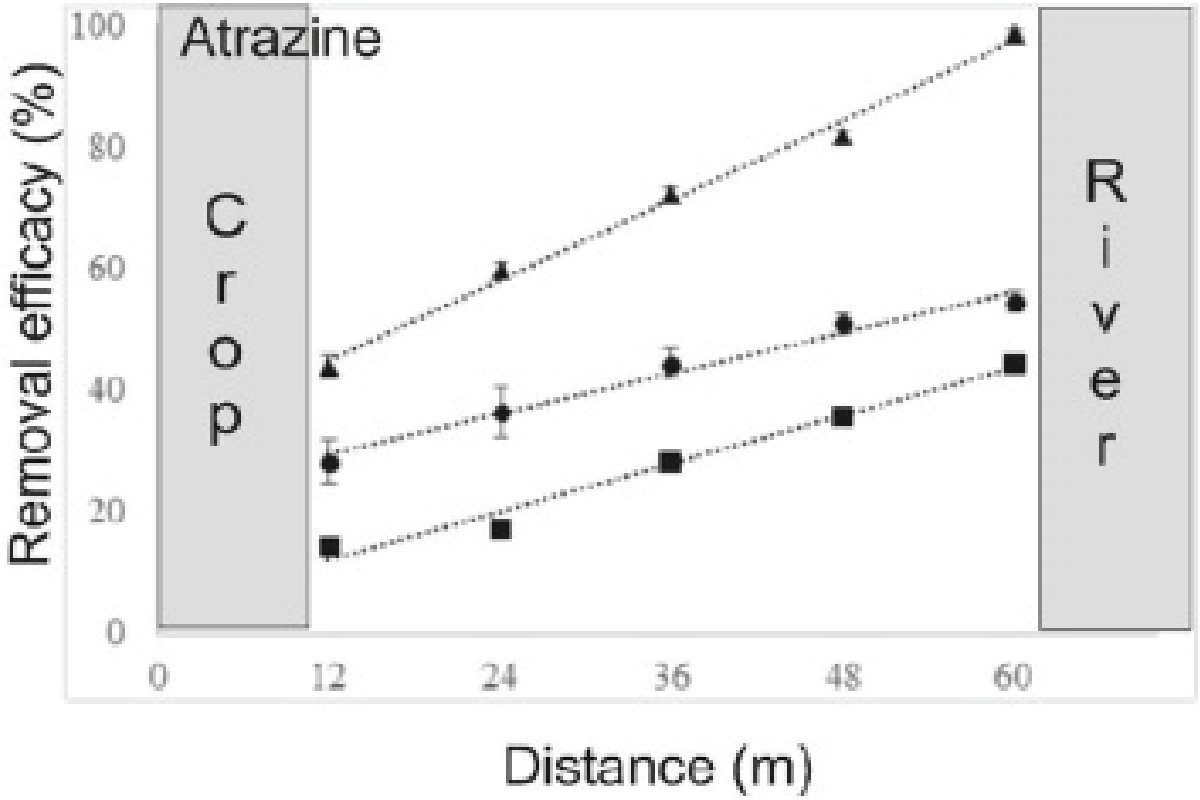

Buffer Effectiveness

Other pollutants are also removed/retained/treated by riparian buffers

Aguiar Jr., T. R., F. R. Bortolozo, F. A. Hansel, K. Rasera, and M. T. Ferreira. 2016. Riparian buffer zones as pesticide filters of no-till crops. Environ Sci Pollut Res 22:10618–10626.

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

75 acres of riparian forest buffers

44 swales, totaling 3 miles

1.5 acre floodplain wetland

4 miles of stream enhanced with large wood

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

NATIONAL FISH AND WILDLIFE FOUNDATION
NFWF

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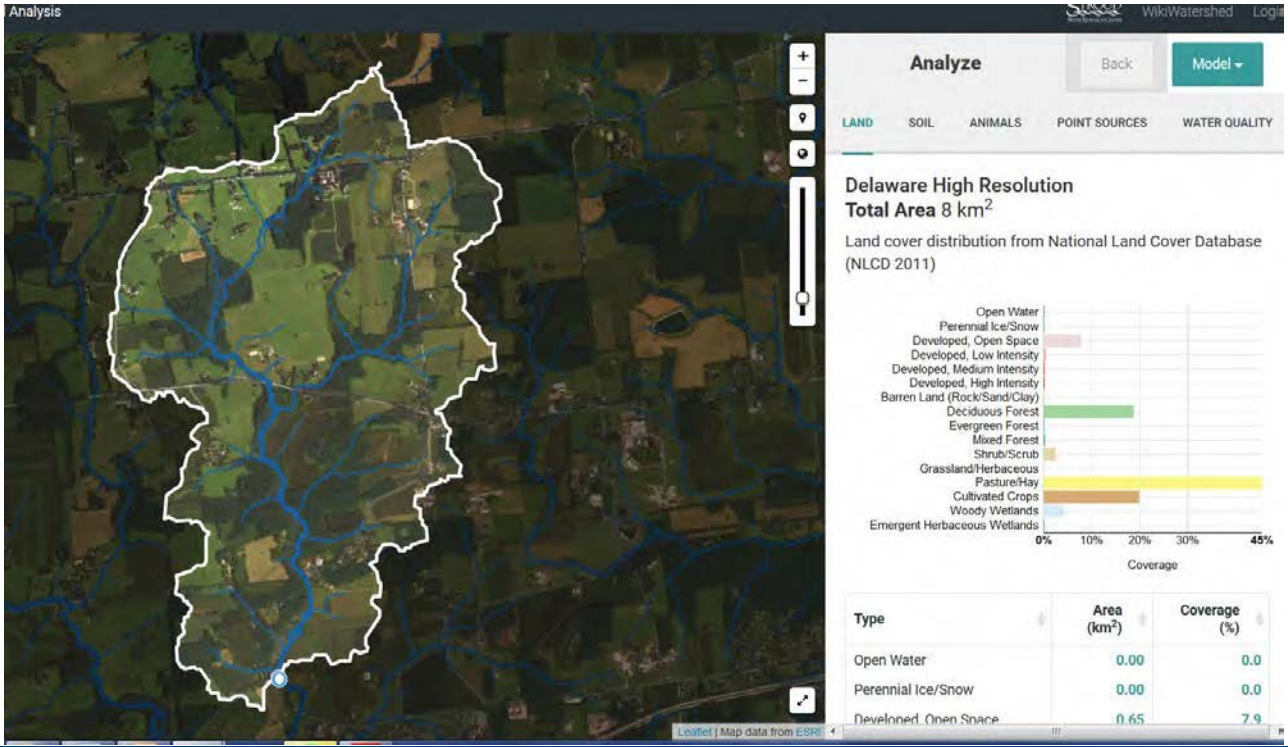
2 inch 24-hr storm yields approximately 37,000 m^3 of runoff

Installed level spreader capacity to capture minimum of 5,150 m^3 of runoff (>10% of total) and 590 kg of fine sediment



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Large Woody Debris

- Slow stormwater flow and downstream sediment movement
- Improve in-stream habitat
- Alter channel shape

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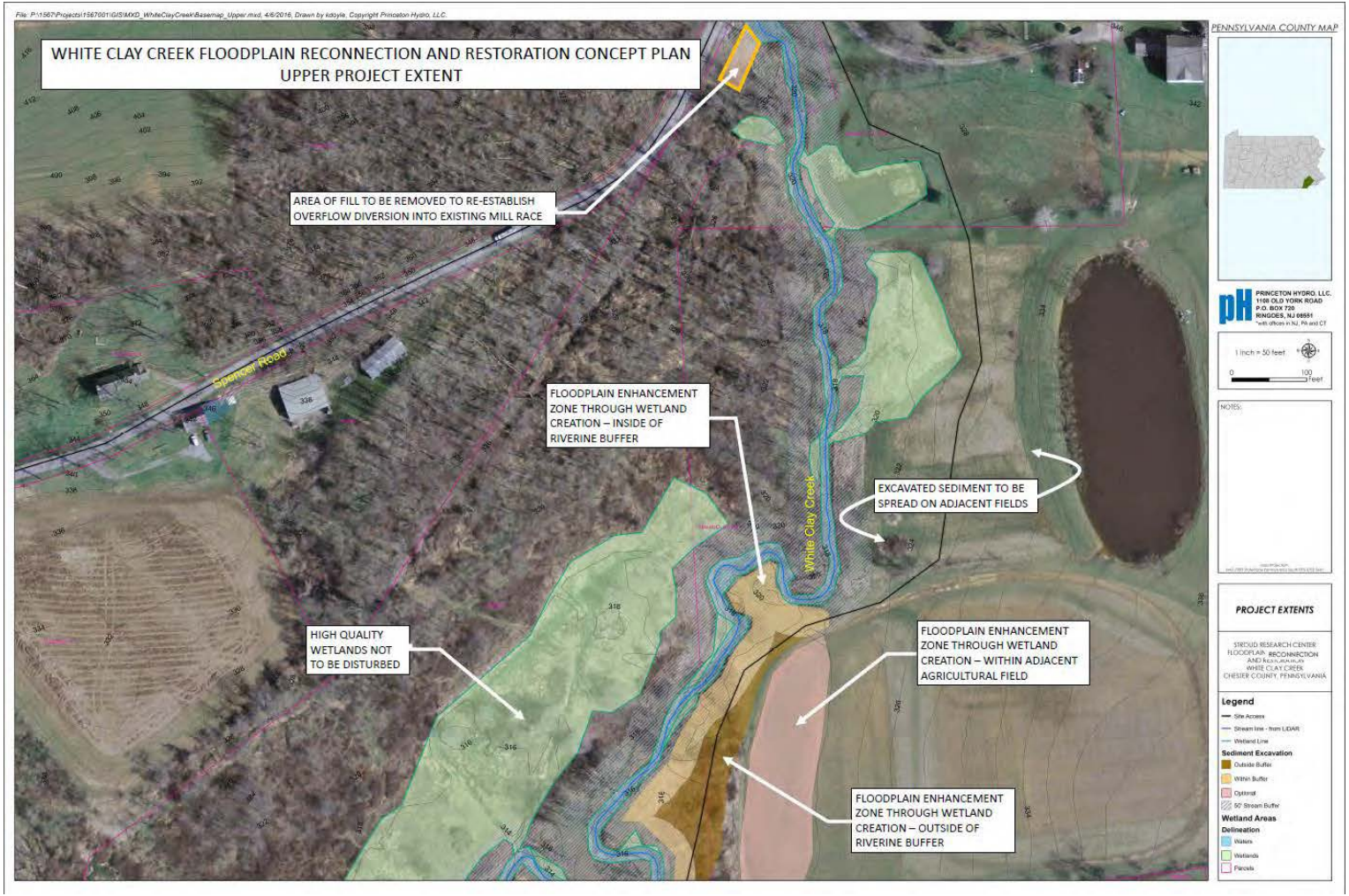

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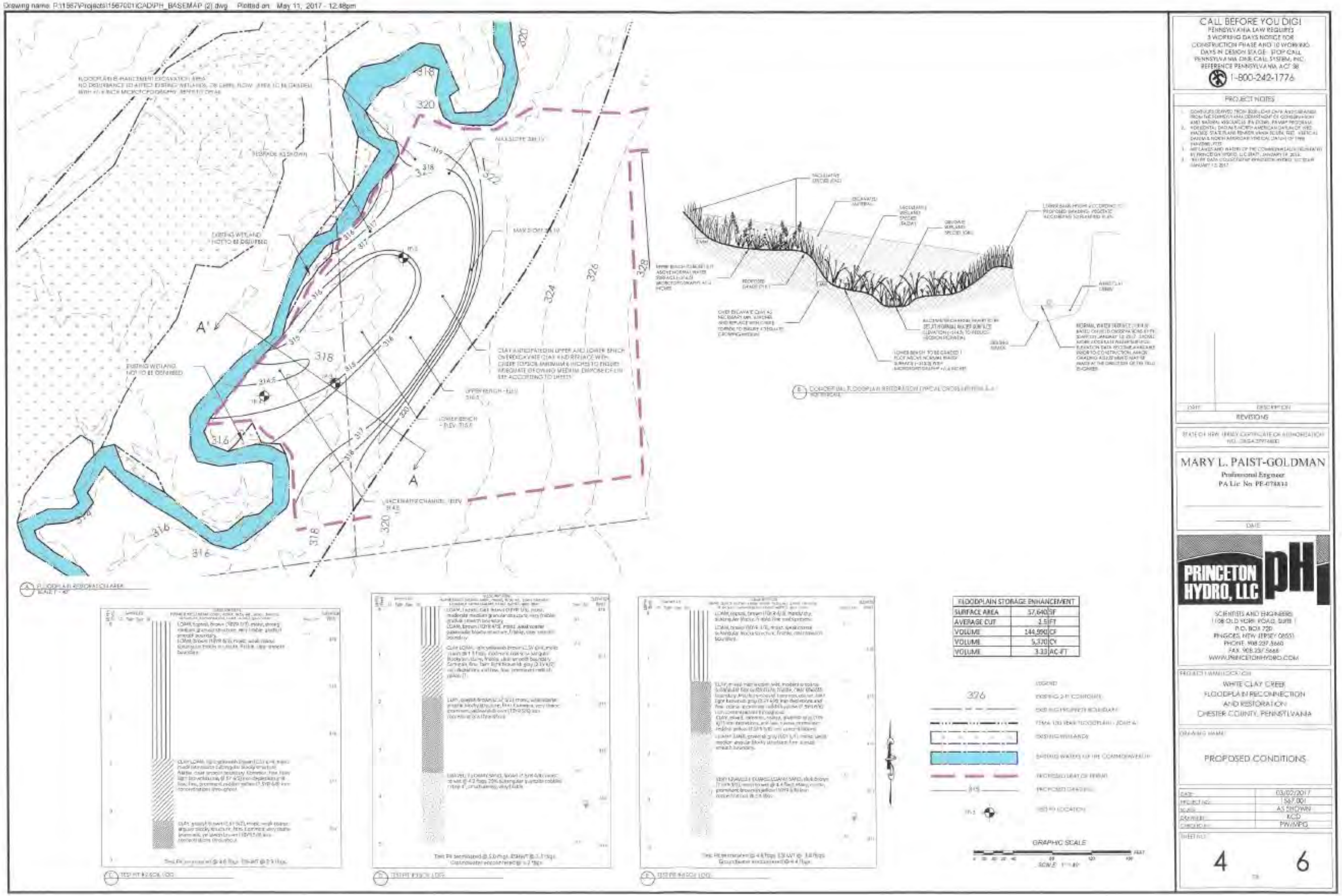

FLOODPLAIN STORAGE ENHANCEMENT		
SURFACE AREA	57,640	SF
AVERAGE CUT	2.5	FT
VOLUME	144,990	CF
VOLUME	5,370	CY
VOLUME	3.33	AC-FT

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Pre-construction

During-construction

Post-construction

Floodplain Wetlands

- Provide Flood Storage
- Capture Sediment
- Provide Critical Habitat

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Beyond the Riparian Corridor,
What is the Watershed Context?

How much can you impact Water Quality and Water Quantity with Watershed Management?

What impact will that have on the stream system?

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Farm Stewardship Program:

Whole Farm Conservation

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Funded by:

NATIONAL FISH AND WILDLIFE FOUNDATION NFWF

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Chesapeake Bay Stewardship Fund

Chesapeake Bay Program
Science. Restoration. Partnership.

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CONTACT
Looking for technical assistance? Find a specialist.
Enriching the Foundation
of the Keystone State
Technicial Assistance
Meet the Members
Join an Event
COMMUNICATION
Connect with others about projects, ideas and topics
EDUCATION
Coordinate outreach efforts for maximum benefit.
COLLABORATION
Discover new and exciting ways to work together.

Soil Health Principles

MAXIMIZE CONTINUOUS LIVING ROOTS

- Crop Rotation
- Relay Crops
- Forage and Biomass Planting
- Perennial Crops
- Cover Crops

MINIMIZE DISTURBANCE

- No-till
- Reduced Tillage
- Controlled Traffic
- Avoid Tillage When Wet
- IPM

MAXIMIZE BIODIVERSITY

- Crop Rotation
- Rotational Grazing
- IPM
- Pollinator Plantings
- Organic Fertilizers
- Legumes in Mix
- Agroforestry
- Cover Crops
- Crop/ Livestock Integration

MAXIMIZE SOIL COVER

- Mulching
- Reduced Tillage
- Forage and Biomass Planting
- Residue Retention
- Cover Crops
- Green Manures

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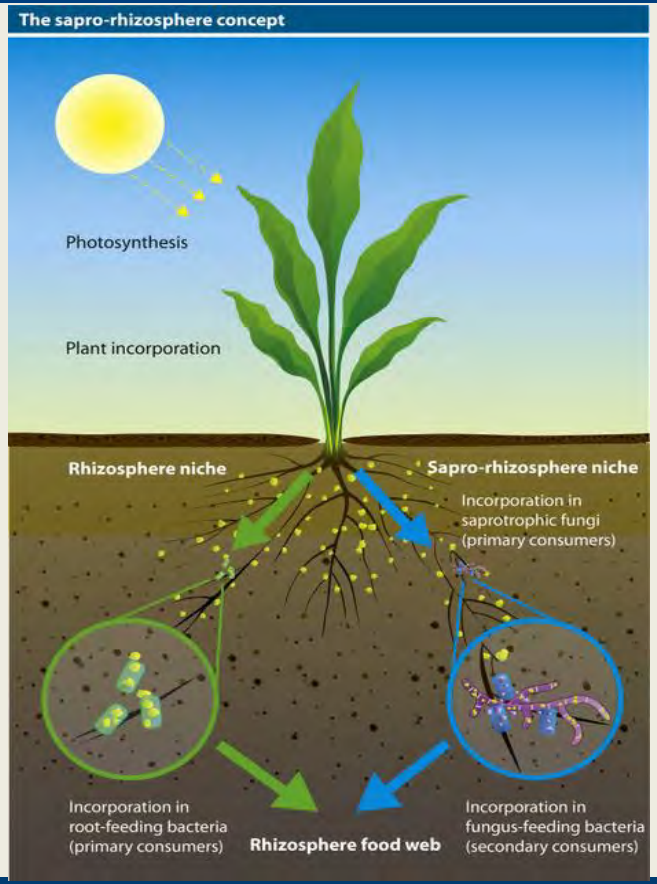
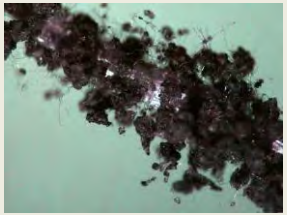
Agricultural soils are part of a complex ecosystem



Living roots feed the soil biology

Ecosystem services:

- Nutrient cycling and mineralization
- Sequestering carbon & building organic matter
- Disease & pest suppression
- Building soil structure



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Living plants & soil microbes build soils

For every 1% increase in soil organic matter, soils can have an additional 17,000 – 25,000 gallons of available water per acre

Improved soil structure and increased soil organic matter

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Improving Infiltration

Double Ring Infiltrometer

August 2014 (Buchanan soil)	December 2014
Test #1 – 3.5 inches	Test #1 – 2.8 inches
Test #2 – 4.0 inches	Test #2 – 9.6 inches
Test #3 – 5.7 inches	Test #3 – 4.2 inches
Test #4 – 5.7 inches	Test #4 – 7.9 inches
Average = 4.7 inches	Test #5 – 10.1 inches
	Test #6 – 10.2 inches
	Test #7 – 13.9 inches
Schrack Farms	Test #8 – 7.5 inches
Loganton, PA	**Average = 8.3 inches**

"We don't have a runoff problem, we have an infiltration problem"

– Ray Archuleta

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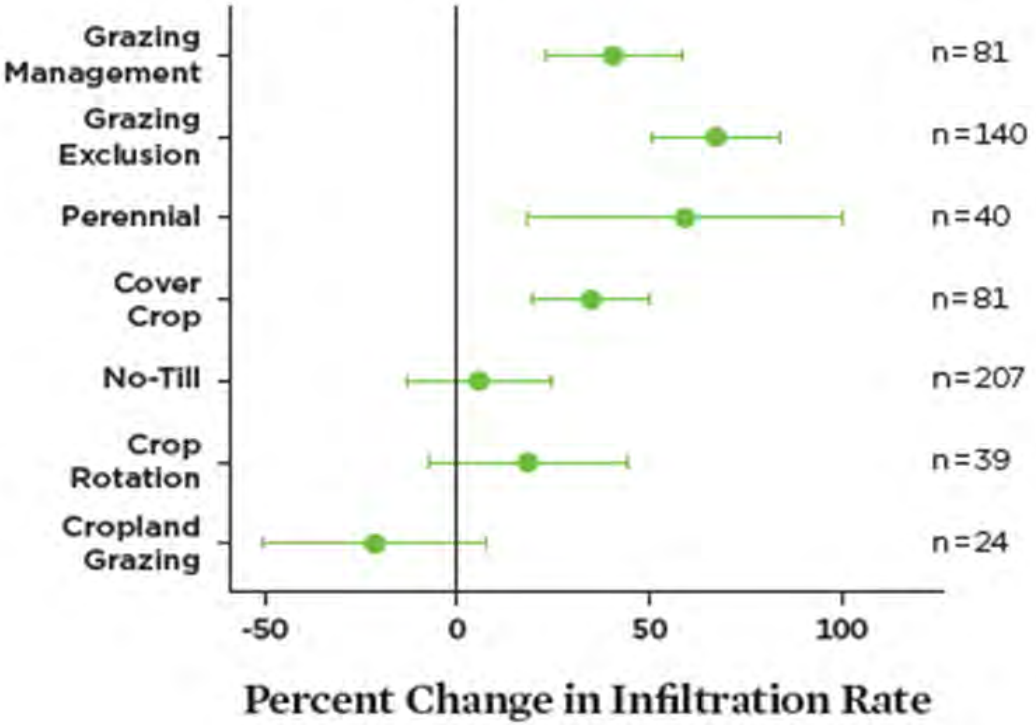
FIGURE 3. Water Infiltration Improves with Alternative Crop and Soil Practices



From Union of Concerned Scientists, 2017. "Soils as Sponges"

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Less runoff = less flooding

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Sediment transport

Excess sediment leads to:

- Loss of habitat
- Changes in stream morphology dynamics
- Delivery of nutrients and sometimes pesticides and other potential contaminants

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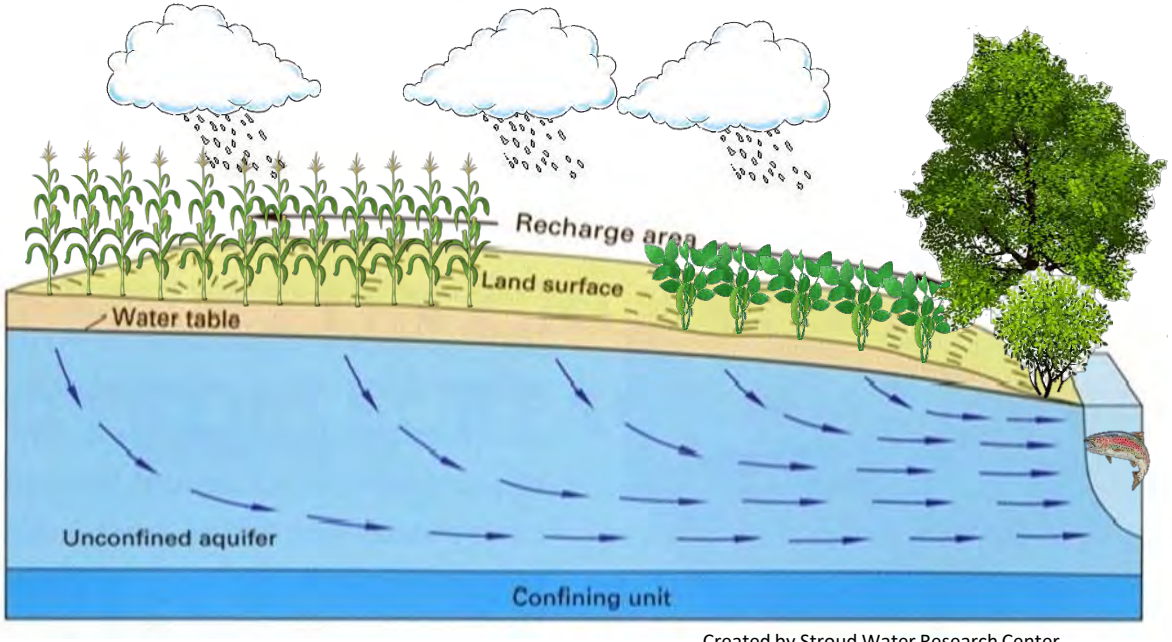
Groundwater recharge



Created by Stroud Water Research Center

Improved soil infiltration rates allow for more groundwater recharge and increases base flow conditions in the streams. Groundwater flow paths can help process nutrients, filter some pollutants, and can help provide cool stream water in summer months

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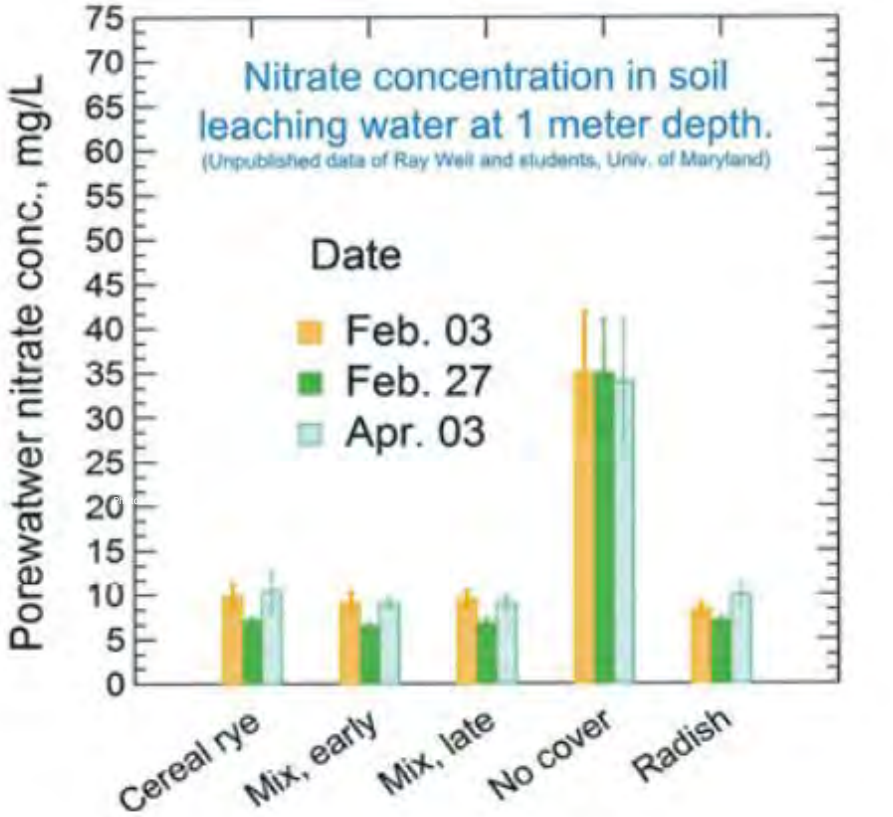
Cover crops can capture nitrates



Harborview Farm data collected by Ray Weil, University of Maryland, 2020.

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Nutrient loss to the environment

- Only about half of the nitrogen fertilizer applied is absorbed by the crop
- Some farmers are applying N based on 50+ year old research
- Phosphorus is bonded to soil particles and enters waterways via soil erosion
- Biologically active soils retain and cycle nutrients so less fertilizer is required

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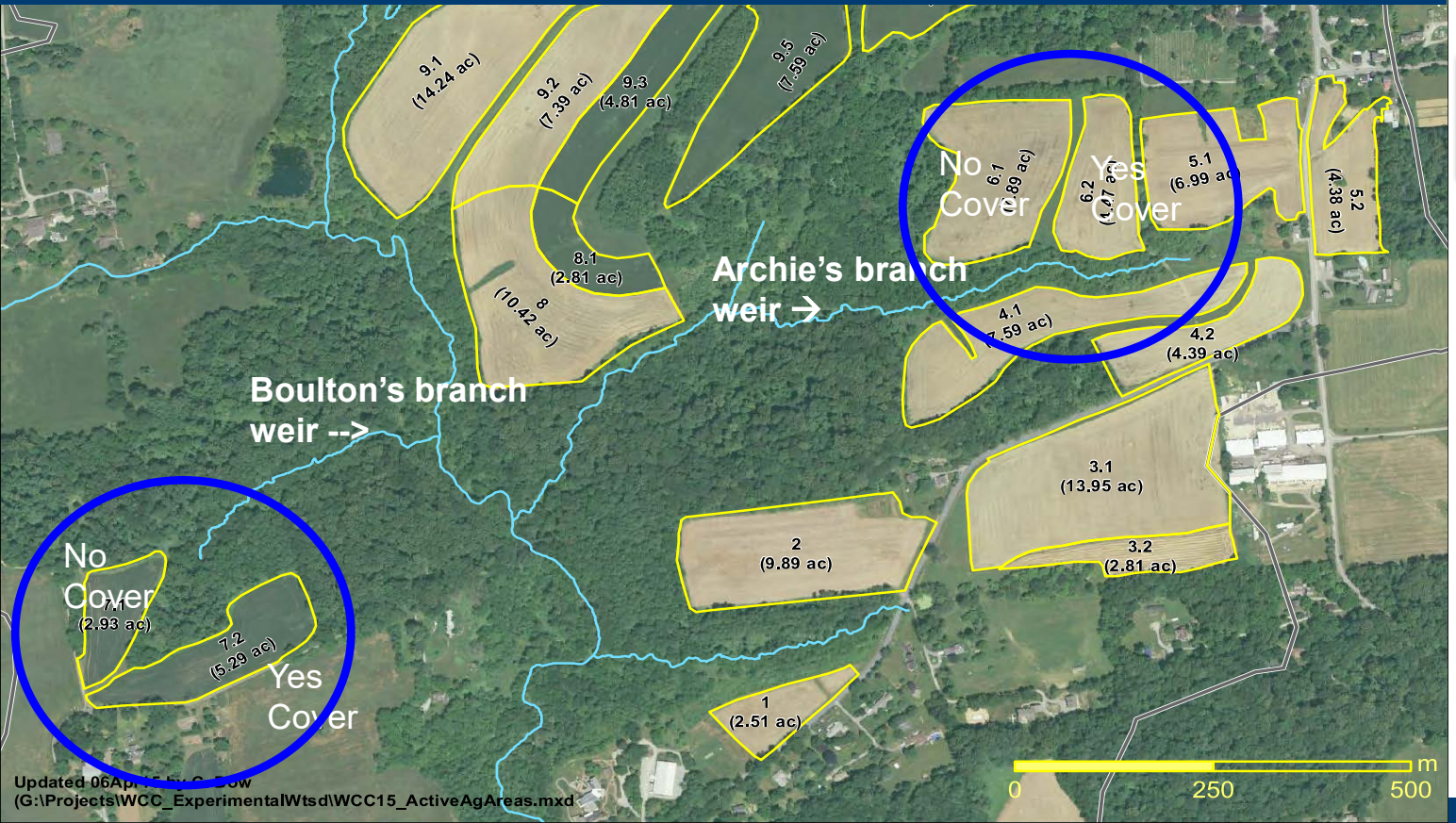
Evaluating How Conventional, Conservation, and Organic Farming Management Practices Enhance Soil Health and Improve Water Quality



USDA United States Department of Agriculture

Natural Resources Conservation Service

PRINCE ALBERT II OF MONACO FOUNDATION

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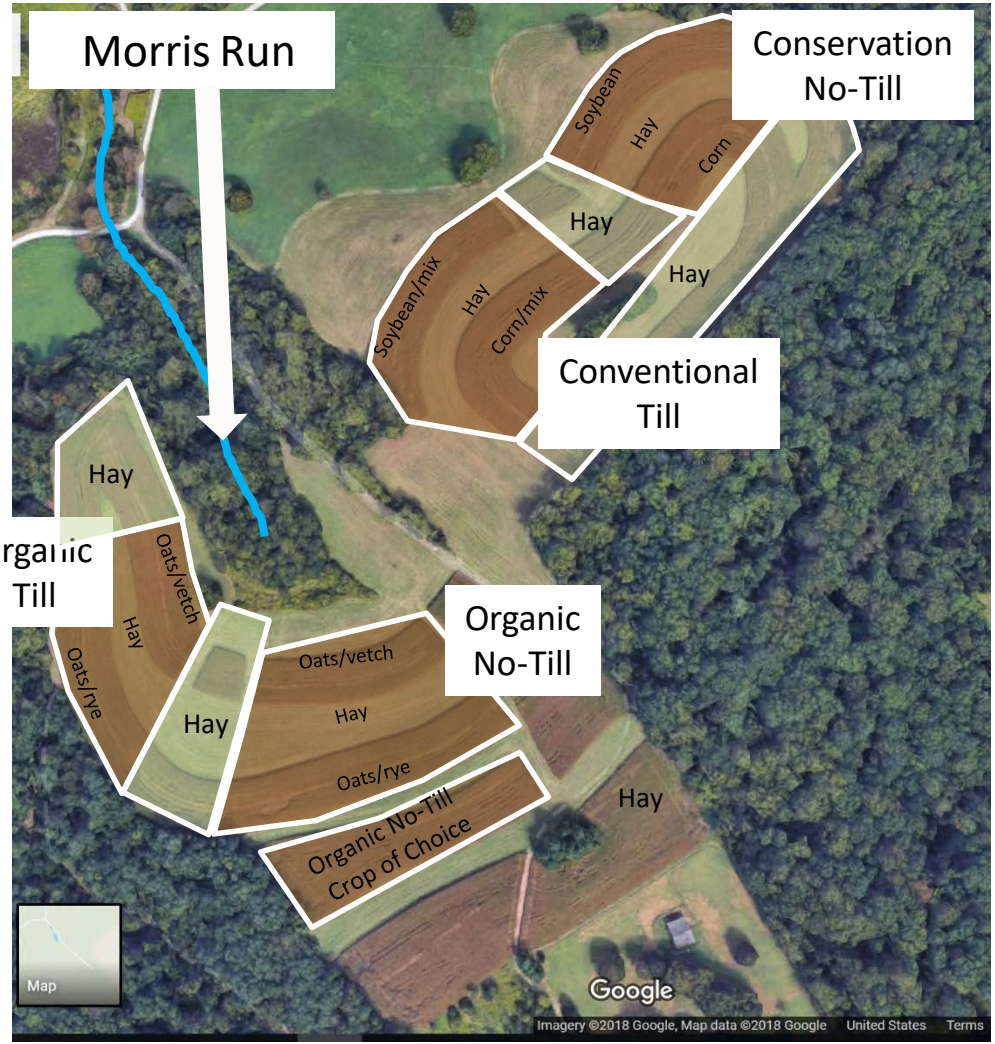
Reducing Pollution from Agriculture in the Delaware River Watershed

WILLIAM PENN FOUNDATION

Research, outreach and education to identify and encourage the most effective “water-friendly” agricultural production methods



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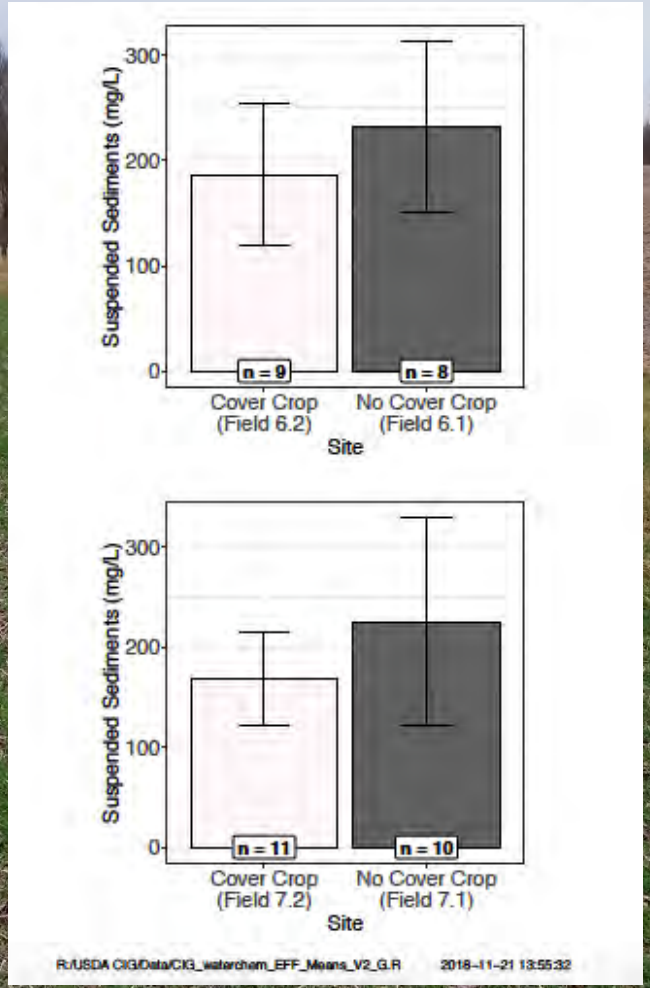
Cover Crop

No
Cover Crop



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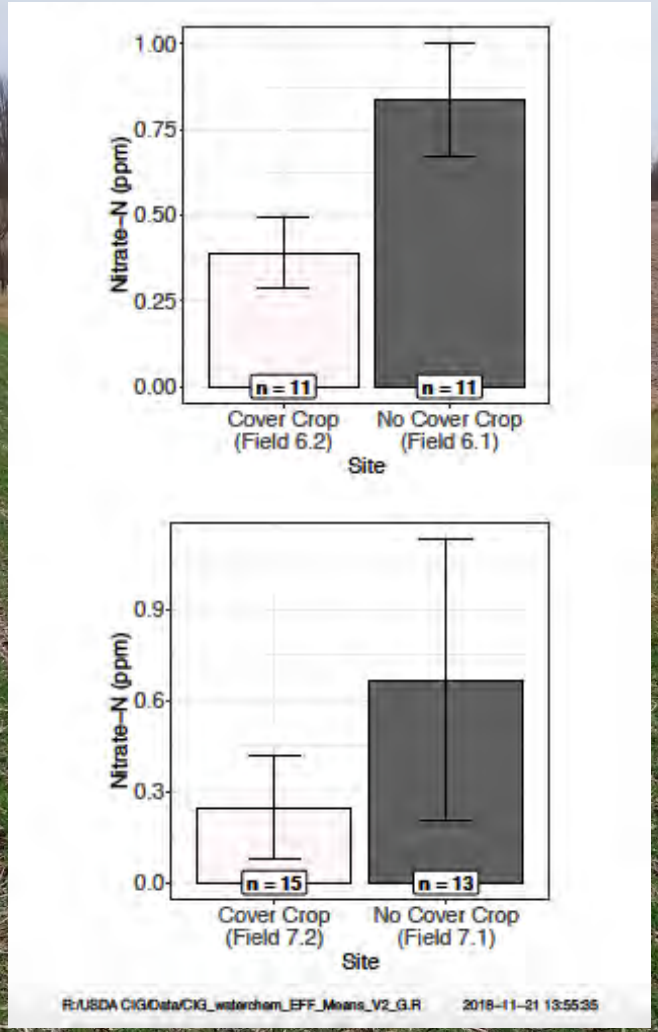
Cover Crop

No
Cover Crop



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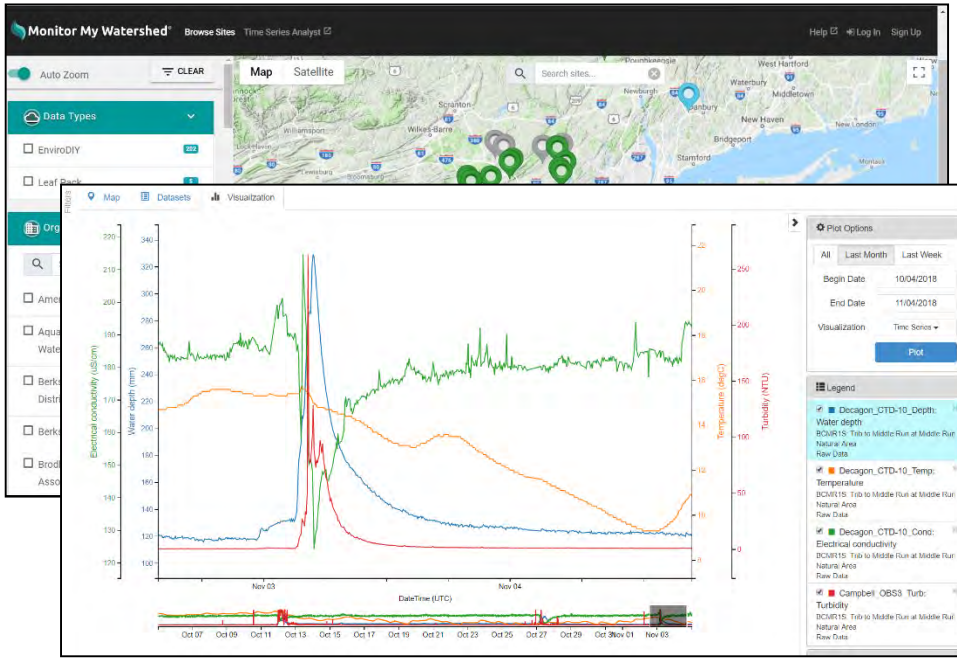
EnviroDIY.org & Monitor My Watershed®

Open-Source Systems for Low-Cost, Realtime Monitoring

U build & deploy



Web software for
data capture/visualization

Monitor My Watershed® & EnviroDIY.org

Webinar Specific Online Resources

WikiWatershed®

https://WikiWatershed.org/

Monitor My Watershed®

http://MonitorMyWatershed.org/

EnviroDIY

https://www.EnviroDIY.org/

Stroud Water Research Center

What is EnviroDIY ?

A community of enthusiasts sharing do-it-yourself ideas for environmental science and monitoring

- open-source compatible hardware/software
- web-based forum for users to help each other
- web-based mapping and data capture/visualization
- workshops for training (researchers, citizens scientist, educators, students)

EnviroDIY promotes do-it-yourself environmental monitoring and sells electronic hardware

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EnviroDIY About Participate Mayfly Blog Forums Videos Shop

Shop

Building an EnviroDIY Monitoring Station Workshop (#260000)

$425.00

Read more

EnviroDIY Mayfly Data Logger Board and Starter Kit (Pack of 5)

$405.00

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Stroud Water Research Center EnviroDIY Mayfly Data Logger Board

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$60.00

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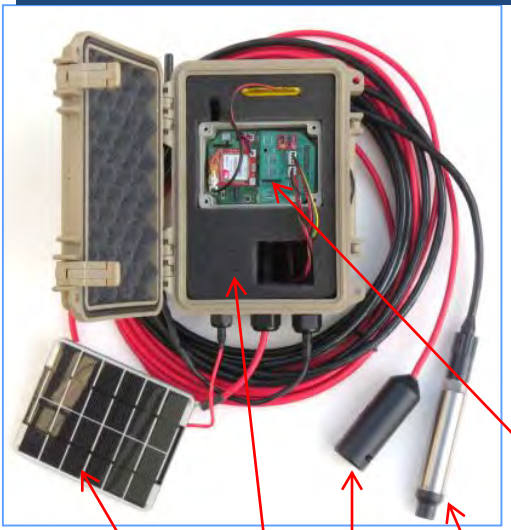
EnviroDIY Sensor Station



Solar panel

Logger box

Decagon CTD-10 sensor – Conductivity, Temperature, Depth

Mayfly data logger board

Campbell OBS-3+ Turbidity sensor

Full station – sensors and logger box with solar panel

Solar panel and logger box

Sensor bundle (sensors, hose clamp, PVC sheath, mounting pin)

Mounting pin – remove to take sensor bundle out of stream

Staff gauge – for on-site reference and use in developing hydrologic rating curves

The Mayfly Datalogger connects to water sensors and transmits data via 4G cell network

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Monitor My Watershed is a web-based data sharing app (an environmental IoT technology)

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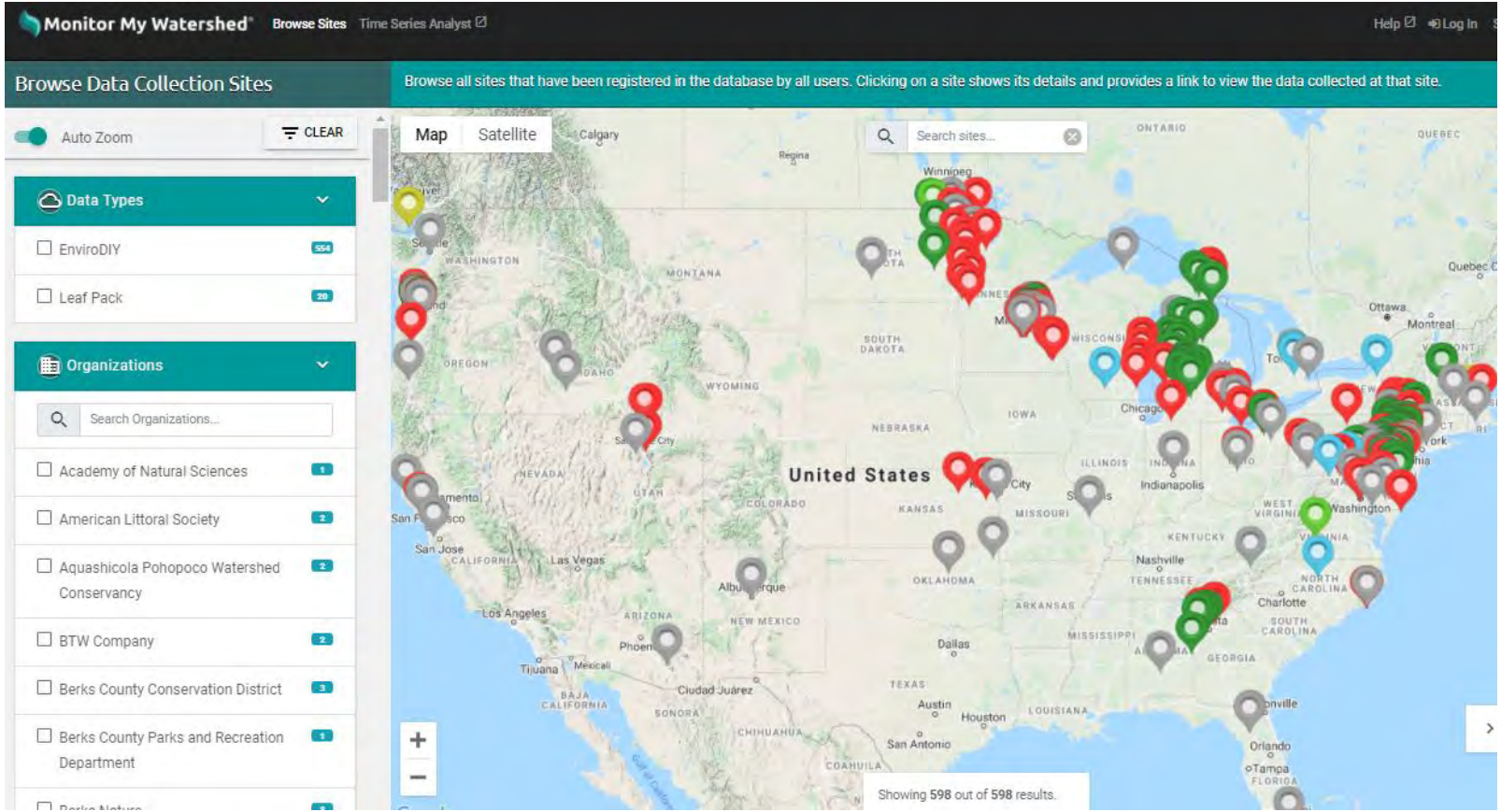
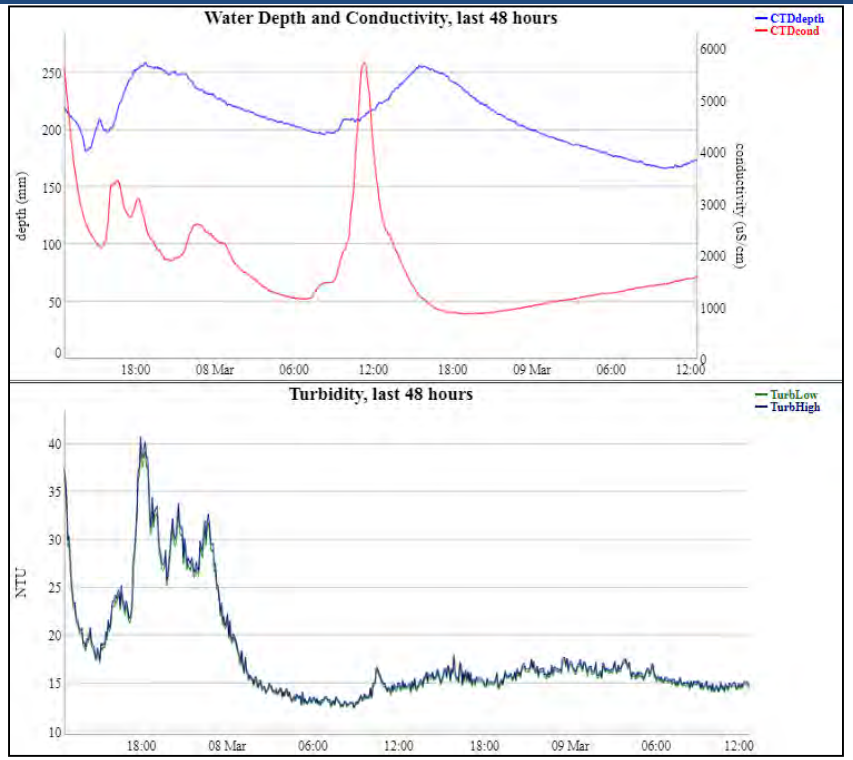


EnviroDIY Sensor Station



Campbell OBS3+ Turbidity sensor

Meter Hydros 21 CTD sensor (formerly Decagon CTD-10)

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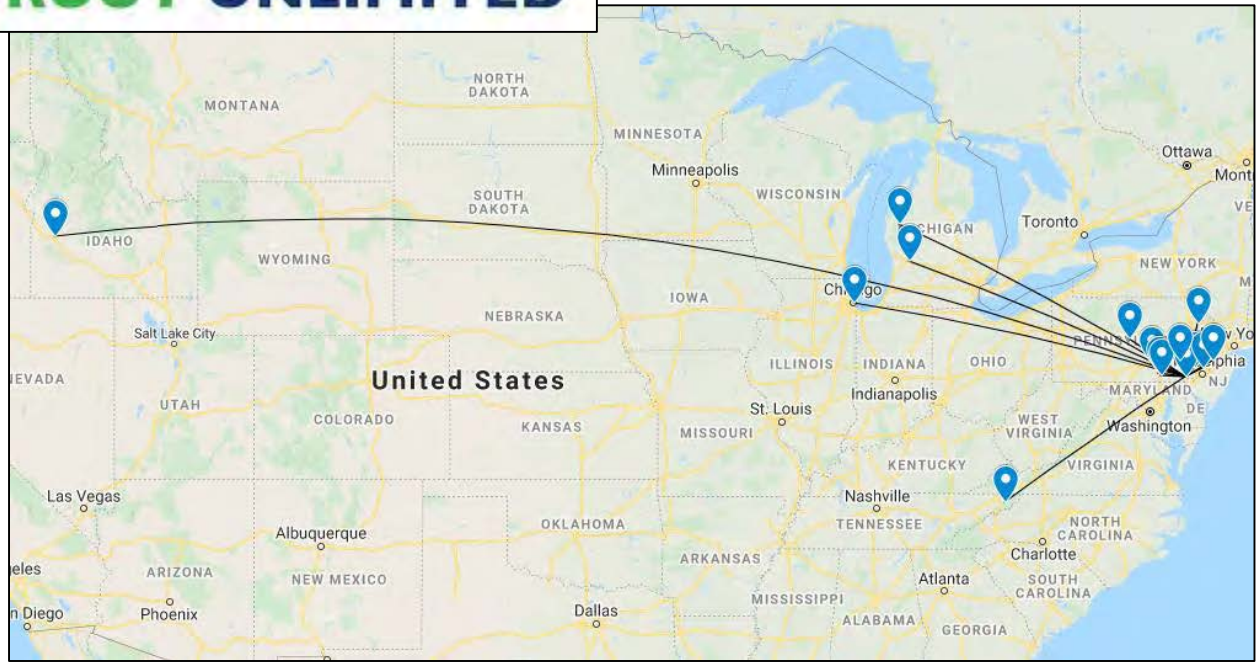
TU Chapters utilizing EnviroDIY/Monitor My Watershed



TU Chapter	State
Valley Forge TU	PA
Pike/Wayne TU	PA
Cumberland Valley TU	PA
Donegal TU	PA
Perkiomen TU	PA
Muddy Creek TU	PA
S.E. Montgomery Co. TU	PA
Pennsylvania TU	PA
Tulpehocken TU	PA
Pere Marquette TU	MI
Grand Rapids TU	MI
Elliot Donnelly TU	IL
Overmountain TU	TN
TU National Science Team	ID
New Jersey TU	NJ

50+ sites belonging to various TU Chapters or individuals working with TU Chapters

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Bear Creek, Michigan installation with Jake Lemon 2019

Rum Creek, Michigan installation during TU workshop 2019

Valley Creek, PA installation with TU members

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EnviroDIY Workshops

½ to 3 days long, hands-on (usually), all audiences

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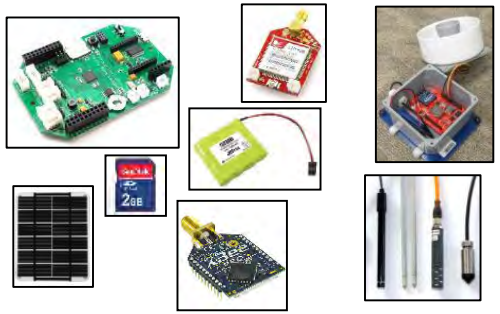
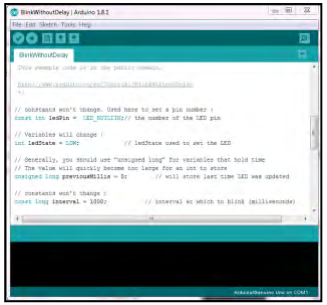
The EnviroDIY Workshop

Hardware Components and Sensors → Programing with Open Source Software → Building Monitoring Stations → Strategies for Deployment





Quality Assurance and Control → Online System for Data Capture and Visualization → Data Management, Analysis, and Interpretation

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User group support workshops and small group trainings

- For individuals who are already using sensor stations
- Time for discussion, networking, and updates; topics:
  - Maintenance/upkeep
  - Field procedures
  - Quality control procedures
  - Data analysis – usage of MonitorMyWatershed
  - Defining/refining goals for data usage

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EnviroDIY Hardware

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EnviroDIY Mayfly Data Logger Board, Arduino Compatible

by Stroud Water Research Center

Be the first to review this item

Price: $60.00 Prime

In Stock.

Sold by Stroud Water Research Center and Fulfilled by Amazon.

- Fully programmable microprocessor board, compatible with the Arduino IDE software
- Atmega 1284p processor, 128K flash memory and 16K RAM
- 24 digital I/O pins, and 8 analog pins, plus a 4-channel 16-bit analog-to-digital converter
- Realtime Clock chip, microSD card slot, Bee RF module socket, and solar battery charging capability

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EnviroDIY Mayfly Data Logger Arduino Compatible Board and Starter Kit

by Stroud Water Research Center

Be the first to review this item

Price: $90.00 Prime

In Stock.

Sold by Stroud Water Research Center and Fulfilled by Amazon.

- EnviroDIY Mayfly Data Logger Board plus accessories to get you started
- Includes waterproof enclosure with clear lid and 0.5watt solar panel
- Custom microSD connector board plugs into Mayfly for easy access to the memory card
- 4GB microSD card and adapter included
- Also includes 1-meter microUSB cable for programming the Mayfly, and 2 Grove cables

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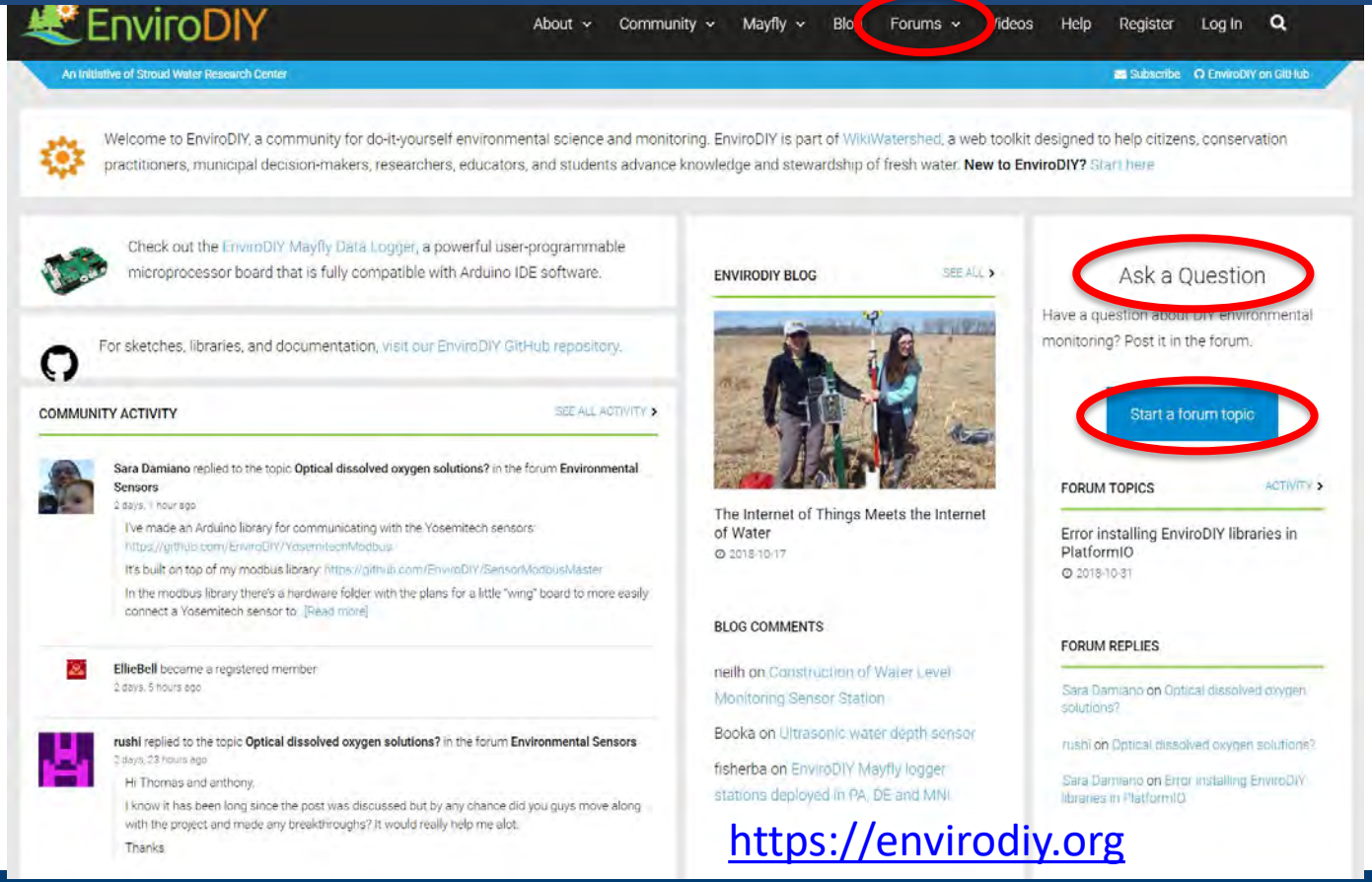

https://envirodiy.org

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EnviroDIY Hardware

EnviroDIY

About Community Mayfly Blog Forums Help darscott

An Initiative of Stroud Water Research Center

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Home > Getting Started With the Mayfly Data Logger

Getting Started With 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. It features the ATmega1284p processor, which is much more powerful than the 328p chip found on most other Arduino boards. It has 4 times more flash memory for sketches, 8 times more RAM, and almost twice as many input pins.

Features:

- 128K Flash memory, 16K RAM
- 28 digital I/O pins, 8 analog pins, plus 4 additional high-resolution ADC pins
- 2 serial UART ports
- microSD memory card socket
- Onboard realtime clock (RTC) (DS3231)
- Solar lipo battery charging
- Low power consumption (6.5 mA when on but idle, 0.27-0.43 mA when in sleep)
- Bee module socket
- 2 LEDs, 1 user programmable pushbutton
- 3.3v main board voltage, additional 5-volt boost circuity for external devices
- Two 20-pin headers for accessing all available I/O pins
- 6 Grove-style sockets for easy connections to sensors and devices

MAYFLY DATA LOGGER BOARD

Getting Started
Hardware
Board Features
Jumper settings
Starter Kit
Accessories
Software
Mayfly Forum

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EnviroDIY Arduino Code

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ModularSensors
An Arduino library to give environmental sensors a common interface of functions for use with Arduino-compatible dataloggers, such as the EnviroDIY Mayfly.
C++ 11 5

Arduino-SDI-12
Arduino library for SDI-12 communications to a wide variety of environmental sensors. This library provides a general software solution, without requiring any additional hardware.
C++ 51 42

EnviroDIY_Mayfly_Logger
Sketches and documentation for Arduino-compatible EnviroDIY Mayfly data logger
C++ 7 15

SensorModbusMaster
An Arduino library to act as Modbus Master to control a sensor/slave
C++ 4 2

YosemitechModbus
A library to use an Arduino as a master to control and communicate with the modbus sensors produced by Yosemitech. Depends on the EnviroDIY/SensorModbusMaster library.
C++

Libraries
Arduino libraries used with the EnviroDIY Mayfly data logger board
1

Users share code here:
https://github.com/EnviroDIY

GitHub

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FUTURE OF FRESH WATER INITIATIVE

Goal: $20 Million

Nowhere else in the world is there an organization like Stroud Water Research Center, which has focused on understanding, preserving, and protecting fresh water since 1967. To strengthen ongoing research and to expand community empowerment programs to protect clean fresh water regionally and around the world, the Stroud Center has announced its Future of Fresh Water Initiative.

PROGRESS 44%

Help us reach our goal. **Give to the Future of Fresh Water Initiative**. ***Gifts to the Executive Director's Fund and the Environmental Education Fund will be DOUBLED thanks to generous challenge grants!***


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