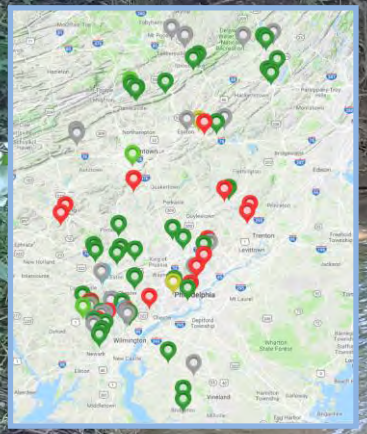
Continuous monitoring stations in the Delaware River Basin for understanding individual sites and regional patterns

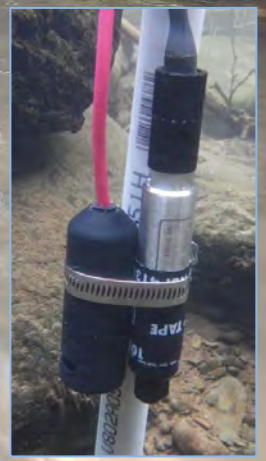
Online, April 2021, 12:30-3:00, National Monitoring Conference

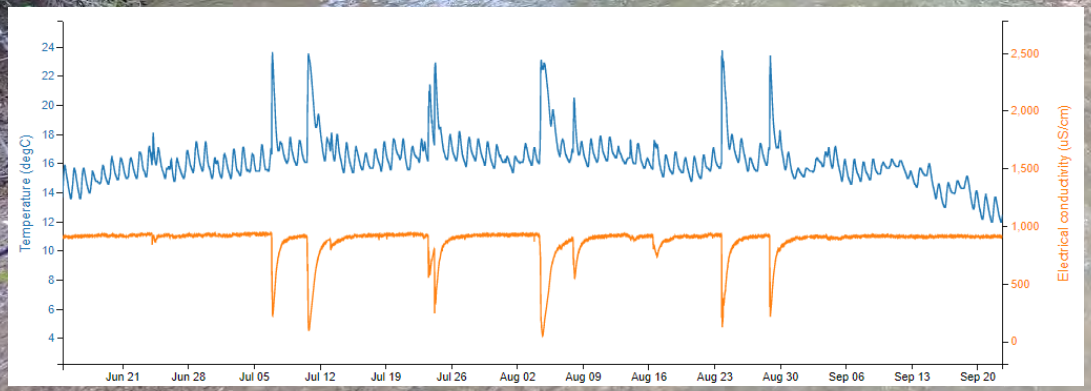
Session: S17 – Using Big Data to Answer National- and Regional-Scale Water Quality Questions

Presenter: David Bressler, Stroud Water Research Center

Contributors: John Jackson, Sara Damiano, Scott Ensign, Diana Oviedo-Vargas, Marc Peipoch







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Parts 1-3

- Part 1 – Introduction to the citizen science project
- Part 2 – Data usage at the local level, watershed characterization
- Part 3 – Directions for the project

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Part 1

- Project overview
  - Intentions
  - Equipment
  - Data portal
  - People

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Project

Goal: Support EnviroDIY continuous monitoring station users to better understand and manage local watersheds

- *Support data-driven action*

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Basic EnviroDIY monitoring station

Conductivity, Temperature, Depth (Meter Hydros 21)

Turbidity (Campbell OBS-3+)

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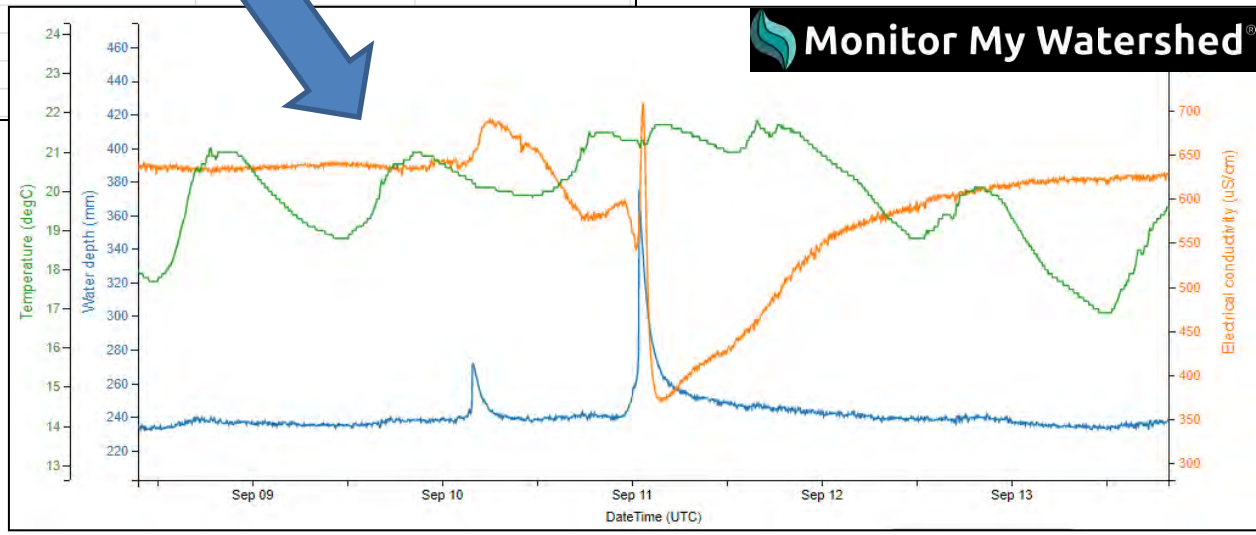
Continuous Data

Measurements in 5-minute intervals, transmitted to Monitor My Watershed data portal

DateTime	TimeOffse	DateTimeUTC	Decagon_CTD-10_Cond	Decagon_CTD-10_Depth	Decagon_CTD-10_Temp
7/29/2020 10:20	-5:00	7/29/2020 15:20	465.2	254	29.5
7/29/2020 10:25	-5:00	7/29/2020 15:25	464.8	252	29.5
7/29/2020 10:30	-5:00	7/29/2020 15:30	466.5	253.8	29.52
7/29/2020 10:35	-5:00	7/29/2020 15:35	466.2	253.8	29.52
7/29/2020 10:40	-5:00	7/29/2020 15:40	465.5	252.3	29.7
7/29/2020 10:45	-5:00	7/29/2020 15:45	466.8	253.3	29.8
7/29/2020 10:50	-5:00	7/29/2020 15:50	464.7	253.3	29.8
7/29/2020 10:55	-5:00	7/29/2020 15:55	466	255.8	29.8
7/29/2020 11:00	-5:00	7/29/2020 16:00	466.2	254.2	29.9
7/29/2020 11:05	-5:00	7/29/2020 16:05	467	254.2	30
7/29/2020 11:10	-5:00	7/29/2020 16:10	467	254.3	30
7/29/2020 11:15	-5:00	7/29/2020 16:15	465.7	253.3	30.1
7/29/2020 11:20	-5:00	7/29/2020 16:20	465.5	255.3	30.1
7/29/2020 11:25	-5:00	7/29/2020 16:25	466.8	256	30.18
7/29/2020 11:30	-5:00	7/29/2020 16:30	466.2	255.8	30.2
7/29/2020 11:35	-5:00	7/29/2020 16:35			
7/29/2020 11:40	-5:00	7/29/2020 16:40			
7/29/2020 11:45	-5:00	7/29/2020 16:45			
7/29/2020 11:50	-5:00	7/29/2020 16:50			

https://monitormywatershed.org/

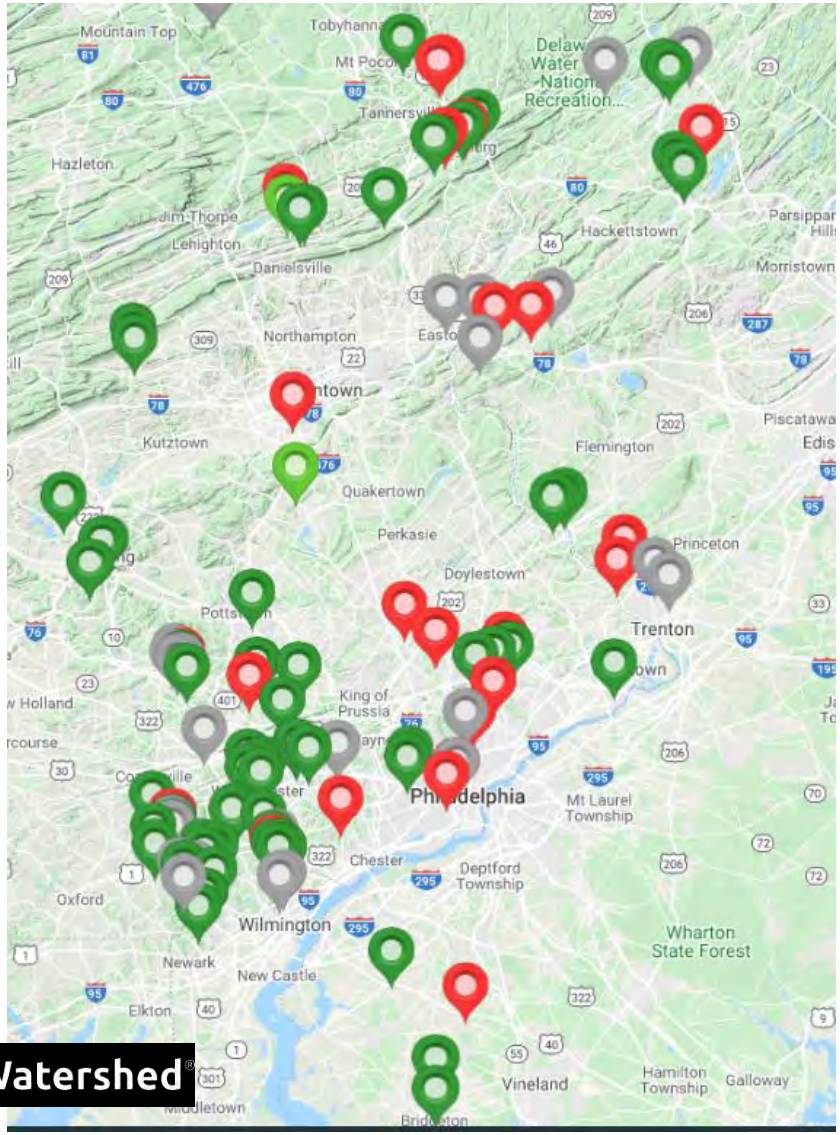


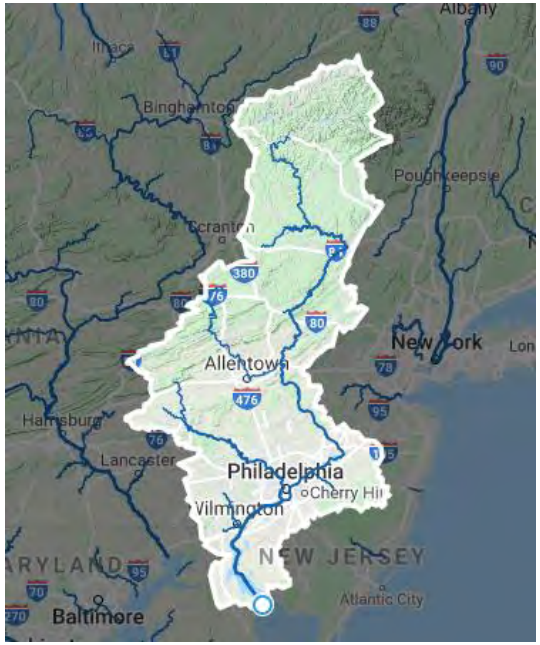
Station deployed across the Delaware Basin

>100 Stations in DRB

Owned by >40 watershed groups

~Median watershed size = 10 km^2 (much smaller than USGS watersheds)





Monitor My Watershed®

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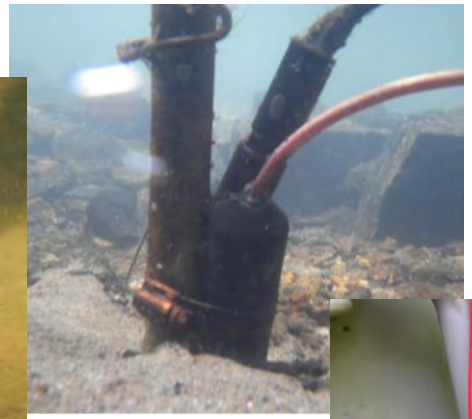
What it takes

Sounds easy but…

- Sensors foul easily and regularly
- Water and weather are destructive
- People and creatures can damage



What it takes

- **Motivated People!**
  - Monitor data and station function
  - Clean sensors and station
  - Quality Control

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What it takes

Stroud Center support

- Technical troubleshooting
- Monthly meetings
- Workshops
- Guidance materials
- 1:1 assistance, consultation
- **Data Analysis and Interpretation**

Part 2

Part 2 – Data usage at the local level, watershed characterization using the basin-wide network for context and reference

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Context

- Polled users on what would help them most in their capacity building
  - #1 response ~“we need help with understanding and applying the data”
    - ~*“We can do the day to day checking of data, maintenance, and quality control but we need help in making meaning of the data”*

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Watershed Characterization, Test Case

- Watershed groups: Wallkill Watershed Management Group and Lopatcong Creek Initiative
    - Kristine Rogers and Juniper Leifer – provided detailed feedback on what they needed to be able to better apply station data
- Site: Paulins Kill in northern New Jersey – headwaters at Sussex County Community College

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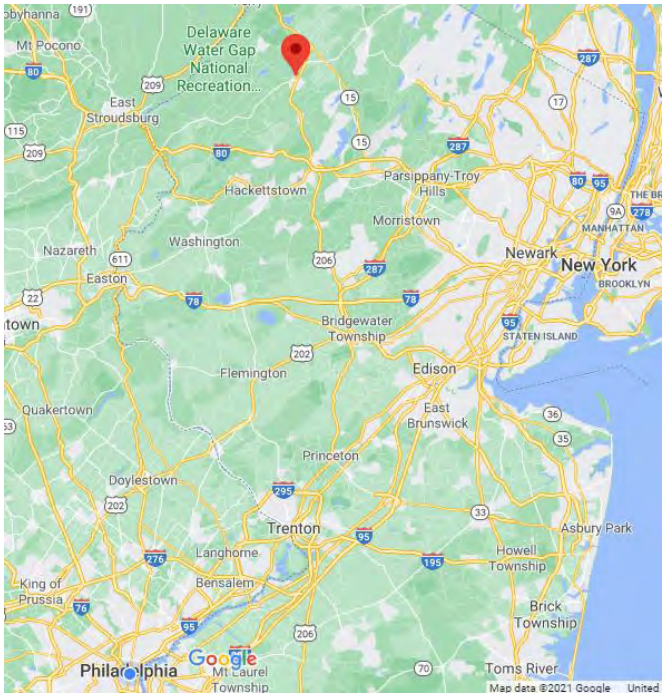
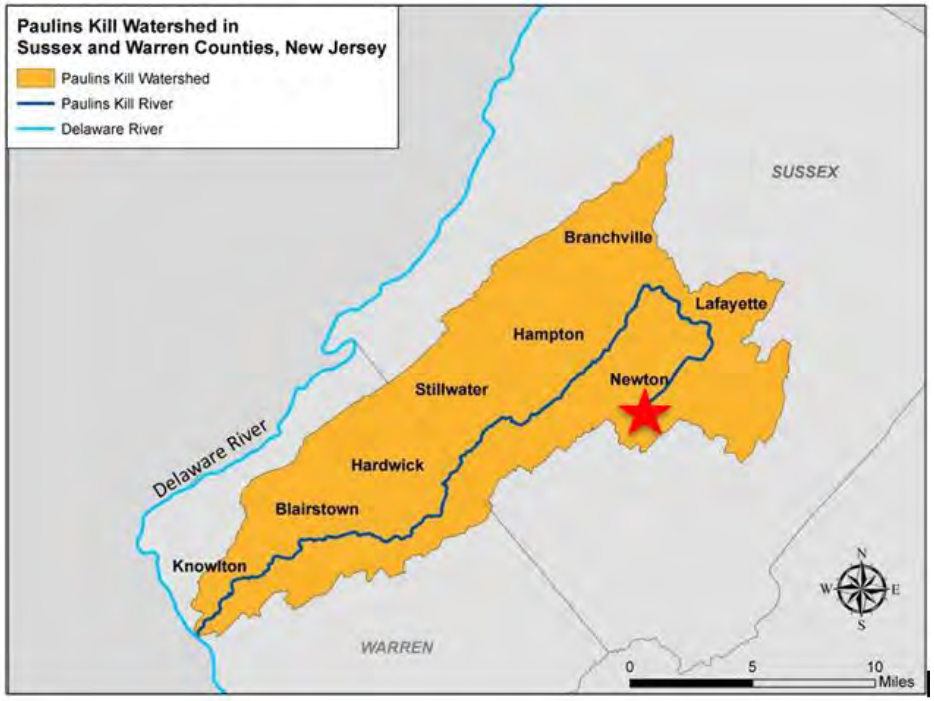
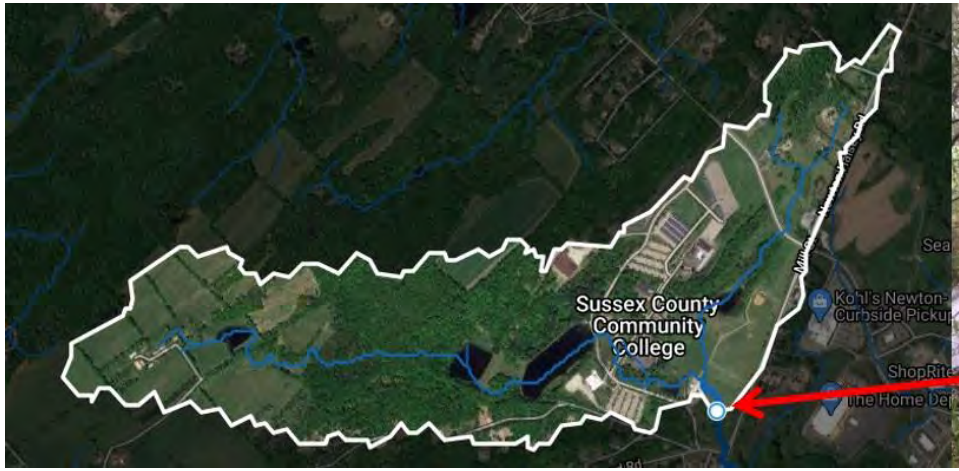
Watershed Characterization, Paulins Kill headwaters







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Watershed Characterization, Paulins Kill headwaters

Paulins Kill at Sussex County Community College – Informal assessment of EnviroDIY monitoring station data including temperature, conductivity, and depth

Prepared by David Bressler (Stroud Water Research Center) for Kristine Rogers (Wallkill River Watershed Management Group)

July 1, 2020

The following is a draft assessment of the continuous conductivity, temperature, and depth data collected using an EnviroDIY monitoring station located on the Paulins Kill headwaters on the campus of Sussex County Community College (Latitude 41.06602, Longitude -74.75547; http://monitormywatershed.org/sites/NHPK9S/). The position of the station represents drainage from a large portion of the community college campus, as well as ball fields and residential areas on the east side of the upstream watershed (Figure 1). Questions being asked in this assessment include:

- How do conductivity and temperature data from the station relate to NJ DEP criteria?
- How do conductivity and temperature data from the station compare to similar data from nearby reference-quality streams?
- What technical and quality control issues need to be addressed to ensure data are usable and reliable?
- Based on current data, what preliminary recommendations can be made regarding additional data collection?
- Based on current data, what preliminary recommendations can be made regarding management of the watershed to improve stream health?

This assessment should be used for guiding future work such as confirming data accuracy, investigating/confirming suspected issues, working on watershed management issues associated with pollution problems identified in this assessment, and informing questions/issues related to Paulins Kill state level classifications and proposed re-classifications. This assessment has not been peer-reviewed and should remain open for critique, updates, and revisions.

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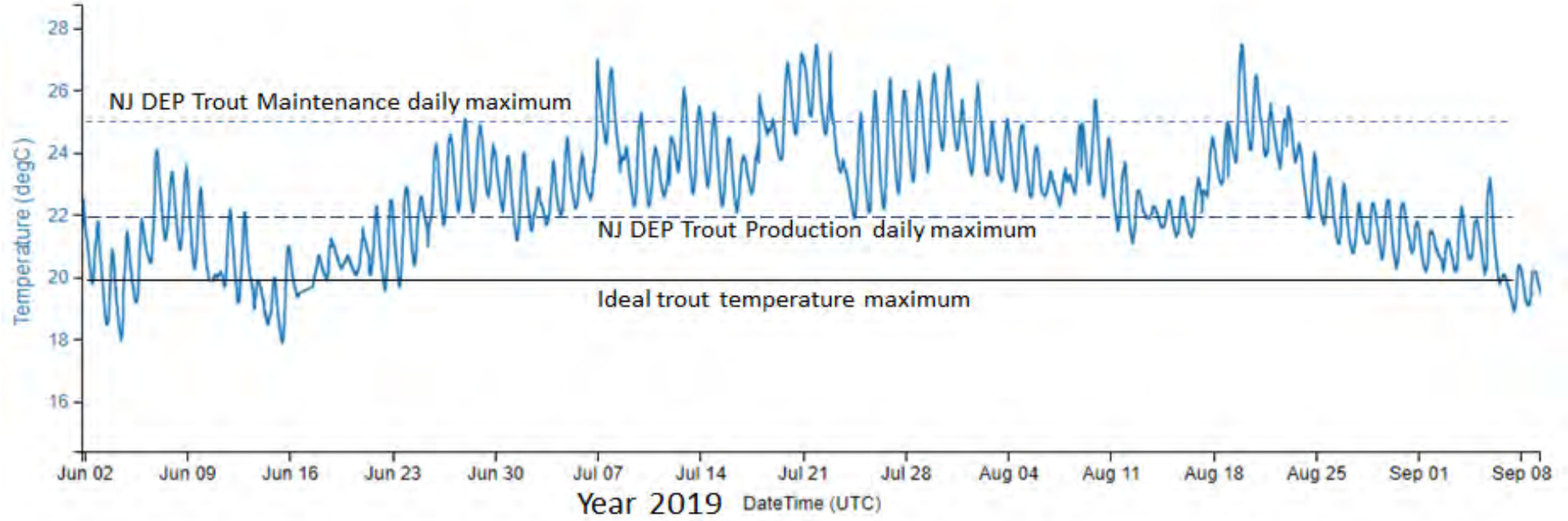
Data Interpretation



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Data Interpretation

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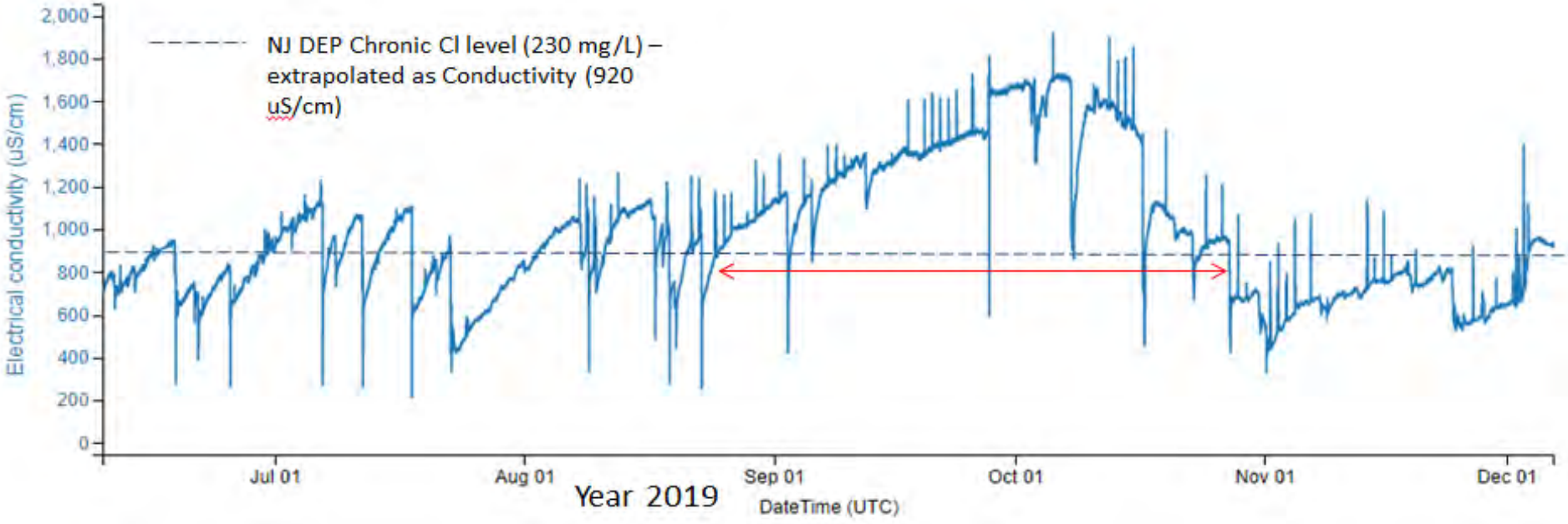
Data Interpretation



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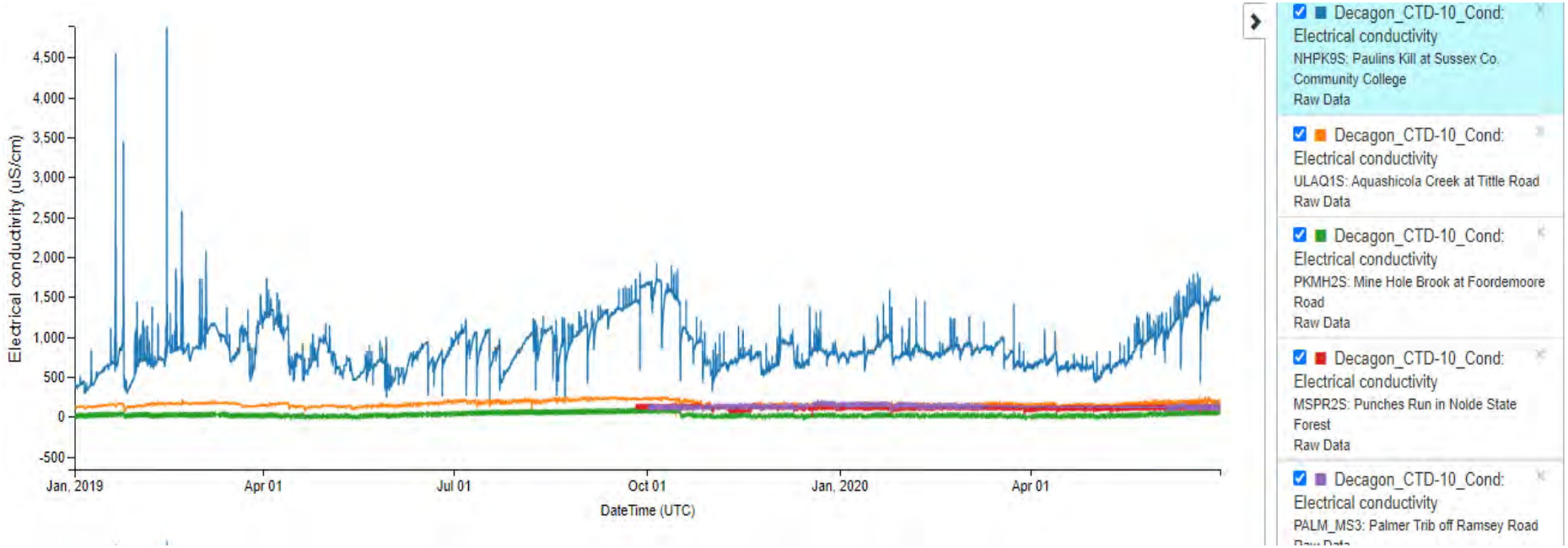
Data Interpretation



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Executive Summary by WallkillWMG

Upper Paulins Kill
Water Quality Report
2020

This water quality report was produced by the Wallkill 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 Jersey water quality standards and highlights the water quality monitoring parameters that have surpassed these thresholds. The second half of the report is a Scientific Assessment that provides a detailed synopsis of the water quality data that have been collected since the sensor station was installed in 2017. The purpose of this report is to inform regional stakeholders of any existing water quality trends that represent a threat to the Paulins Kill River and the surrounding community. The recommendations provided should be used to inform decisions and prevent further degradation of water quality.

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Wallkill River

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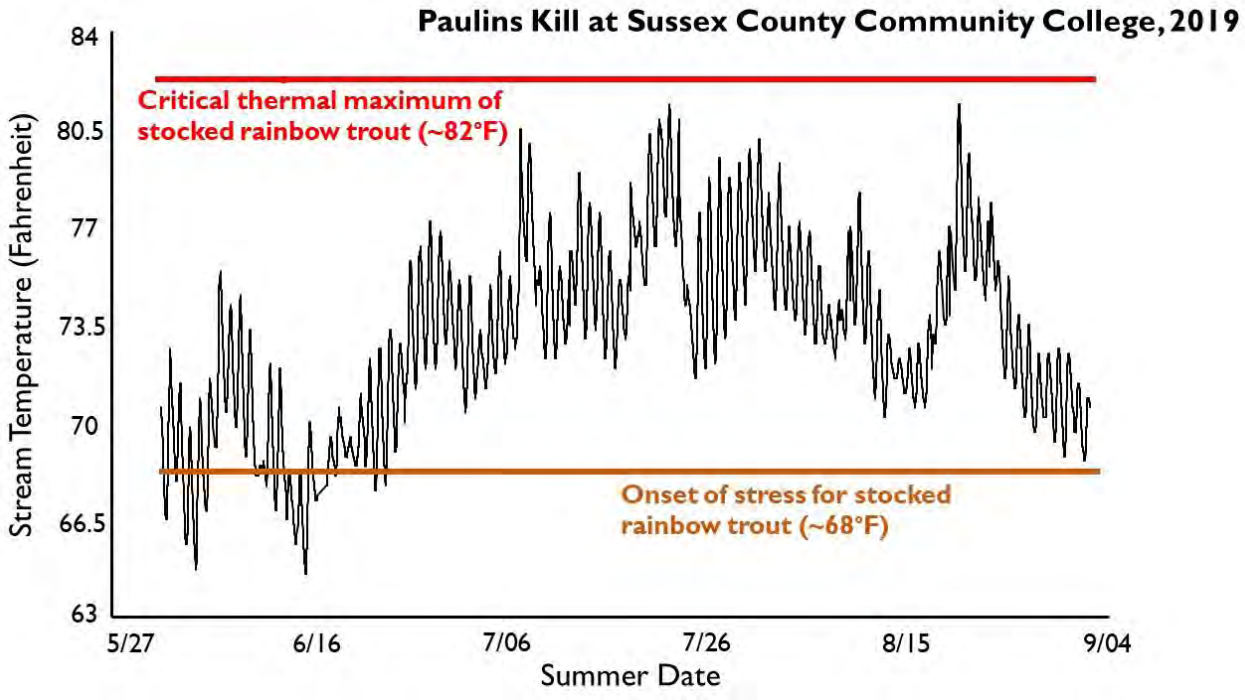
Data Interpretation



Graph 1: stream temperature (Fahrenheit) at SCCC monitoring station during summer 2019

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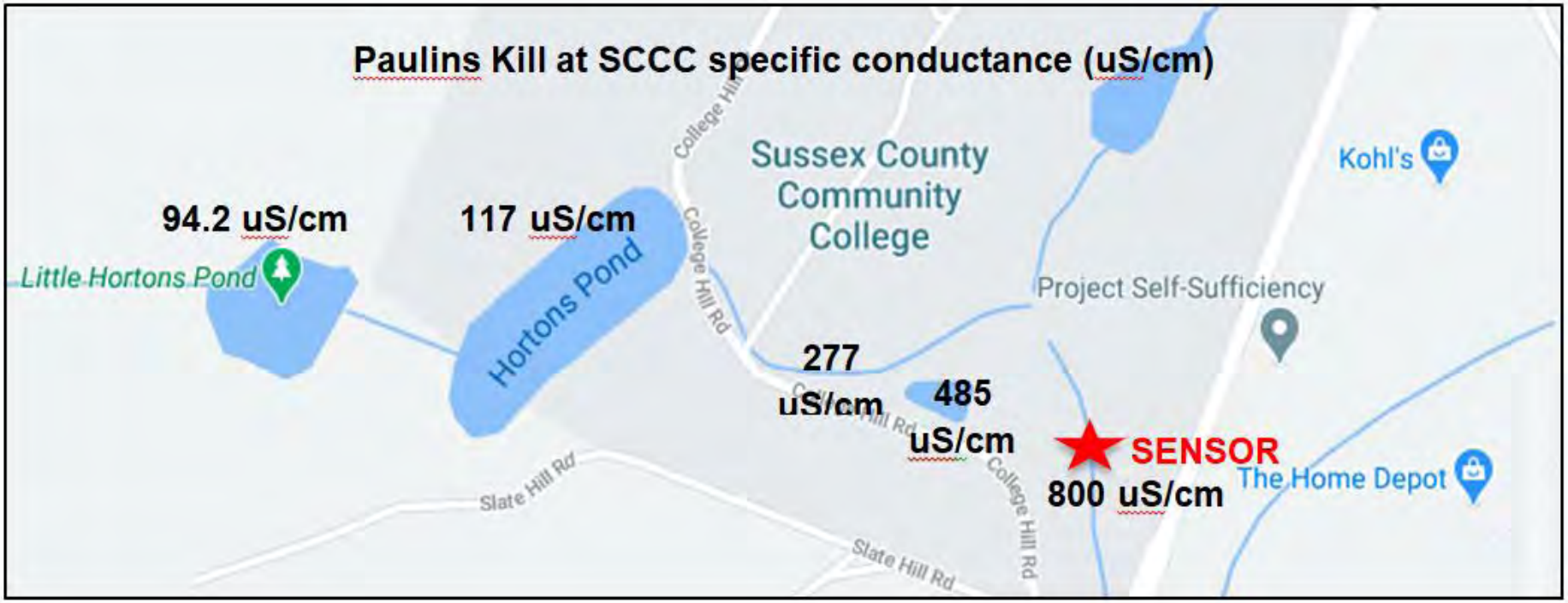
Watershed Characterization, Paulins Kill headwaters



Specific Conductance (uS/cm) on 11/25/20

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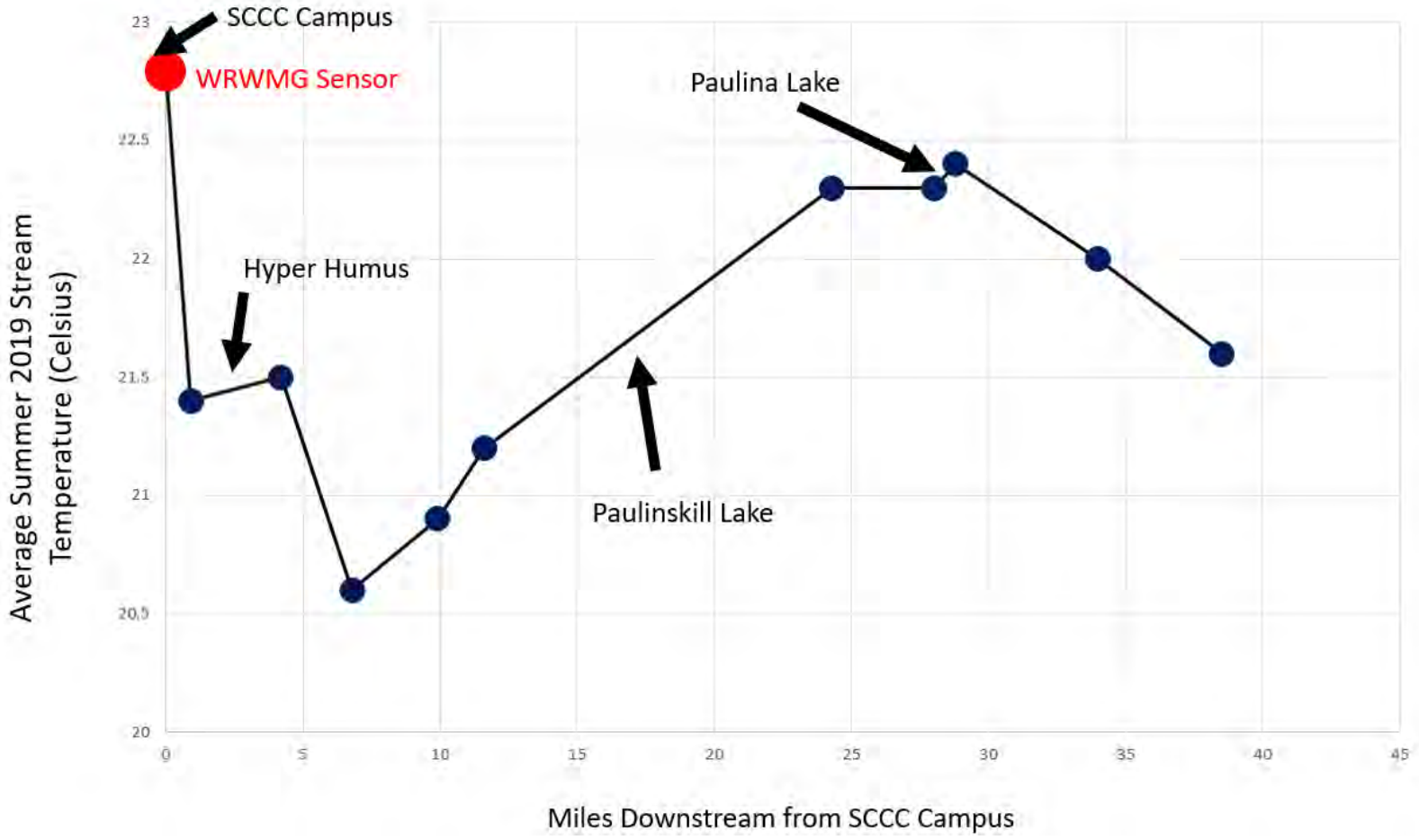
Watershed Characterization, Paulins Kill headwaters



Average summer stream temperature (Celsius) at locations downstream from SCCC

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Recommendations to local stakeholders

Sussex County Community College Administration: Enhanced Long-Term Planning

- Assess alternative methods for road/parking lot de-icing in the winter.
- Determine opportunities to reduce quantities of salt applied in the winter.
- Evaluate whether ponded areas are necessary or if they could be removed to reduce stream warming.
- Find stream reaches where riparian buffers can be expanded.
- Install green infrastructure practices to reduce the volume of stormwater runoff that enters the stream.
- Analyze piped sections of the stream that could be "daylighted" and restored to a more natural channel shape and pattern.

Upstream Landowners: Adjust land use to increase infiltration and reduce runoff

- Plant more trees to increase infiltration of precipitation.
- Install green infrastructure projects, like rain gardens and porous asphalt.
- Remove impervious surfaces from property where practicable.

Local Environmental Organizations:

- Conduct additional water quality monitoring in the headwaters of the watershed to confirm observed trends in the data.
- Work with local landowners to install green infrastructure and re-establish riparian forested buffers in the upper portions of the watershed, prioritizing opportunities to reduce stormwater runoff in Newton.
- Install best management practices that will benefit fish passage.
- Conduct educational outreach efforts to inform the general public about the high conductivity and temperature readings that have been observed.
- Evaluate how elevated temperature in this headwaters region may inhibit downstream efforts to cool the stream and support trout habitat.

Newton Municipal Officials:

- Evaluate whether stronger ordinances should be enacted for stormwater management.
- Consider establishing stormwater utilities that could fund a municipal stormwater management program with the collected user fees.
- Plant trees on township-owned open space.
- Provide public information sessions to inform residents of the issue and advise how they can reduce pollution from their own properties.
- Conduct workshops that introduce solutions to area residents, e.g. rain barrel workshops

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Part 3

Part 3 – Directions for the project

- Broad data set analysis to support standardization of watershed characterizations

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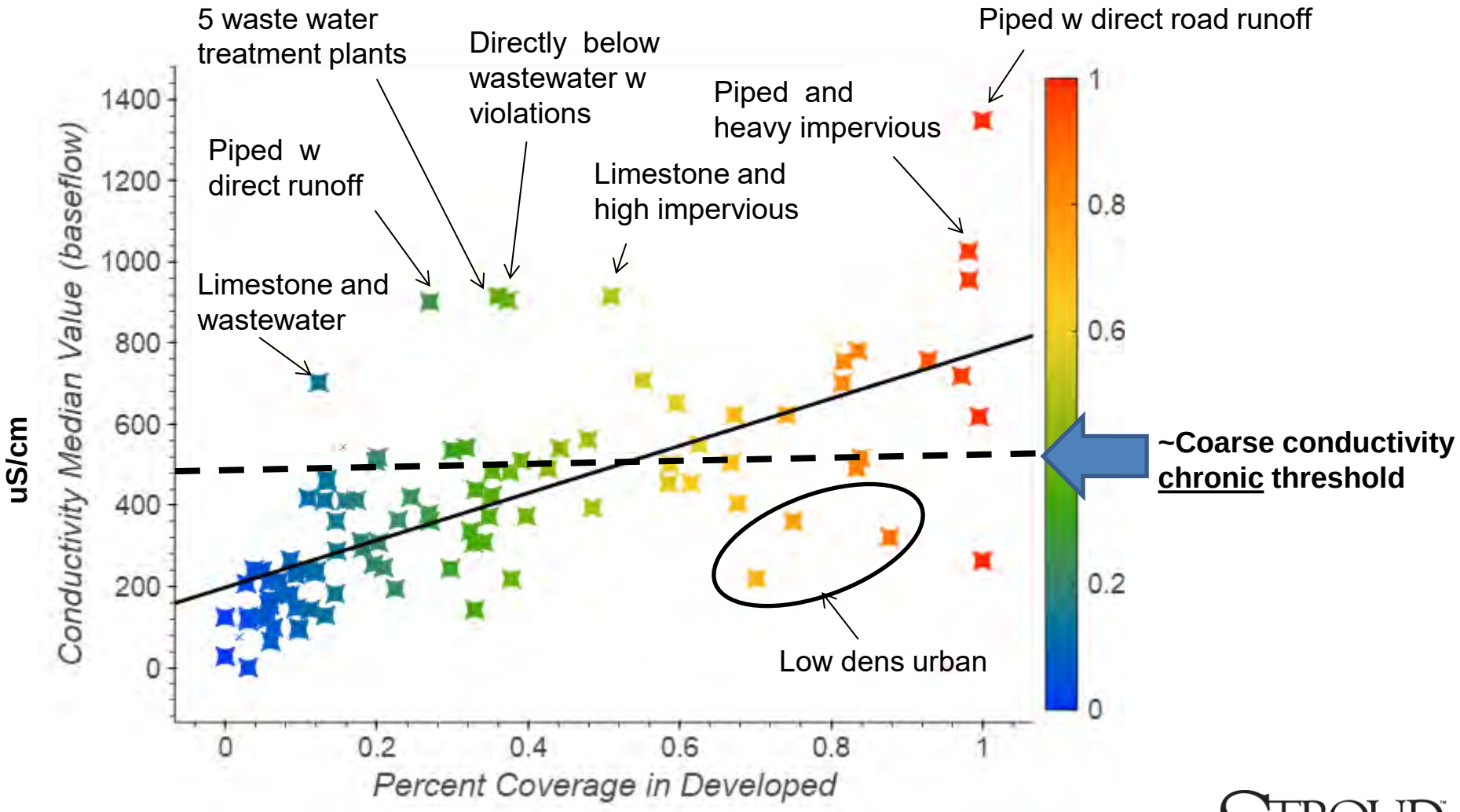
Frame of reference



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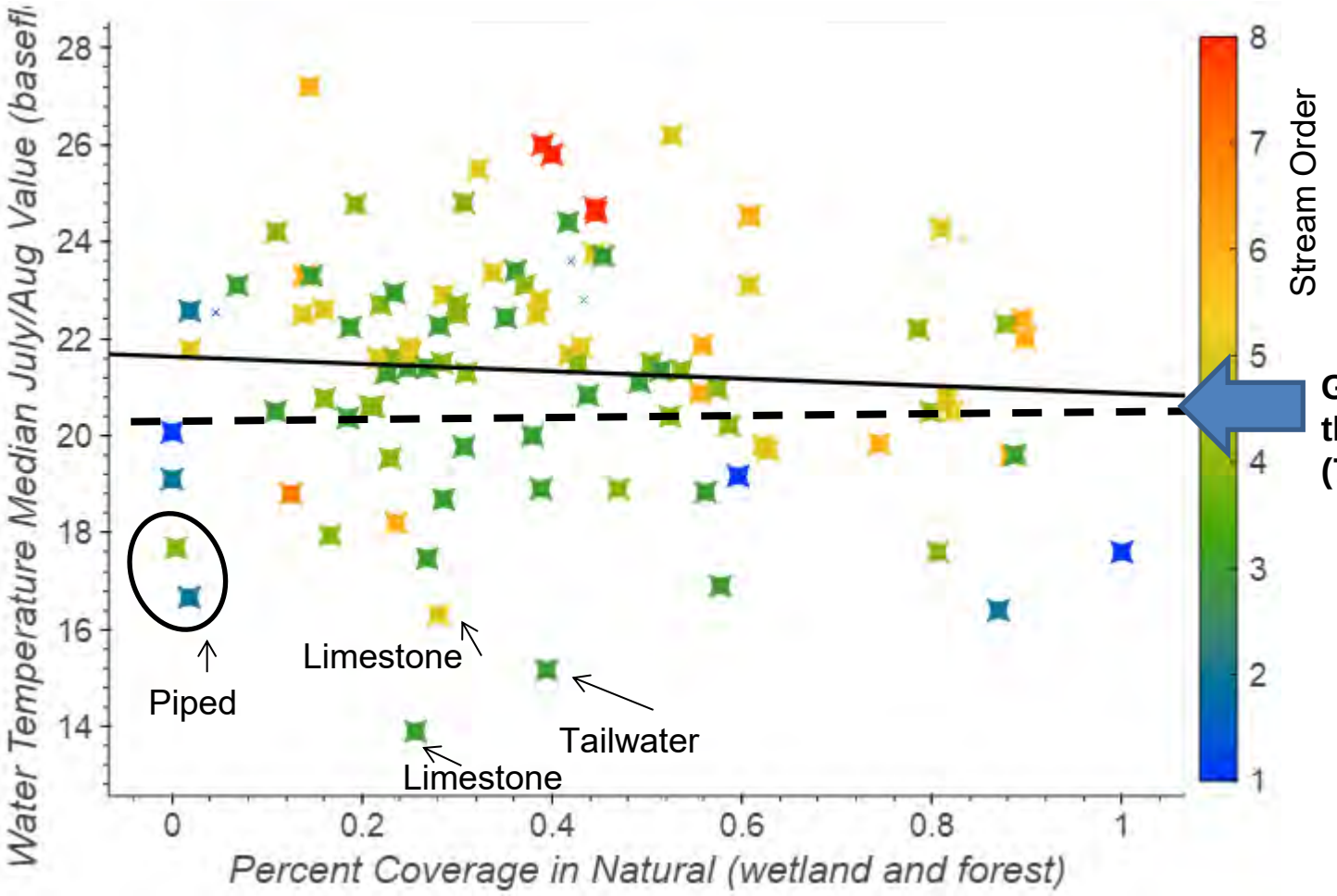

General trout/coldwater threshold ~20-21deg C (70degF)

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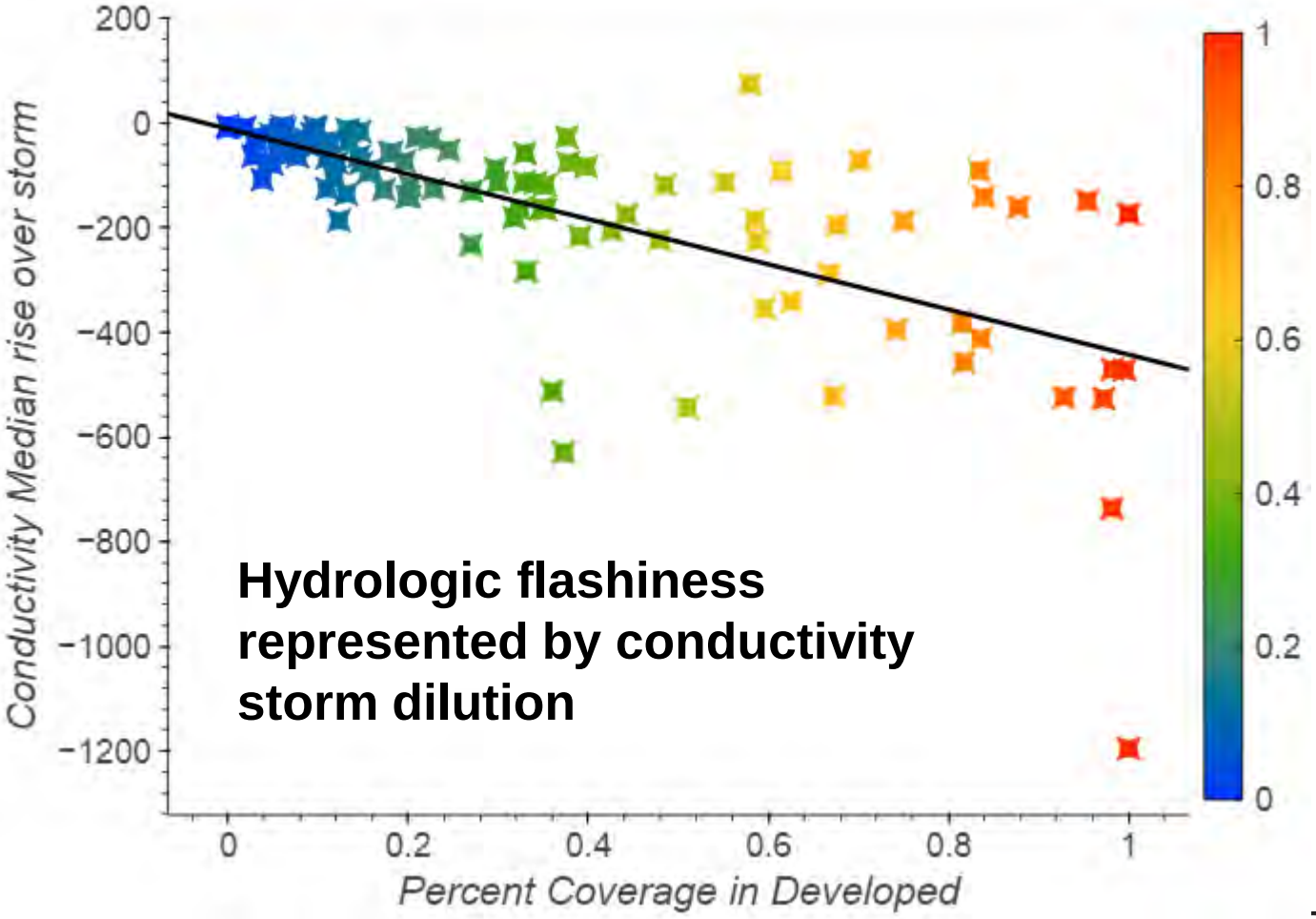
Frame of reference



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Conclusion

- Moving toward a way to make use of the network of users and many sites (currently >100)
- Individual sites are part of the larger group – use this to put things in perspective (is your stream worst, best, median, natural reference, degraded reference, etc)
- Make use of the high population of small streams in network – e.g., seeing super high conductivity in salt flushes (10,000-50,000 uS/cm in some urban streams)

**Feedback welcomed*

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Thank You!

Special thanks to:

- **All the partner watershed groups, volunteers, stewards, schools, and universities**
- **Key Stroud Center engineers/technicians: Shannon Hicks, Rachel Johnson, and Christa Reeves**
- **Chester/Delaware Co. Penn State Master Watershed Stewards Carol Armstrong and George Seeds**

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Consortium for Scientific Assistance to Watersheds

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David Bressler
Stroud Water Research Center
dbressler@stroudcenter.org
410-456-1071 mobile

ADDITIONAL SLIDES

What it takes

Sounds easy! The station does it all!

DateTime	TimeOffse	DateTimeUTC	Decagon_CTD-10_Cond	Decagon_CTD-10_Depth	Decagon_CTD-10_Temp
7/29/2020 10:20	-5:00	7/29/2020 15:20	465.2	254	29.5
7/29/2020 10:25	-5:00	7/29/2020 15:25	464.8	252	29.5
7/29/2020 10:30	-5:00	7/29/2020 15:30	466.5	253.8	29.52
7/29/2020 10:35	-5:00	7/29/2020 15:35	466.2	253.8	29.52
7/29/2020 10:40	-5:00	7/29/2020 15:40	465.5	252.3	29.7
7/29/2020 10:45	-5:00	7/29/2020 15:45	466.8	253.3	29.8
7/29/2020 10:50	-5:00	7/29/2020 15:50	464.7	253.3	29.8
7/29/2020 10:55	-5:00	7/29/2020 15:55	466	255.8	29.8
7/29/2020 11:00	-5:00	7/29/2020 16:00	466.2	254.2	29.9
7/29/2020 11:05	-5:00	7/29/2020 16:05	467	254.2	30
7/29/2020 11:10	-5:00	7/29/2020 16:10	467	254.3	30
7/29/2020 11:15	-5:00	7/29/2020 16:15	465.7	253.3	30.1
7/29/2020 11:20	-5:00	7/29/2020 16:20	465.5	255.3	30.1
7/29/2020 11:25	-5:00	7/29/2020 16:25	466.8	256	30.18
7/29/2020 11:30	-5:00	7/29/2020 16:30	466.2	255.8	30.2
7/29/2020 11:35	-5:00	7/29/2020 16:35	467	254.3	30.2
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7/29/2020 11:45	-5:00	7/29/2020 16:45	466	254	30.3
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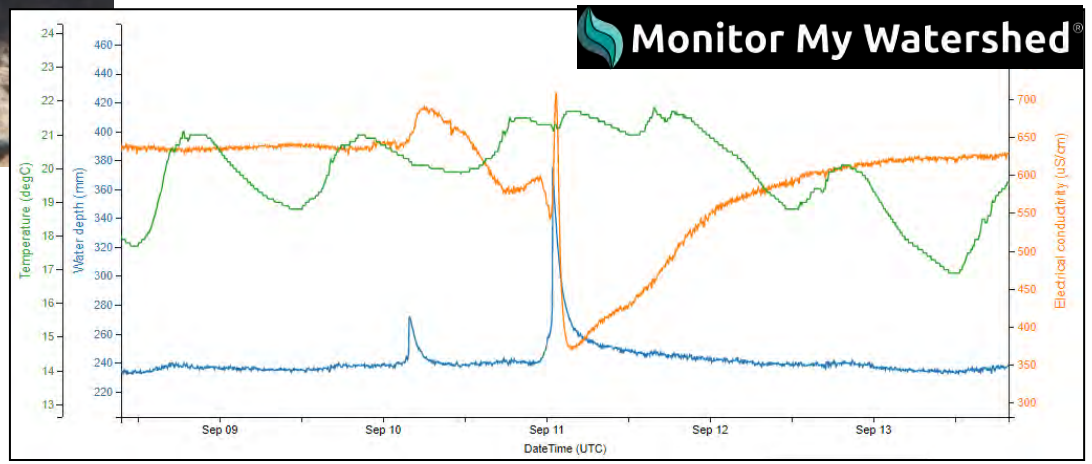
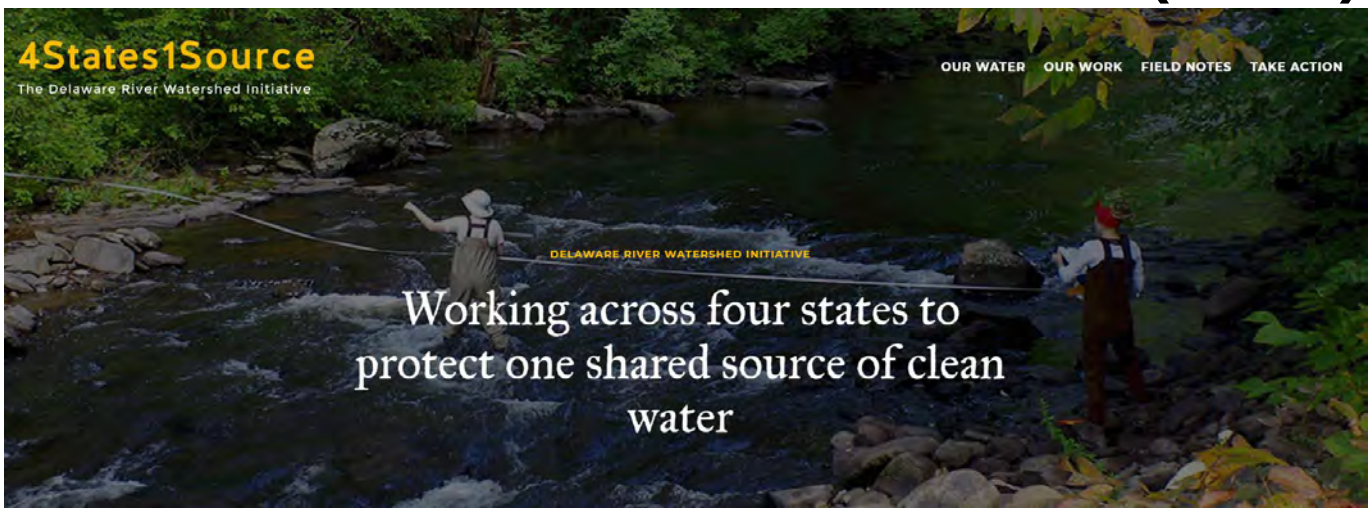


Project

Citizen science using EnviroDIY monitoring stations in the Delaware Basin

Delaware River Watershed Initiative (DRWI)



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- THERE IS NOT THE BANDWIDTH FOR DETAILS – THEY NEED TO KNOW WHAT I WANT THEM TO REMEMBER (THE LESSONS FROM JUNIPER/KRISTINE IN LAST SEVERAL MONTHS) – TALK ABOUT THAT WE CAN'T DO THIS FOR EVERY SITE SO TRYING TO STANDARDIZE THE APPROACH
- Talk about this data set – smaller streams (median size ~10km2)
- Talk about the partnership – paulins kill tells us that the groups want to know more about their stream(s) – tell the story of the paulins kill, why chosen, then bring in the broader analyses (sit back and say what do people need to know and what do I want to talk about, what are we learning from our – translation of data into ex summary, feedback through stroud, action plan based on new understanding – bring in other sensors as they provided perspective); then lessons learned 1) even with training and lots of volunteers data analysis and interpr is a challenge in conducting and owning it (need authority stamp like stroud), 2) with right people there is desire to put action plans together once problem is understood, 3) individual sites as part of larger group puts things in perspective (are you worst, best, median, etc); circle back to small streams and benefits of this – e.g., see super high cond
- Good message we've learned recently – two secrets – 1) every sensor has a local partner on a relatively small watershed that is engaged in this watershed (diff than usgs network), 2) at this point even with all the training we've done our partners are looking to stroud for support on understanding the data (bring in three tier citsci model)
- Being part of the network is meaning you're not alone and your data are important to others and others are important to you for the perspective that both bring

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Project

Citizen science using EnviroDIY monitoring stations in the Delaware Basin

- **2017-2019, Stations built by Stroud Center** and granted or purchased by groups (2017-2019)

- **2020-2021, Stations built by groups** via EnviroDIY manual, workshops, Stroud Center consultation

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- NMC 2021 (week of April 19, 2021), https://www.nalms.org/2021nmc/
- Abstract submission, deadline Oct 8, 2020: https://www.nalms.org/2021nmc/call-for-abstracts/, https://www.nalms.org/2021nmc/abstract-submission/
- Jackson suggest topic area: S17 – Using Big Data to Answer National- and Regional-Scale Water Quality Questions (this is a "Proposed Session" whatever that even means), https://www.nalms.org/2021nmc/proposed-sessions/
- **Continuous monitoring stations in the Delaware River Basin for understanding individual sites and regional patterns**
- **Bressler, Diana, Marc, Scott, Jackson**
- In the last three years the Stroud Center has facilitated deployment of over 70 EnviroDIY monitoring stations with watershed groups, schools, and universities across the Delaware River Basin (DRB). These stations record conductivity, temperature, and depth (and in many cases turbidity) every five minutes, and transmit the data to the Monitor My Watershed data portal. While continuous data generates insights important to understanding each site, the combined effort across stations has provided invaluable perspective for both the individual sites and for regional water quality issues. The data collected are being used in combination with land use analysis to identify potential drivers of water quality degradation. In addition, we are developing conductivity and temperature criteria that better reflect regional/local conditions and incorporate state water quality guidelines and known ecological/toxicological thresholds to address stakeholder needs. In this presentation we will describe how we are using continuous data to support watershed groups in using monitoring stations to educate their communities and enact change at the local level.

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- John Jackson:
  - So I think we focus on messages they need to know - how the data are informing volunteers. What they know now that they did not know before.
  - Streams warmer than normal and/or expected
  - Streams saltier than normal and/or expected
  - Personalize by making an example of the groups most into data, and the whole network provides perspective.
  - Maybe also highlight the value of superstars and our roving helpers.

Frame of Reference

e.g., *Centroptilum triangulifer*

LC 50s for a few mayflies
moderately hard water at 20°C

	Chloride (mg/L)	Conductivity (uS/cm)
Acute (96 h)	311-2894	1013-8603
Chronic (30 d)	151-898	543-2738

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Jackson, Stroud Water Research Center

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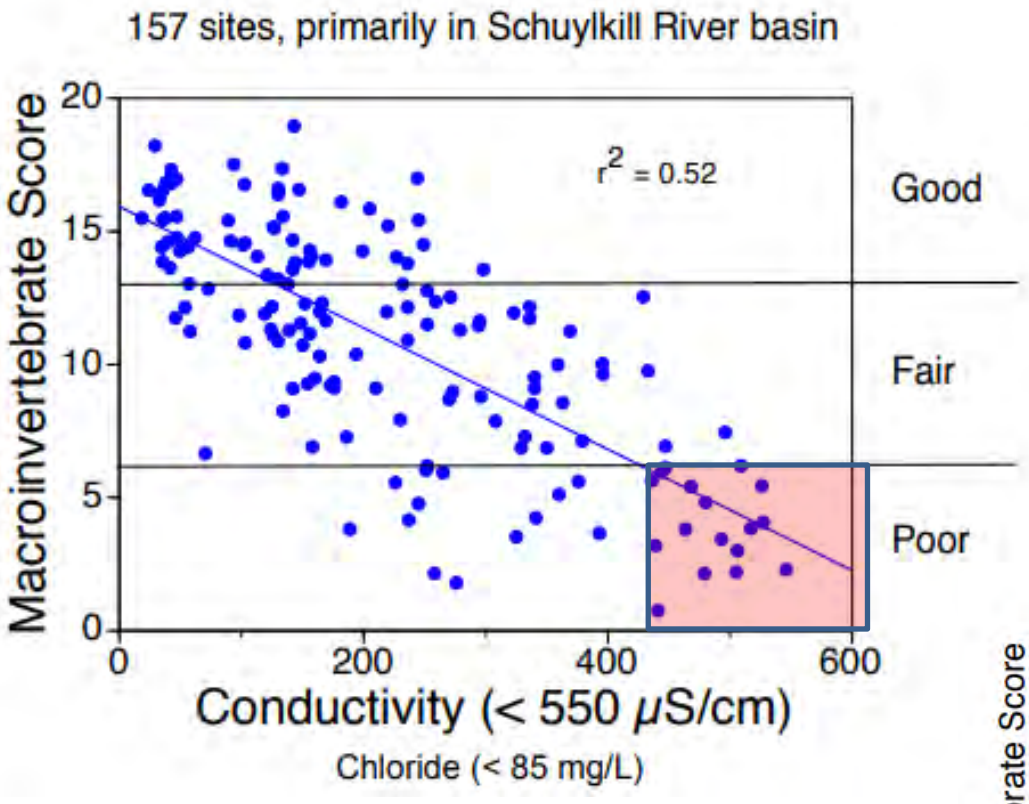
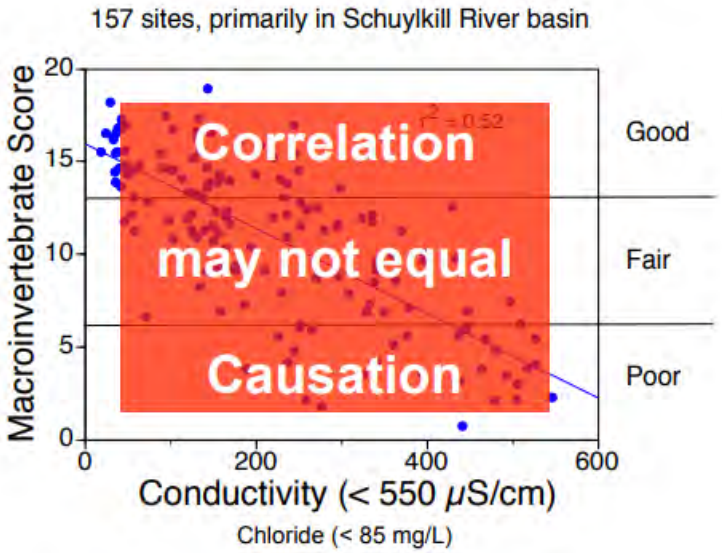
Frame of Reference





Jackson, Stroud Water Research Center

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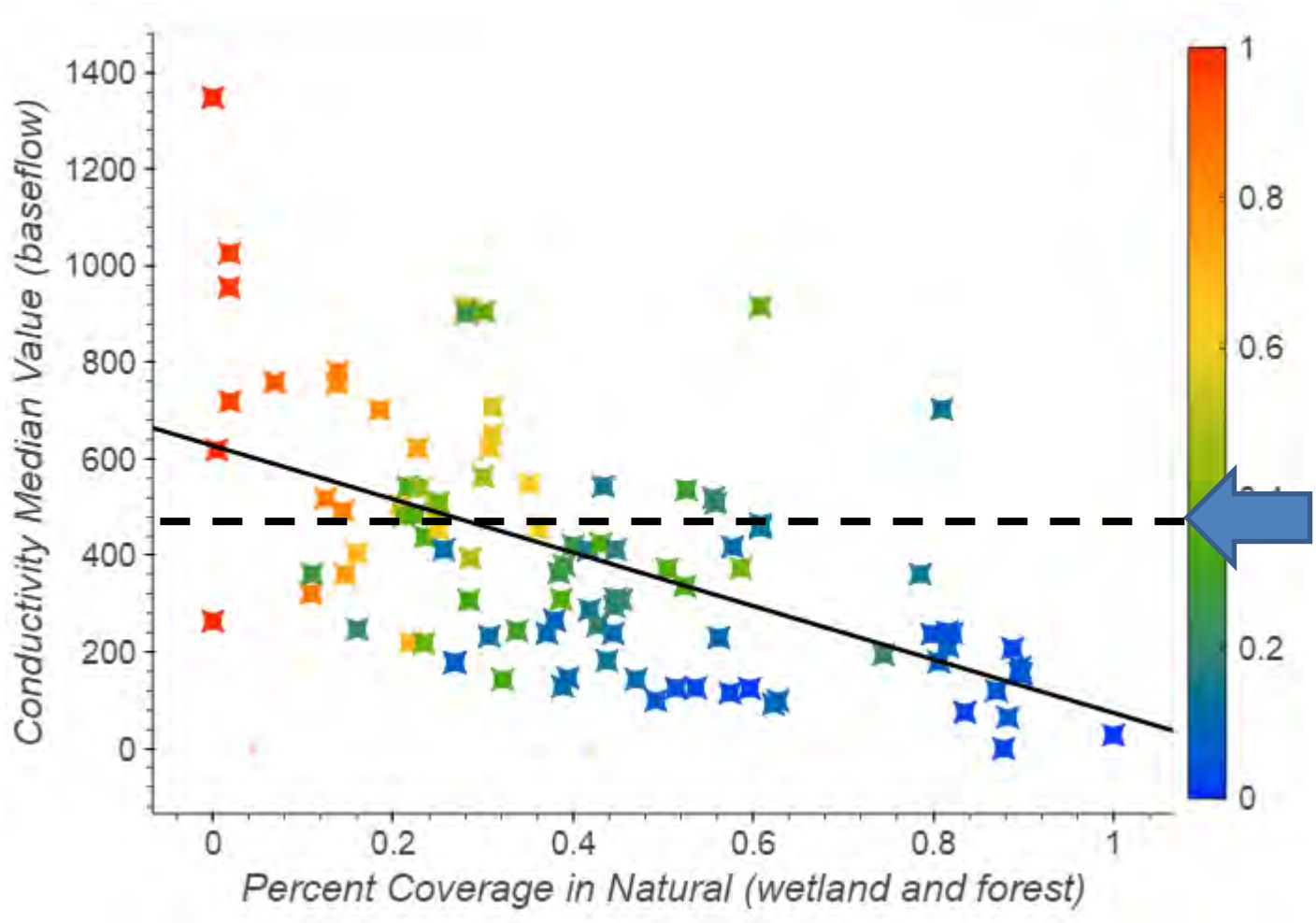

~Coarse conductivity <u>chronic</u> threshold

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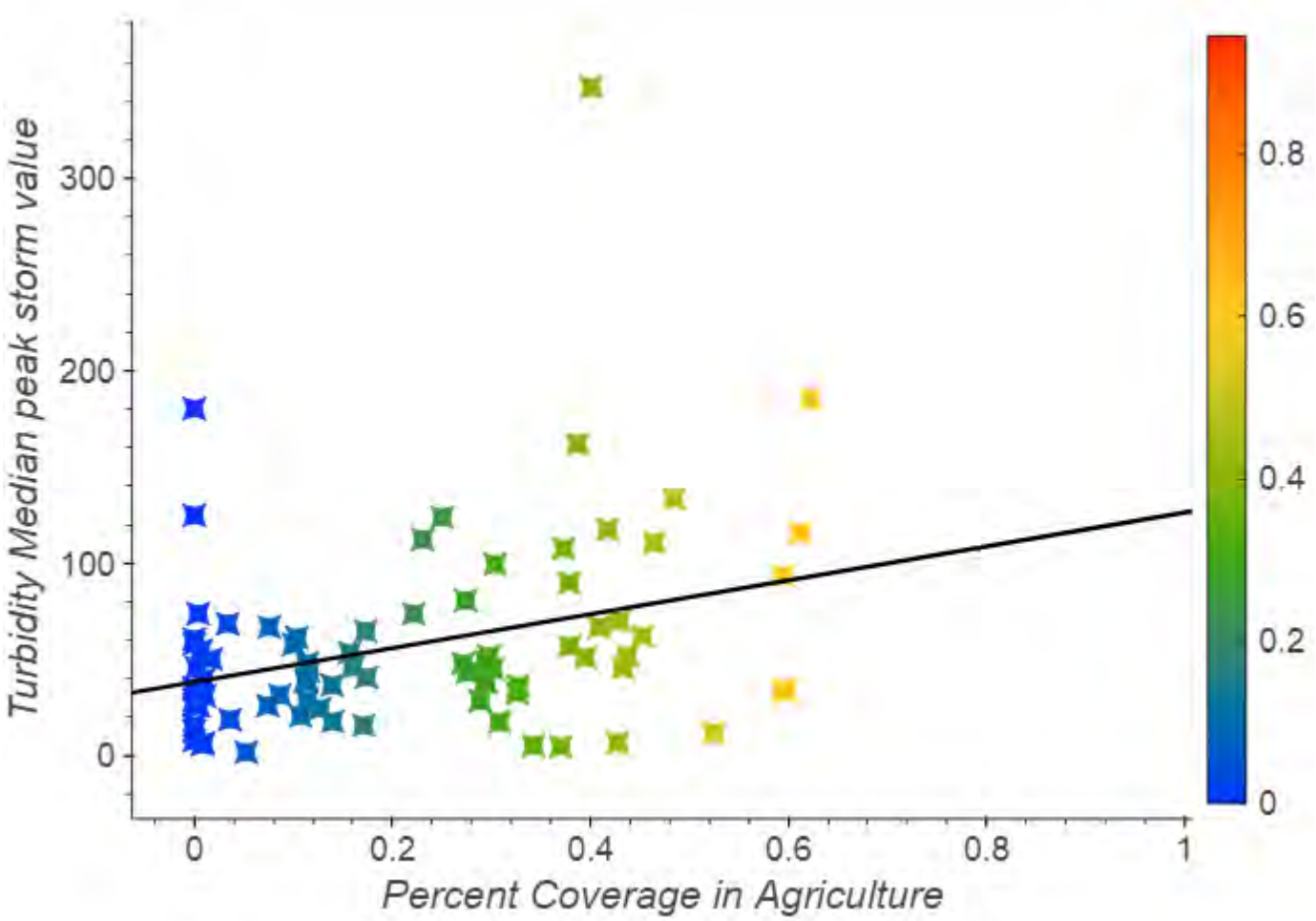
Frame of reference



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Utility of continuous data

- Fuller story
- Know where you're at presently
- Track where you came from
- Predict where you might go

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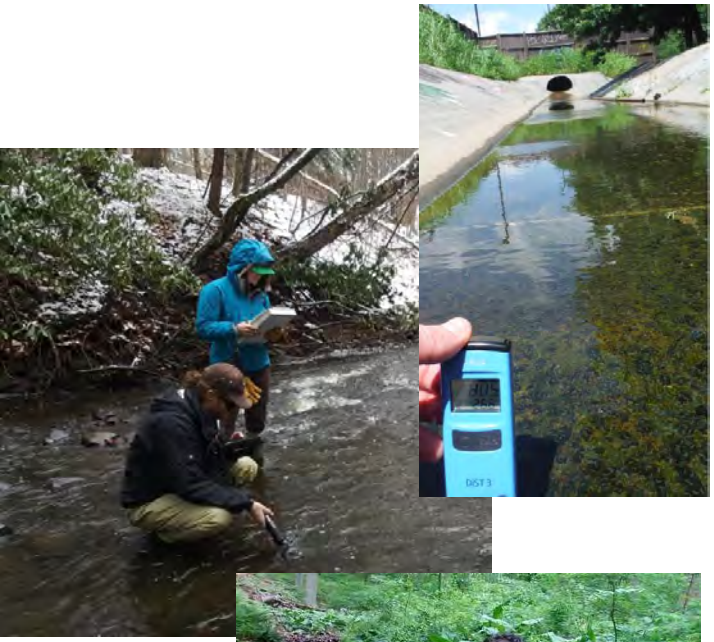
Continuous data

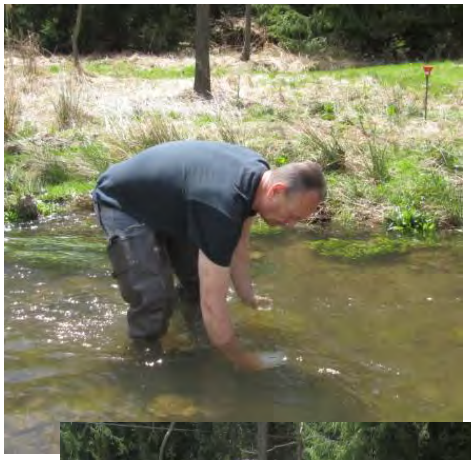
Measurements taken automatically – no person necessary(?) Less time and effort(?)

Standard, Single point measurements

Alternate to continuous, lots of time and effort!



Hand held meters



Grab samples for lab analysis

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What it takes

Clean sensors

329 uS/cm before cleaning

356 uS/cm after cleaning

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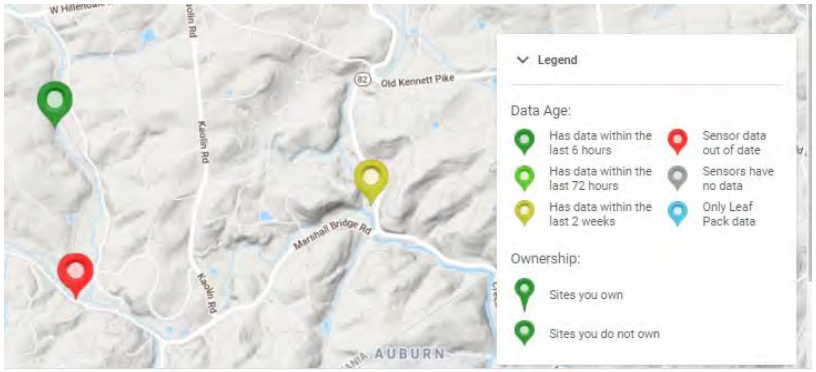
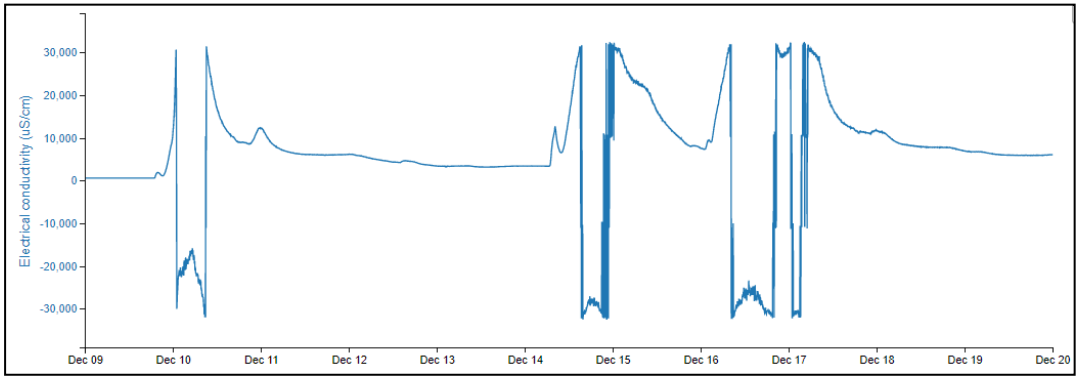
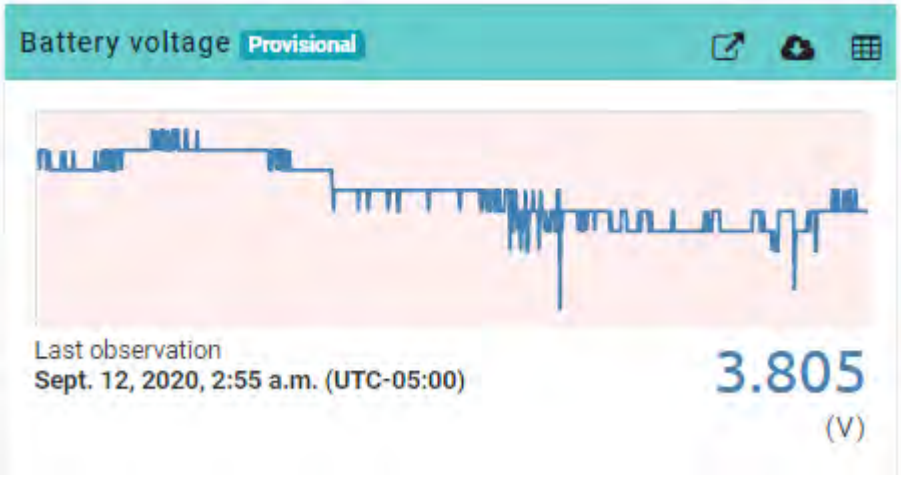
What it takes

Monitor live data feed for station function





Rccky Run at Marriott



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What it takes

Quality Control cross checks using calibrated hand-held meter and/or grab samples

314.8 uS/cm ⟷ 380 uS/cm

Red flag! Numbers not matching up! Suggests a problem with continuous data

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Take home

- Continuous data help to develop a fuller picture of a stream
- Long-term patterns, short-term and rare events can all be detected
- Although automated, stations need attention and quality control to ensure reliable data
    - **State agencies and other regulators beginning to accept and incorporate these type of data*

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Part 2

- Patterns in conductivity, water temperature, and turbidity across the Delaware River Basin
  - High conductivity – freshwater salinization syndrome
  - Water temperature – trout implications
  - Turbidity ranges

INCLUDE NEW STATS AND GRAPHS FROM SARA D

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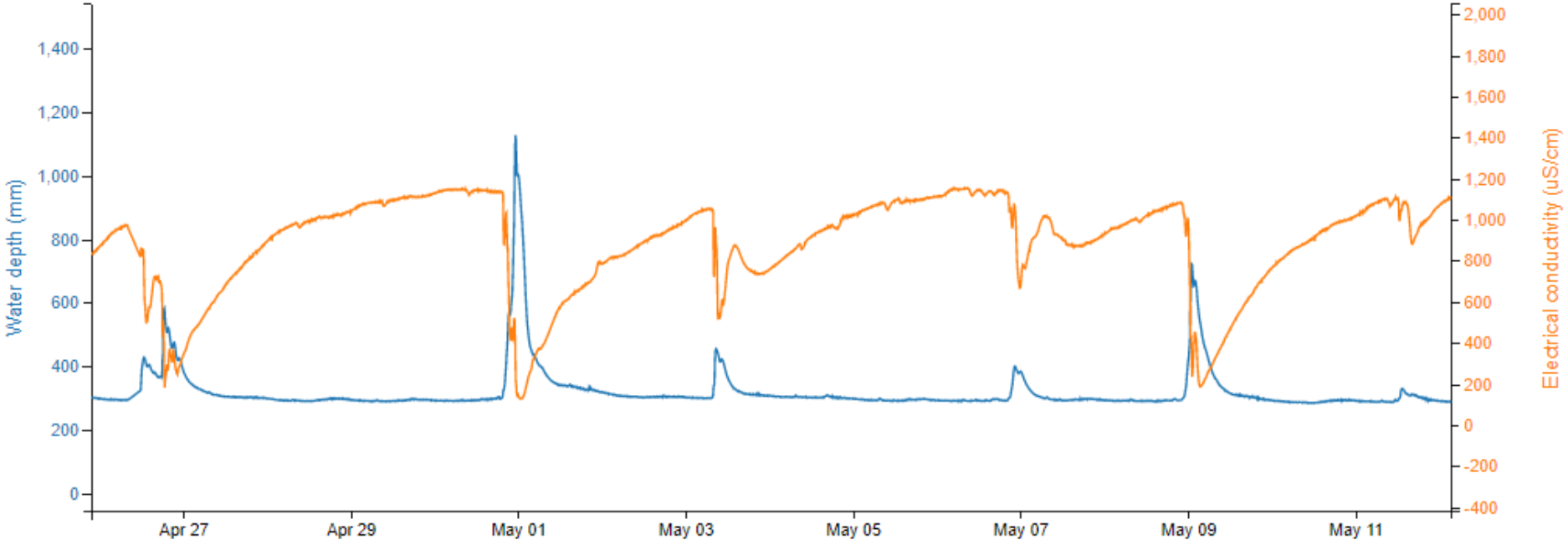
General Education – Ecological Patterns

Stormwater enters stream, conductivity goes down – dilution of ions



Goose Creek at Greenfield Park

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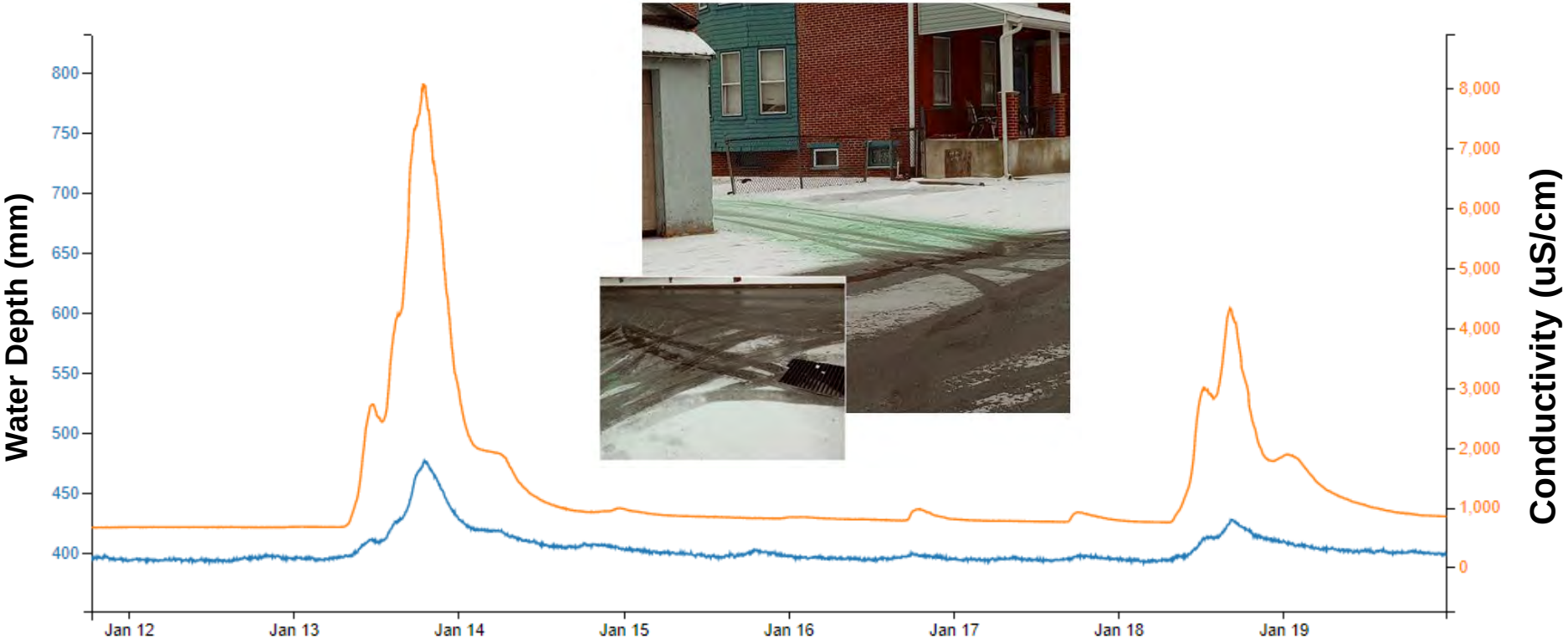
Road salt and de-icer pollution events



Naylors Run at Drexel Garden Park, 2019

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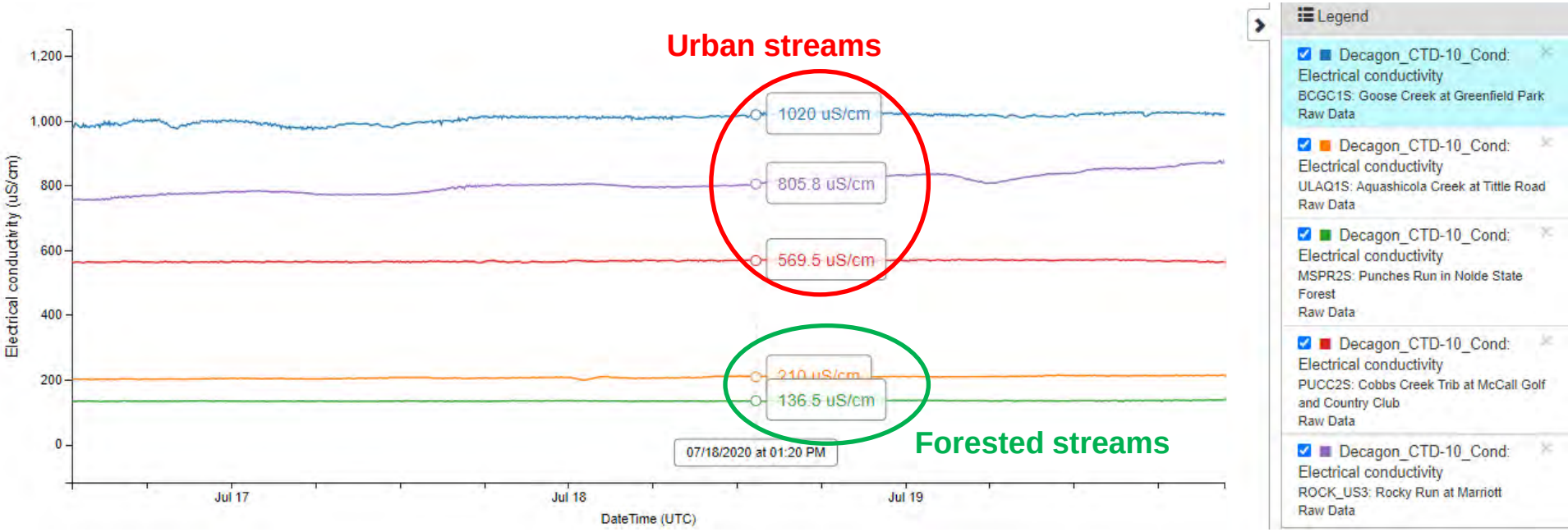
High conductivity in urban streams



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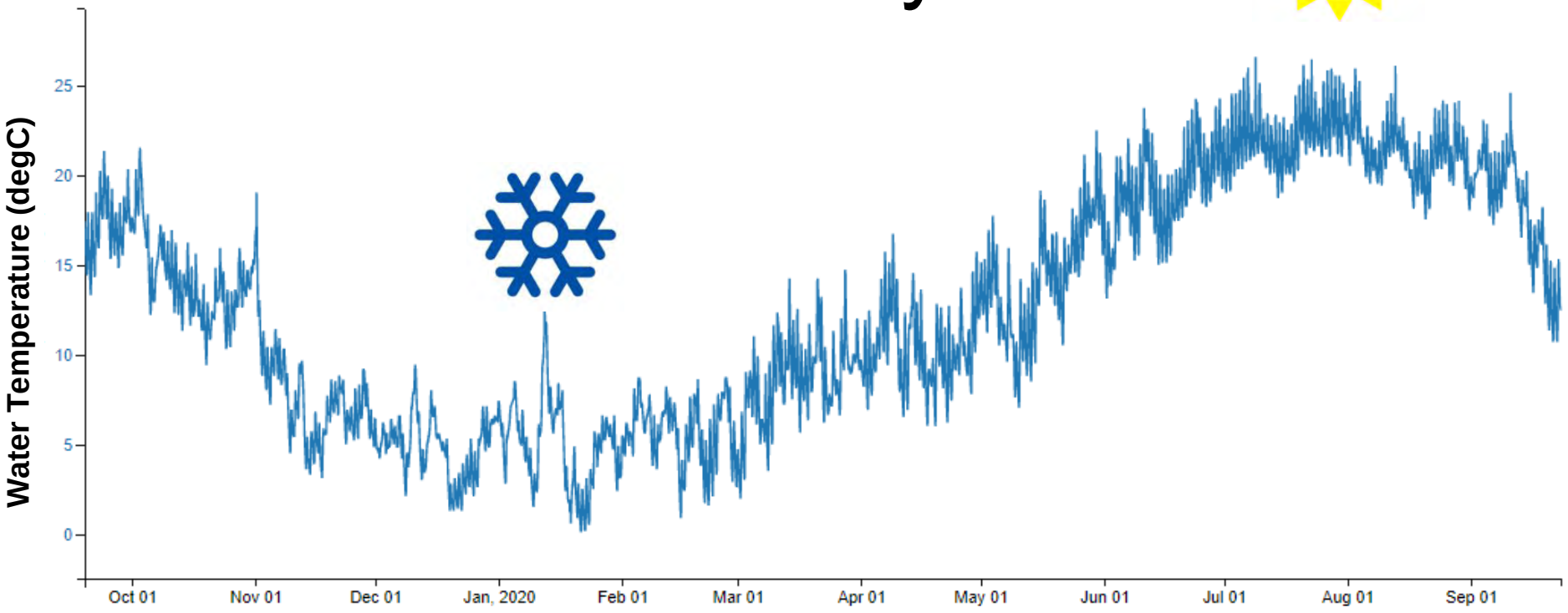
Seasonality



Angelica Ck downstream of The Nature Place, 2019-2020

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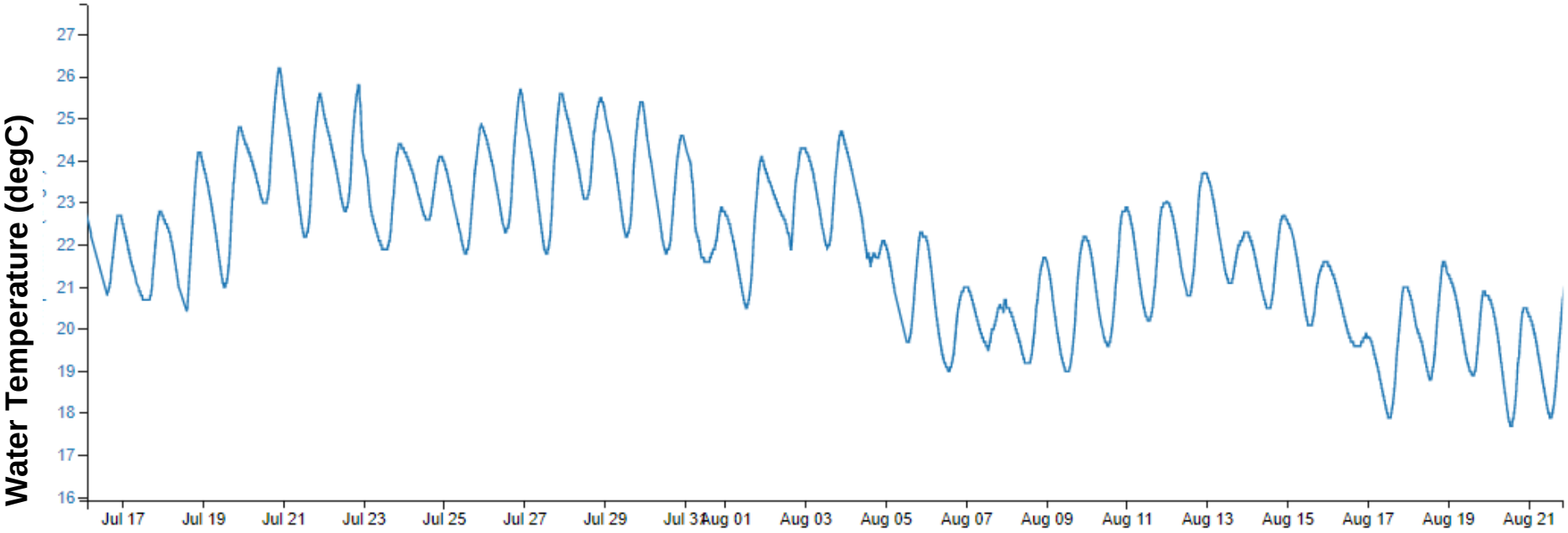
Diel (day and night)



Hosensack Creek at Hwy 29, 2020

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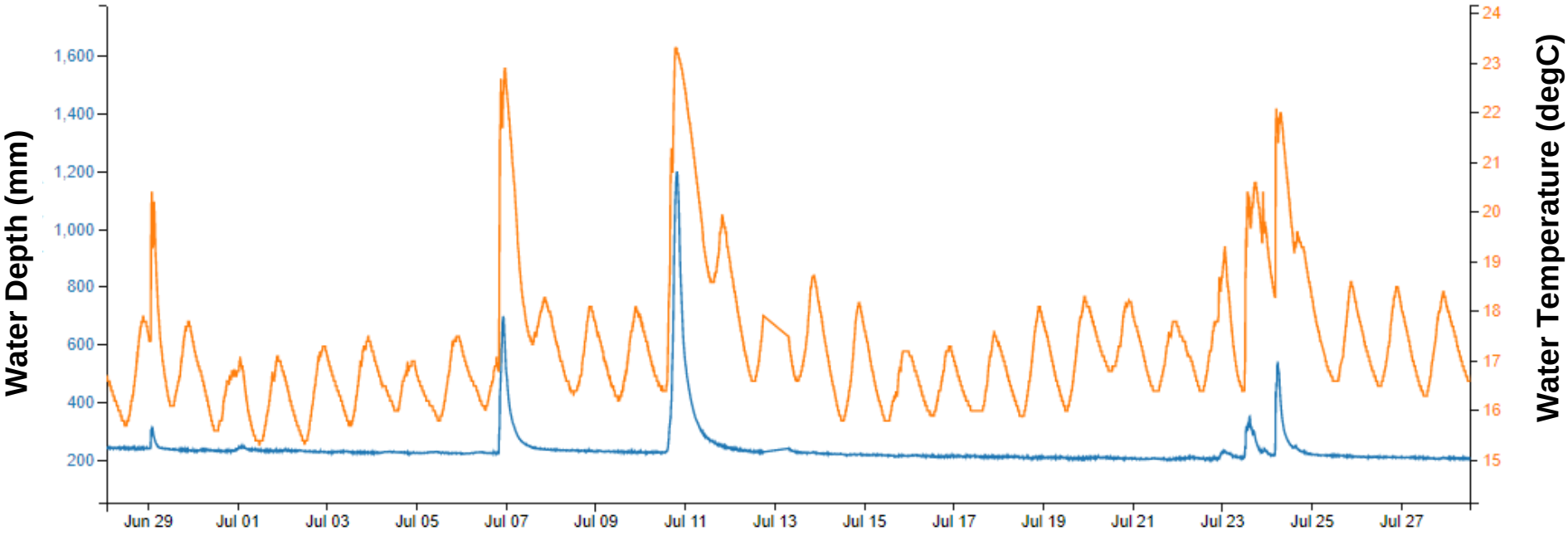
Thermal pollution during summer storm events



Valley Creek at Valley Creek Park, 2020

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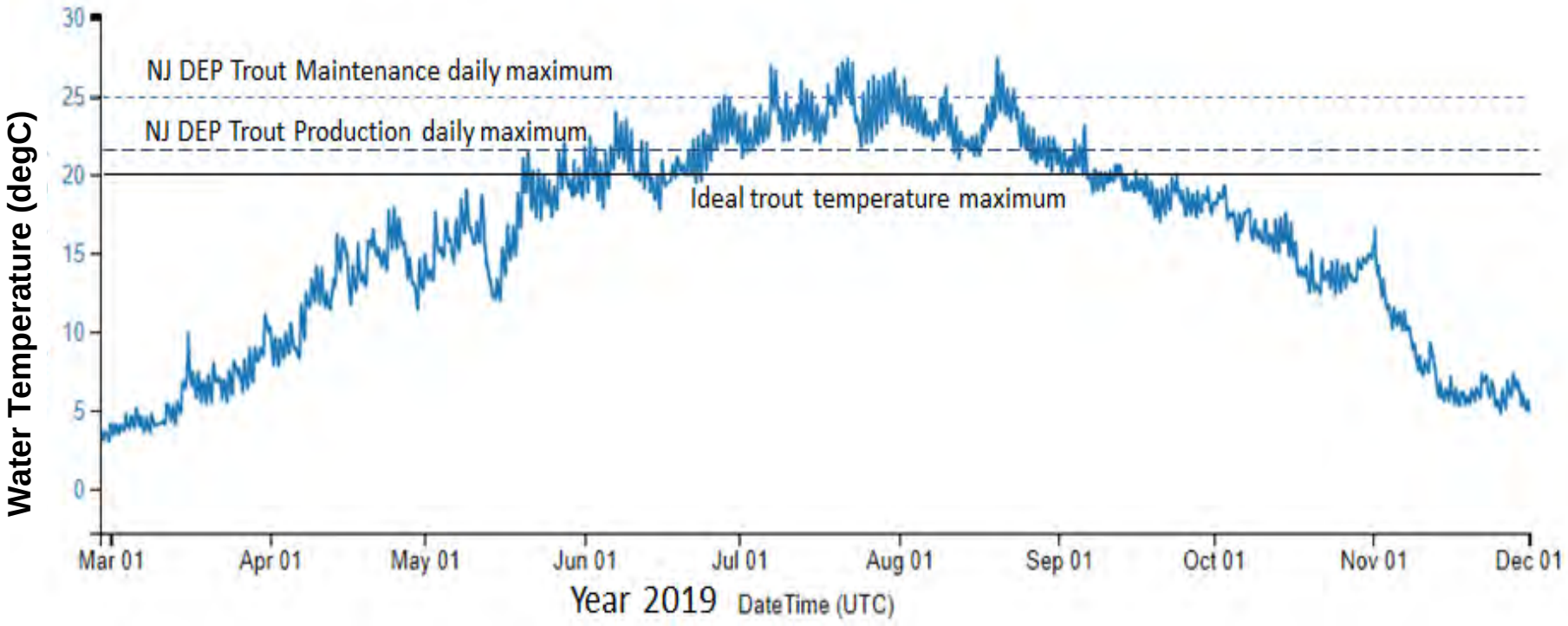
Temperature considerations for trout management



Paulins Kill at Sussex County Community College

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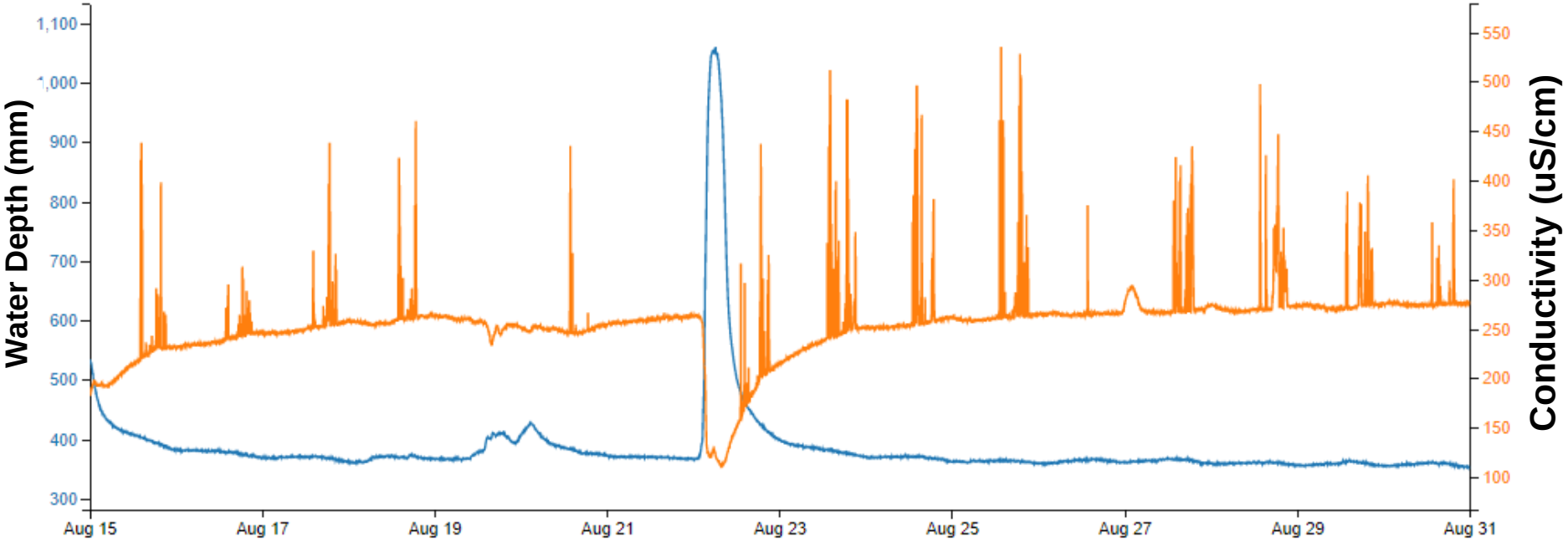
Non-storm events

Conductivity spikes during baseflow conditions



Pickering Creek at Montgomery School, 2018

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