

# Monitor My Watershed® Online Data Analysis Lab Series Introduction

## Overview

The [Monitor My Watershed®](http://www.monitormywatershed.org) Online Data Analysis Lab Series is a growing collection of web-based lab activities designed to help learners build scientific process and data analysis skills using real-world, real-time data. Throughout this lab series students will access data from [Monitor My Watershed®](http://www.monitormywatershed.org) as well as other online resources to explore and discover patterns in nature through data and develop understandings of interactions that occur between biotic and abiotic factors in a watershed, including impacts from human activities. [Monitor My Watershed®](http://www.monitormywatershed.org) (*MonitorMW*) is one component of the [WikiWatershed Toolkit](#), a collection of web tools dedicated to advancing knowledge and stewardship of fresh water. *MonitorMW* is an open-source online data sharing platform that enables individuals, organizations, businesses and more to monitor, access, analyze, and collect raw data from EnviroDIY (which monitors bodies of water) and the Leaf Pack Network (which monitors macroinvertebrates) from around the world. Our goal is for *MonitorMW* to be an easy to use resource with a wealth of high-quality, real-time data that transforms the practice of environmental science, resource monitoring, and watershed protection.

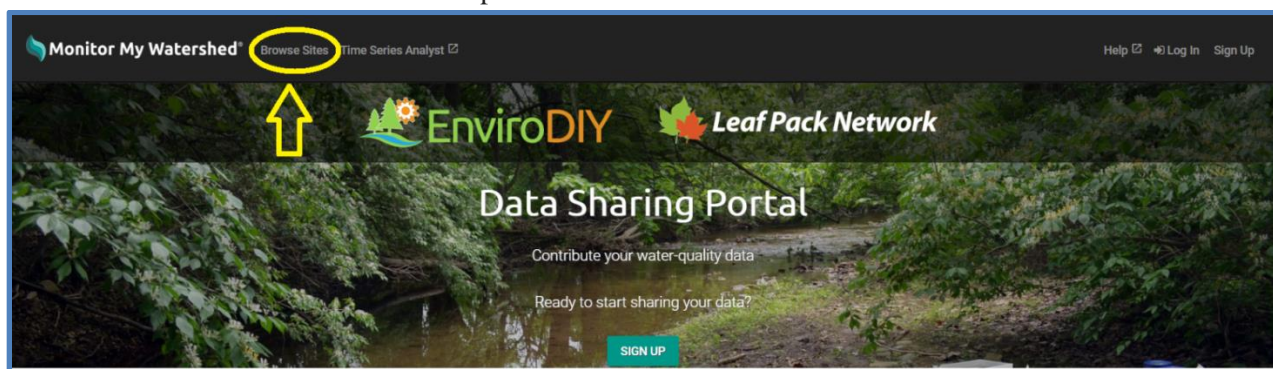
In this lab series you will access data on *MonitorMW* collected every five minutes from a network of Mayfly Data Logger Board™ Sensor Stations installed in streams throughout the Delaware River Basin and beyond. These Sensor Stations measure and transmit important data to the *MonitorMW* web portal that can be accessed by anyone interested in understanding and monitoring watersheds. 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 introduction learners will be able to navigate the [Monitor My Watershed®](http://www.monitormywatershed.org) web portal, browse and access data from sensor stations, and manage the data to make observations and identify connected data patterns.

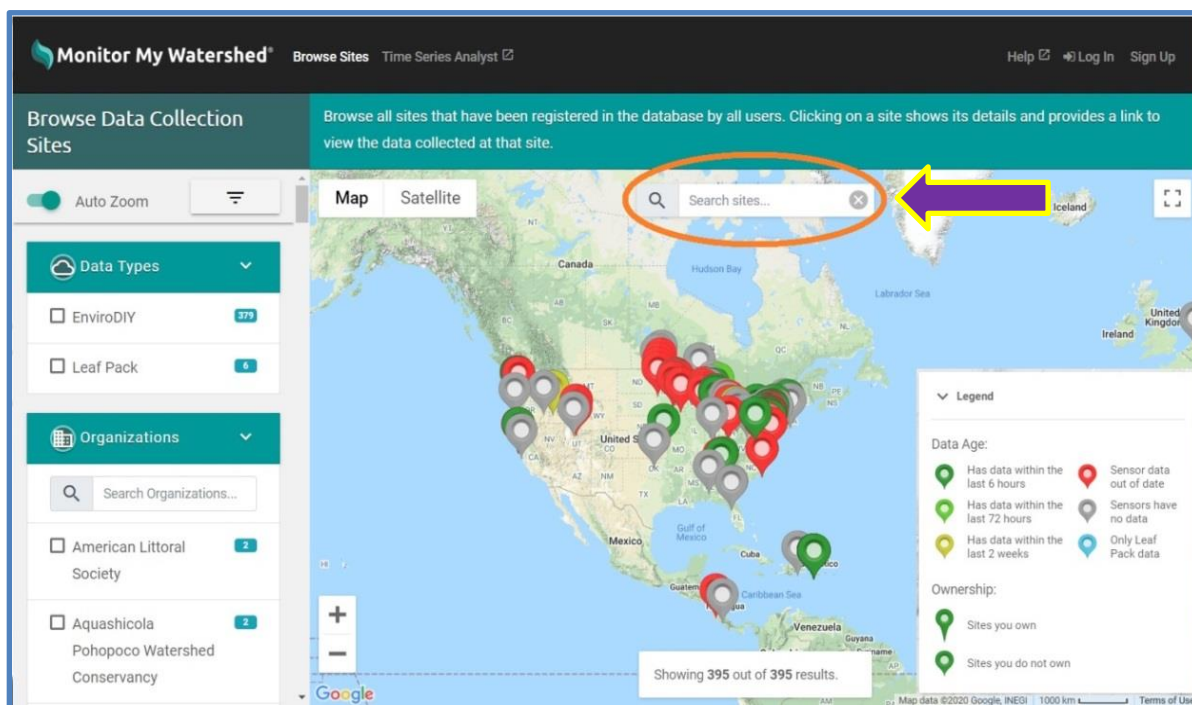
## Introduction to [Monitor My Watershed®](http://www.monitormywatershed.org)

1. On a computer load the website: <https://www.monitormywatershed.org>
2. Click on **Browse Sites** in the top banner



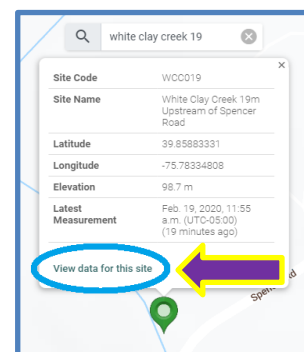
A webpage will load with a map that displays all the sensor stations registered in the network with “balloons.” The color of the balloons provides information about the status of each site. Look in the legend to see what each balloon color means.



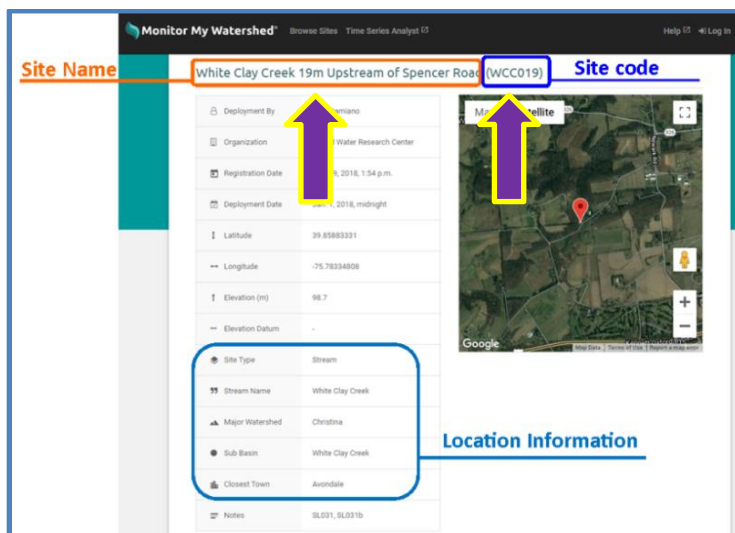


Users can click and drag to move the map and zoom in and out to explore individual stations. When you click on a sensor station site balloon, an information box will appear over the site balloon.

3. In the “Search sites” box (top center of the map) enter “white clay creek 19.” As you type the map will zoom in and center over a sensor station site balloon.
4. Left click on the site balloon logo (often twice) to open a site quick view, and then **right click** on “View data for this site” and select “Open link in a new tab” to preserve your browse map.



A sensor station site information page will load that includes an identification panel and individual sensor observations. At the top of the identification panel will be the full sensor station site name and site code. The “Search sites” box can find sensor stations based on the site name, site code, organization, or location information. Users should always record key identification data about the sites they analyze so they can access the same site and information at another time.



**Record the following:**

Site Name: \_\_\_\_\_

Site code: \_\_\_\_\_ (in parentheses after the site name) Site Type: \_\_\_\_\_

Organization: \_\_\_\_\_ Deployment Date: \_\_\_\_\_

Stream Name: \_\_\_\_\_ Major Watershed: \_\_\_\_\_

Scroll down and observe the variables (or parameters) measured at this sensor station. Every variable has a box that describes what is being measured, where, and with what sensor. Each box has a graph of the data captured for the last 72 hours as well as the most recent measurement. Below each graph you will see a table that provides the “Medium” and “Sensor” type. The “Sensor” explains the type of sensor taking the measurements, and the “Medium” describes where the sensor is located.

**Record the variables (or parameters) measured at this sensor station:**

_____	_____	_____
_____	_____	_____
_____	_____	_____

Below each graph is a table that provides the “Medium” and “Sensor” type. The “Medium” describes where the sensor is located, and the “Sensor” explains the type of sensor taking the measurements.

**What are the two “Medium” types at this station?**

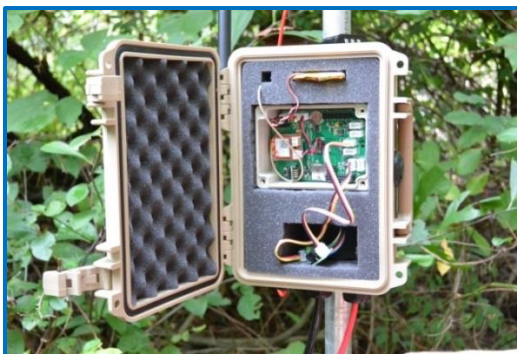
_____	_____
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Other possible “Medium” types include soil, air, and sediment.

**What are the three “Sensor” types at this station?**

_____
_____
_____

“Liquid aqueous” means the sensor is submerged in the water like the Decagon\_CTD sensor pictured below (left).



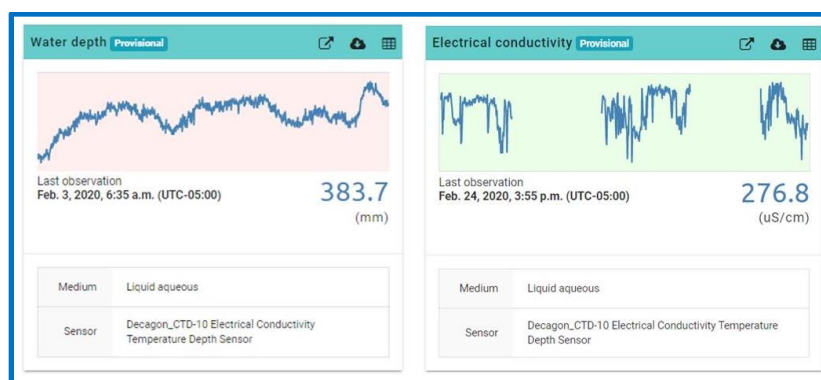
“Equipment” means the data is measured on the Mayfly Data Logger Board™ pictured above (right).

The **Decagon\_CTD-10 Sensor** (above left) is installed in the stream and measures three variables: Electrical Conductivity, Temperature, and Depth. Throughout the lessons we will refer to this sensor as “CTD-10” and the data relates to the stream in which the sensor is deployed. The **Campbell\_OBS-3+ Sensor** measures Turbidity on two scales (0-260 $\mu$ S/cm and 0-1000 $\mu$ S/cm). The readings should be very similar until the upper threshold is surpassed (260 $\mu$ S/cm), at which point only the high turbidity reading will be accurate. The Mayfly Data Logger Board™ typically has two onboard sensors: temperature and battery voltage. These are used to help monitor the condition of the sensor station and troubleshoot potential issues.

**Note:** “Equipment Temperature” measured on the Mayfly Data Logger Board™ is not the same as air temperature because the sensor is installed on the Mayfly Data Logger Board™ that is insulated in the sensor station box. This sensor follows a similar pattern as air temperature. Actual air temperature data should be collected from nearby weather stations when accurate data is needed.


### The Nature of Science

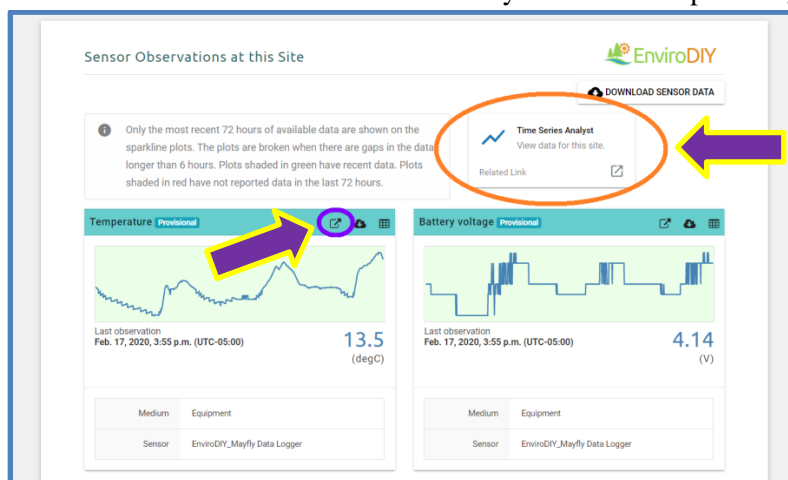
Real-world science can be messy! Sometimes the equipment we use experiences issues, and data collected may not be quite as accurate as intended. Each variable being measured has its own data block with a sparkline plot that displays the data for the last 72 hours. The sparkline will be discontinuous (see example on right) if the sensor station has gaps communicating data longer than six hours. Plots shaded in green have recent data while plots shaded in red have not reported any data in the last 72 hours.



### Viewing the Data


There are two ways to view the complete range of data for this sensor station from this point.

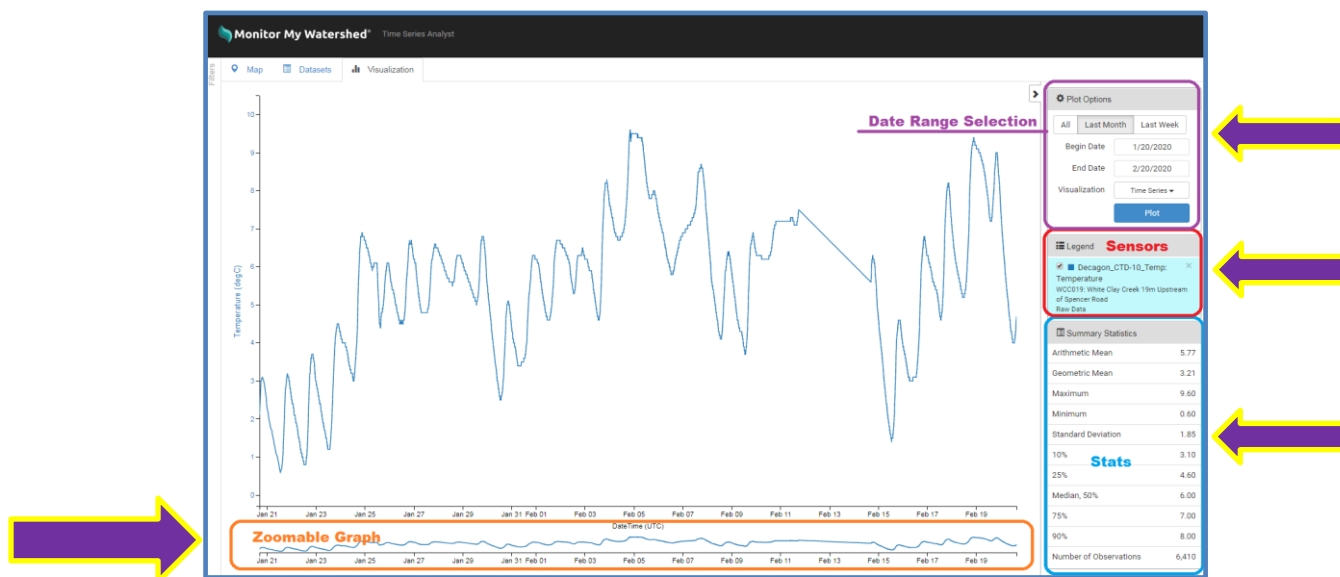
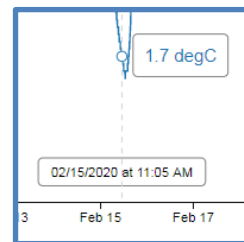
- Click on the box with arrow icon  in the header bar for the variable you would like to view or
- Click on the box with arrow icon in the Time Series Analyst box at the top of the graphs





**View One Variable:**

- Click on the box with arrow icon  in the header bar for the “**Temperature: Liquid aqueous.**” A new tab will load with one month of data for the selected variable in the “Visualization” tab.
- Move the cursor around in the large graph to explore the data. Balloons will appear that provide the details for each data point: one for date and time (UTC) and one for each variable represented in the graph.

**Visualization Panel**

**Plot Options:** Allows users to select a specific date range or choose: All, Last Month, or Last Week.

Visualization of the data can be changed from “Time Series” (line graph) to “Box and Whisker” or “Histogram.” Users must click on the “Plot” button for the graph to update and wait for the graph to update.

**Legend:** Lists which sensors are shown in the graph. Individual sensors can be unchecked or re-checked to removed or added back into the graph visualization.

**Summary Statistics:** Provides detailed statistics for the date range selected. These statistics only update when a new date range is selected and the “plot” button is pushed.

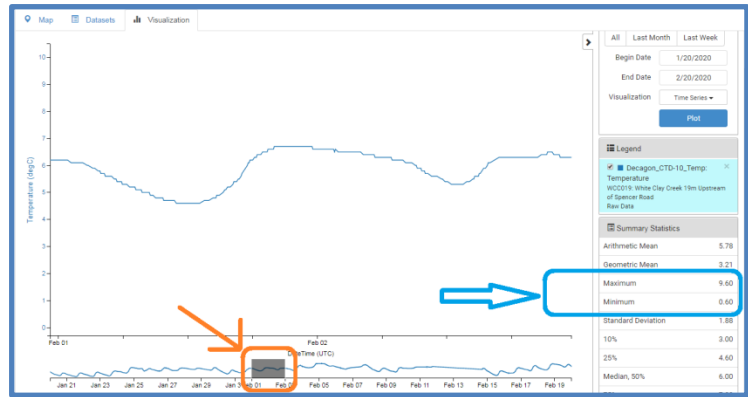
- In the “Plot Options” box enter a “Begin Date” of **1/20/2020**, and an “End Date” of **2/20/2020**, then click on “Plot” and wait for the new graph to draw.
- Move your cursor over the large graph to scan the data and answer the question below.

What was the temperature in the stream at midnight on February 13, 2020 (UTC)? \_\_\_\_\_

This is an example of how missing data is represented in the Time Series Analyst graphs. Any gaps in data will be represented with a straight line between the last two recorded data points. Sensor station managers have the capacity to upload missing data from the SD memory card installed on the Mayfly Data Logger Board™, so this data will be filled in when the actual missing data is uploaded. Missing data can occur if the cellular connection is unavailable, the battery has insufficient power, or when the power switch is turned off on the Mayfly Data Logger Board™.

**Secondary Graph:** Below the main graph is a smaller graph that can be used to “zoom in” on a particular time frame. This feature allows users to scan smaller segments of the data to look for specific events or anomalies. Click and drag to select a portion of time to zoom in on (a grayed area will appear on the secondary graph). Drag the selection (grayed area) around the graph to adjust the zoomed in area. Double click on the secondary graph to return to the original date range.

9. Move the cursor to the secondary graph below the main graph; left click and drag between two date intervals to select about 48 hours of data. The graph will immediately change as you make your selection.
10. Left click and hold on the grayed area in the secondary graph and drag back and forth to scan a “zoomed in” portion of the data.
11. Look at the “Summary Statistics” box on the right and identify the values for “Maximum” and “Minimum” temperatures.
12. Drag the grayed area through the secondary graph and use your cursor to find the specific dates and times where the maximum and minimum temperatures occurred, and record these below. *(Double click the secondary graph to zoom out and re-create the grayed area as needed)*



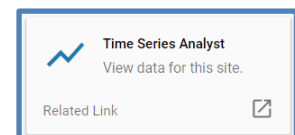
Maximum Temperature: Date: \_\_\_\_\_ Time: \_\_\_\_\_ (UTC)

Minimum Temperature: Date: \_\_\_\_\_ Time: \_\_\_\_\_ (UTC)

### View Multiple Variables:

Users can graph up to five variables at the same time to explore and analyze relationships and develop new questions and understandings.

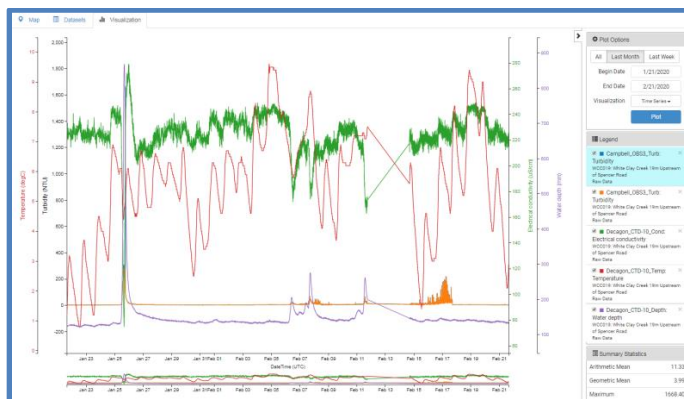
13. Close the current tab to return to the original sensor station information page and click on the “Time Series Analyst” box above the individual variable graphs. A new tab will open displaying all of the variables measured at this site over the last month.



14. In the “Plot” column on the left click the boxes for all three Decagon\_CTD-10 sensors (water depth, temperature, and electrical conductivity) as well as both Campbell\_OBS3 Turbidity options.

Plot	Series	Network	Site Code	Variable Code	Variable Name	Quality Control Level	Number Observations
<input type="checkbox"/>	213	EnviroDIY	WCC019	EnviroDIY_Mayfly_Temp	Temperature	Raw Data	556438
<input type="checkbox"/>	214	EnviroDIY	WCC019	EnviroDIY_Mayfly_Batt	Battery voltage	Raw Data	555870
<input checked="" type="checkbox"/>	215	EnviroDIY	WCC019	Decagon_CTD-10_Depth	Water depth	Raw Data	556159
<input checked="" type="checkbox"/>	216	EnviroDIY	WCC019	Decagon_CTD-10_Temp	Temperature	Raw Data	556163
<input checked="" type="checkbox"/>	217	EnviroDIY	WCC019	Decagon_CTD-10_Conc	Electrical conductivity	Raw Data	556163
<input checked="" type="checkbox"/>	218	EnviroDIY	WCC019	Campbell_OBS3_Turb	Turbidity	Raw Data	556163
<input checked="" type="checkbox"/>	219	EnviroDIY	WCC019	Campbell_OBS3_Turb	Turbidity	Raw Data	556163

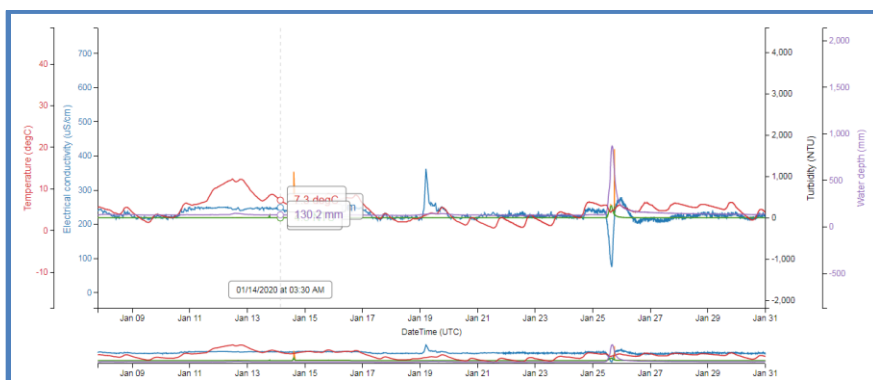
15. Then click on the “Visualization” tab above the variables and a graph will load showing all of the data for the selected variables over the last month.
16. Change the date range in the “Plot Options” box to a “Begin Date” of **1/1/2020** and an “End Date” of **1/31/2020**, then click on “Plot” and wait for the new graph to draw.



Each variable represented has its own Y-axis that is color coded and can be modified to best visualize the data. The position of the data can be moved up or down by adjusting the position of the integers on the Y-axis. The data can be expanded or condensed by changing the intervals of the integers on the on the Y-axis.

Outcome	Touch Pad	Mouse w/o wheel	Mouse w/wheel
<b>Increase the integer interval (expands the data)</b>	Double click the axis	Double left click the axis	Click on the axis and roll the wheel away (forth)
<b>Decrease the integer interval (compresses the data)</b>	Hold Shift key and double click the axis	Hold Shift key and double left click the axis	Click on the axis and roll the wheel towards (back)
<b>Shift the axes interval (moves the data up or down)</b>	Left click and drag the axis up or down	Left click and drag the axis up or down	Click on the axis with the wheel and drag the mouse away or towards (back or forth)

17. Use the chart above to practice modifying the positioning and scale of the data.
18. Make all of the data lines fit in a narrow range together.



Notice that sometimes data lines tend to move in similar directions, and sometimes they move in opposite directions. These relationships between variables will be explored throughout the Monitor My Watershed Online Data Analysis Lab Series. Including many variables creates a graph that can be overwhelming and confusing. Users can uncheck variables in the “Legend” box to remove data from the graph, and re-check variables to add the data back in.

19. In the “Legend” box on the right panel uncheck the boxes for “Electrical conductivity” and both “Turbidity” variables (leaving “Water depth” and “Temperature”).
20. Adjust the position and density of the Y-axis for each to bring the data lines closer together.

Do the lines tend to follow a similar or opposite pattern, or do they seem to be “unconnected?”  
(Circle one below)

Similar

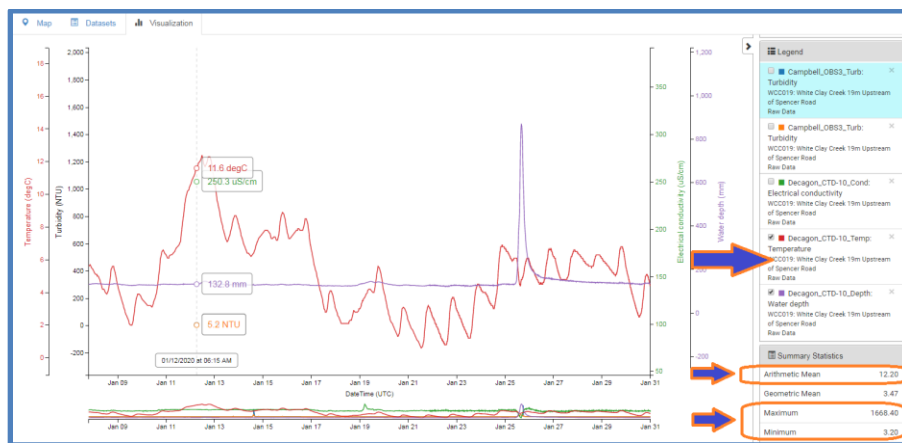
Opposite

Unconnected

As scientists, we are looking for data patterns that show some “relationship” between data patterns. Variables that move in the same or opposite patterns suggest that a possible relationship exists. Data that moves in “unconnected” ways generally means they do not impact each other and are “unrelated.”

### Collect Summary Statistics:

The “Summary Statistics” box in the lower right panel of the graph view (Visualization tab) provides detailed statistics about the variable highlighted in light blue in the “Legend” box for the selected date ranges in the “Plot Options” box. The statistics will not change when “zooming in” with the secondary graph. To view the summary statistics for a different variable, click on the particular variable panel in the “legend” box. Let’s examine and record summary statistics for multiple variables.



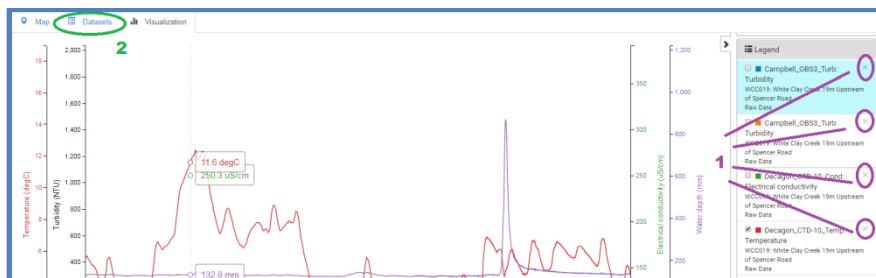
21. In the “Legend” box click on the “CTD-10 Temperature” variable panel to observe the summary statistics for “Stream temperature” and record the data in the table below. (The panel you select will be highlighted in light blue).
22. Repeat this process by clicking the variable panels and record the summary statistics for “Electrical conductivity” and “Water depth” in the table below.

	Water depth (mm)	Electrical conductivity (uS/cm)	Stream temperature CTD-10 (degC)
Arithmetic Mean			
Maximum			
Minimum			



## Adding and Removing Variable Datasets

To remove variables from the “Visualization” graph, you can click on the “x” in the upper right corner of each variable, or return to the “Datasets” tab to control which variables you want to examine. Let’s try this out.



23. In the “Legend” box, click the “x” in the top right corner of each variable panel except “Water depth.”
24. Click on the “Datasets” tab in the top left of the graph.
25. In the “Plot” column, check the boxes “EnviroDIY\_Mayfly\_Temp” and “EnviroDIY\_Mayfly\_Batt” and click on the “Visualization” tab.”
26. Adjust the Y-Axis for each variable to see if a “connected pattern” exists between any two variables on the graph (Water depth, Mayfly\_Temp, and Mayfly\_Batt).
27. Use the secondary graph to zoom in (and the cursor) to examine the data closely.

Do you see a connected pattern between any of these three variables? (Circle one)      Yes      No

If so, describe the pattern you see. Include the variables involved and a possible explanation for this relationship.

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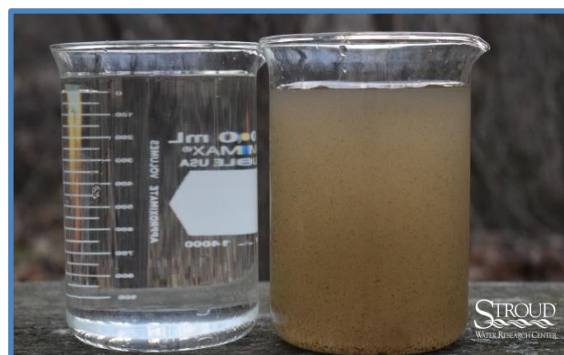


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Unchecking variables in the “Legend” box allows users to quickly add and remove data lines to look for connected relationships. Adding and removing variables from the “Legend” box with the check boxes in the “Plot” column on the “Datasets” tab, and removing variables with the “x” in the “Legend” box are great ways to view specific data.

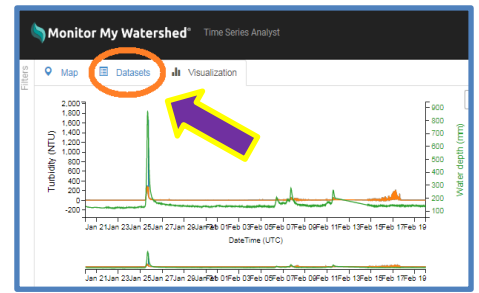
## Interpreting Anomalies:

Data from live sensor stations can be affected by many factors that may not follow a “typical” pattern. These anomalies provide an opportunity to explore and interpret interesting phenomena. Turbidity is a measurement of the “cloudiness” of water, which is normally caused by increased sediments and dissolved solids floating in the water. Do you have a stream near your home? What happens to the color of the water when a big rain storm happens? Turbidity measures how murky or cloudy water is by



sending a beam of “near-infrared” light into the stream and measuring how much light is reflected back into the sensor. If more light reflects back, then the meter reads the water as more cloudy. Less light will reflect back when the water is clear.

28. Left click on the “Datasets” tab at the top left corner of the main graph.
29. Use the check boxes in the “Plot” column to remove “Mayfly\_Temp” and “Mayfly\_Batt,” and add both “Turbidity” datasets.
30. Click on the “Visualization” tab and a new graph will load.
31. Change the date range in the “Plot Options” box to a “Begin Date” of **1/20/2020** and an “End Date” of **2/20/2020**, then click on “Plot” and wait for the new graph to draw.
32. Double left click on the Y-axis scale for “Turbidity” to increase the integer interval (expand the data) and drag the Y-axis up to see a range of about 0-240 NTU.
33. Double left click on the Y-axis scale for “Water depth” to increase the integer interval (expand the data) and move the Y-axis to see a range of about 100-500 mm.



In the graph you should see four instances when turbidity increases. During three of these events the water depth also increases, which is a “typical” pattern in nature (storm increases stream height and erosion occurs increasing turbidity). The event between February 14<sup>th</sup> and 18<sup>th</sup> is different. Use the secondary graph to examine this event.

34. Left click and drag on the secondary graph between February 14<sup>th</sup> to 18<sup>th</sup> to “zoom in” and take a closer look at this event.

Does the water depth increase during this turbidity event? (Circle one)

YES NO

Notice that the turbidity fluctuates sporadically and then drops quickly back to a low “baseline” (4.7 – 6 NTU). What do you think could cause this pattern?

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This is a “typical” turbidity pattern when the sensor gets dirty (algae growth). As the algae or debris builds up on the sensor, the turbidity readings increase and become more sporadic. This is a sign for the steward to visit the sensor station and clean the sensor with a brush.

How would the graph look different if debris became lodged against the turbidity sensor, or if an animal (fish, eel, or deer) were to pass close by?

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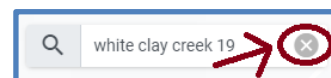
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35. In the plot options box, change the “Begin Date” to **8/29/2019** and the “End Date” to **9/9/2019** and then click on “Plot.”
36. Left click and drag in the secondary graph to select about half a day of data creating a gray “zoom” block. *(Double left click the secondary graph to erase the selection and try again if needed)*
37. Click and drag the gray “zoom” block back and forth in the secondary graph to examine the turbidity spikes on September 3<sup>rd</sup> and 5<sup>th</sup>.

Notice that the water level remains relatively stable while the turbidity spikes. These events are more typical of animals or debris moving by the sensor when a measurement occurred. The Mayfly Sensor Stations are programmed to take a reading from all sensors every five minutes, so you are seeing “snapshots” instead of continuous data. From these “snapshots” scientists, students, and citizens can see a larger picture of what is happening in the stream. By examining conditions at one station over time or comparing conditions between stations we can learn more about the dynamics of the streams in our watersheds and identify patterns and potential problems.

### Scan the Map for Sensor Stations near Your School

Return to the “Browse Sites” main page map and clear the “Search sites” box by clicking on the gray circle with an “x.” Use the “+ & -” buttons in the bottom left



corner to zoom in and out. Click and drag to move the map to locate your school and home. Are there any sensor stations nearby? If so, record the name(s) and site code(s) for sensor stations nearby to use in later lab activities or for local water monitoring.

Sensor Station Name

Site Code


## Skills Inventory

In this lesson you have learned to use the tools of [Monitor My Watershed®](http://www.monitormywatershed.org) to access, manage, and examine scientific data collected by Mayfly Data Logger Board™ Sensor Stations. Take a moment to review the skills below and rate your comfort level with completing each task by drawing a star in the appropriate box.

	Not comfortable		I think I can		I've got this!
Task/Skill	1	2	3	4	5
Searching for a Sensor Station with map tools (zoom & drag)					
Searching for a Sensor Station with the "Search sites" box					
Locating and recording the "Site Name" and "Site code" from the sensor station identification panel					
Opening the data graph for a single variable					
Opening the data graph for multiple variables					
Changing the data range in the "Plot Options" box					
Adjusting the Y-axis intervals to compress or expand the data and shift the scale up or down					
Removing and adding data lines with the "Legend" box					
Removing and adding variables in the "Datasets" tab					
Scanning data with the cursor to find specific dates and times of events					
Zooming in and out on the secondary graph to scan events and data					
Creating a gray area in the secondary graph to zoom in and scan back and forth					
Clicking on variable panels in the "Legend" box to view different "Summary Statistics"					

The new skills and knowledge that you have gained will help you analyze real world data throughout the lessons in this series. You will be able to make discoveries about our watersheds and how our actions impact water quality. Let's go explore and learn!