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DATA Nugget

Surviving the flood

Featured scientists: Andrew Blinn (he/him) and Dave Costello (he/him)
from Kent State University

Research Background:

When imagining a stream, you may think of pristine water flowing through a forest or mountain valley. However, streams are found everywhere, including cities. Many of these urban streams run through a pipe, disappear underground, or are filled with water that doesn't seem to be moving. These streams are often overlooked because they appear more like deep ditches or canals, but they play an important role in water management.

This stream near Cleveland, Ohio is flooded from rain events. Flooding happens so regularly that there is a gate for safety.

When rain falls in a forest, it flows through the soil, moving in the small spaces between soil particles. Eventually, it reaches a stream. This journey slows the water and prevents flooding. However, when rain falls in an urban area, it often does not move through soil before getting to a stream. Urban streams are instead surrounded by buildings, roads, and parking lots. Water races over these surfaces, causing rapid flooding. This water, called **stormwater runoff**, can cause a stream to go from ankle-deep to over your head in just a few hours!

A team of stream ecologists, including graduate student Andrew and his advisor Dave, wanted to see whether stormwater floods disturb urban stream ecosystems. Urban streams provide important habitat for many species – fish, insects, crustaceans, bacteria, and algae. Andrew and Dave have observed how large stormwater floods can sweep algae off rocks or bury algae with sediment that is washed in from parking lots. However, algae and other organisms in urban streams are used to living in a habitat with frequent disturbance and can cling to the rocks during small floods.

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Andrew and Dave focused their research on algae because they are an important part of aquatic ecosystems. Algae use energy from sunlight and building blocks from carbon dioxide gas to create sugar and oxygen. This process is called **photosynthesis**. By photosynthesizing during the day and not at night, algae cause large changes in the amount of oxygen in stream water. Taking a closer look at these daily oxygen changes, you can see how well algae are doing and how healthy a stream is.

Andrew recording field notes about an urban stream.

Andrew and Dave monitored daily changes in the stream by using sensors that collect oxygen concentrations every 10 minutes. They also needed to measure the intensity of flooding during different kinds of storms. They used a measure called **discharge**, which accounts for both the amount of water flowing in a stream and how fast it's moving. During a rain event, the time when the most water at the highest speed is rushing through the stream is called the **peak discharge.** For this measure, Andrew and Dave had some help from the United States Geological Survey, which has instruments in streams and rivers all over the country measuring discharge all the time. Looking at this dataset, Andrew detected a total of 13 storm events of different sizes during a one-year study period.

When the peak discharge is very high, the fast-moving water and flooding disturb algae by sweeping them off rocks and other surfaces, sending them downstream with the flow of water, and the algae are unable to photosynthesize. To answer their question, they looked at the oxygen concentrations for the day leading up to and following the 13 storms that Andrew identified. The difference in oxygen produced by algae before and after storms is a simple way to look at whether the algae resist the flooding or are disturbed by the flooding. If the oxygen concentration is the same after the storm as it was before the storm, the algae were resistant. If oxygen is lower after the storm than before the storm, that means that the algae were disturbed. Andrew and Dave thought that intense storms with high discharge will disrupt the algae more, resulting in lower oxygen concentrations after a storm than before a storm.

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Mats of algae growing in an urban stream.

Scientific Question: How do algae in urban streams respond to storms of different intensity?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data on the following page to answer the scientific question.

Storm event date: Looking at discharge data, Andrew detected a total of 13 storm events of different sizes during a one-year study period.

Peak depth (meters): The highest depth measured by sensors during a storm event.

Peak discharge (cubic meters per second): The highest discharge during a storm event. Discharge is the volume of water moving through a stream over a unit of time.

Oxygen produced by algae on the day before storm (grams of O_2 per square meter per day)

Oxygen produced by algae on the day after storm (grams of O_2 per square meter per day)

Difference in oxygen produced by algae (grams of O_2 per square meter per day): the before-storm oxygen value is subtracted from the after-storm oxygen value.

Percent (%) **change in oxygen produced by algae**: the difference in oxygen is divided by the before-storm oxygen value and multiplied by 100 to convert the difference to a percent change, which makes it easier to compare across the 13 storms.

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Storm event date	Peak depth	Peak discharge	Oxygen produced by algae (day before storm)	Oxygen produced by algae (day after storm)	Difference in oxygen produced by algae	Percent change in oxygen produced by algae
9/19/18	0.35	3.03	1.05	1.06	0.01	1
9/26/18	0.80	22.29	0.53	0.16	-0.37	-70
10/2/18	0.25	1.37	0.43	0.52	0.09	22
10/6/18	0.58	10.02	0.51	0.44	-0.07	-14
11/1/18	0.60	11.16	0.07	0.02	-0.05	-75
12/21/18	0.54	8.58	0.44	0.01	-0.42	-97
12/31/18	0.57	9.91	0.47	0.06	-0.42	-88
1/8/19	0.44	4.59	0.85	0.09	-0.76	-89
4/14/19	0.30	2.01	0.70	0.41	-0.29	-41
5/26/19	0.32	2.50	4.15	0.92	-3.23	-78
7/11/19	0.60	11.33	3.37	0.50	-2.87	-85
7/17/19	0.73	18.01	0.86	0.16	-0.70	-82
7/21/19	0.59	10.79	0.92	0.14	-0.78	-85

Which data will you graph to answer the question?

Independent variable(s): ____

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Dependent variable(s): ____

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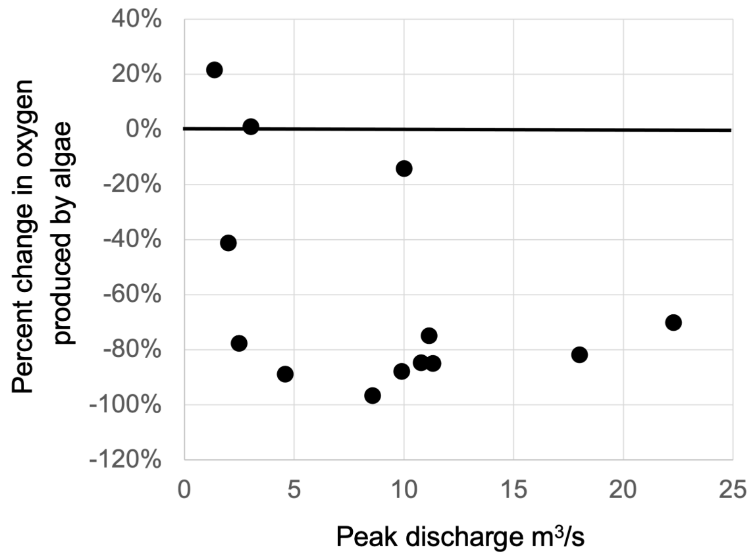
<u>Interpret the graph below</u>: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see and write one sentence describing what you see next to each arrow.



<u>Interpret the data:</u>

Make a claim that answers the scientific question.

What evidence was used to write your claim? Reference specific parts of the table or graph.

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Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how storms may act as a source of disturbance in urban streams.

Did the data support Andrew and Dave's hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

<u>Your next steps as a scientist:</u> Science is an ongoing process. What new question(s) should be investigated to build on Andrew and Dave's research? How do your questions build on the research that has already been done?