WELCOME!

Thank you, teachers, for all the hard work you do day-in and day-out inspiring our kids. Our hope is that this Water Quality Curriculum will provide you with hands-on and meaningful activities that get your students out into nature, give your students opportunities to make positive change in their communities, and foster your students' sense of environmental stewardship for their community.

This version of the Duke University Marine Lab Water Quality Curriculum is the result of many collaborators from Duke University Marine Lab, The University of North Carolina-Institute of Marine Sciences, and North Carolina State University. The ideas in this curriculum resulted from research at DUML and UNC-IMS, suggestions from teachers, as well as suggestions from community organizations working to make sure our waterways are clean. We could not have done this alone, so thank you to everyone who has made this Curriculum better. A special thanks goes out to Rachel Noble -- a Distinguished Professor at UNC-IMS. Dr. Noble’s research and her commitment to community and clean waterways funded many of the pilot projects in this Curriculum -- thank you for your commitment Dr. Noble! Lastly, thank you to all of the teachers for your willingness to teach our youth. We continue to be inspired by your students, their creativity, and their passion for making the world a better place... one cleaned waterway at a time!

Regards,

Liz DeMattia
Research Scientist
Director, Community Science Initiative
Duke University Marine Lab

INTRODUCTION

Our oceans, beaches, and coastal waterways are full of many land-based items that do not naturally belong there. Plastics, metals, rubber, fabrics, abandoned boats, derelict fishing gear, pesticides, fertilizer and more make their way into our waterways and have created an enormous water quality problem. In Eastern North Carolina’s 3,000 plus miles of coastline, the issue of water quality is especially poignant because pollution and marine debris negatively affect the health of our marine environment.

This Water Quality Curriculum combines community science at the Duke University Marine Laboratory (DUML) Community Science Initiative and University of North Carolina - Institute of Marine Sciences (UNC-IMS) with hands-on water quality and stormwater literacy activities and research. Our hope is that your students participate in the community science research, showcase their results with the local community, are inspired to do even more research, and inspire others to help make a positive difference in our waterways.

As teachers, you know your class and students best. Please feel free to deliver the activities in a time frame that works best for your classroom. Topics and activities can be focused over a few weeks, spread out over a month, or peppered throughout the semester. We also have included optional activities that allow your students to further research local stormwater and water quality issues.
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INTRODUCTION

This lesson plan was created to help students understand the basic goal of science. The students will discuss definitions of science, learn how to break down research questions, and learn how to effectively communicate research questions of their own.

OBJECTIVES

Students will be able to:

- Discuss/describe/tell what science is
- Analyze research questions
- Assess what a good research question looks like
- Devise their own research questions

END OF LESSON GOAL

Students will be able to:

- Explain how scientific inquiry helps us understand the world
- Confidently generate their own research questions

KEY POINTS

- Science is not scary
- Science can be easily defined
- We can talk about science in a lot of different ways, but we are all using science to answer questions
- We can generate research questions with 3 key components
  - A subject, a verb, and an object
  - An independent variable, a verb, and a dependent variable
  - How does ____ affect ____?

MATERIALS:

- PowerPoint (PPT) slides to guide the lesson
- Whiteboard and marker
- Worksheet (pg. 13)
CLASS DISCUSSION

- Ask students “what are you curious about?” This question can be specific to things in nature or not. The purpose is to engage students in the lesson.
  - Write their answers on the board to highlight examples and have their words/ideas be part of the lesson

INTRODUCTION TO SCIENCE (15 minutes)

Ask students “what is science?” in a Think-Pair-Share:
- Give students several minutes to write a definition in their own words
- Pair off with another student and discuss what they wrote
- Share definitions with the class
  - Write key words from the students’ definitions on the board
  - Compare/contrast students’ definitions
- Give several definitions of science on a PPT slide.
  - Compare/contrast the students’ and the provided definitions
- Emphasize that science is a tool to answer questions, explain relationships, and help us understand the world.

TALKING ABOUT SCIENCE (15 minutes)

Ask students “why do you think science is confusing?” This will help to understand their point of view.

- Describe two main reasons for confusion:
  - Poor communication -- people often don’t know how to effectively communicate what they are studying
  - Different ways to talk about science -- different people talk about cause and effect in different ways
- Write cause and effect on the white board
  - Ask “what does cause mean?” (n) person or thing that gives rise to an action, phenomenon, or condition
  - Ask “what does effect mean?” (n) the change that is the result of an action
- Ask the students to identify synonyms for each

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>EFFECT</th>
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<tbody>
<tr>
<td>Independent variable (the variable that is manipulated in an experiment)</td>
<td>Dependent variable (the variable that changes as a result of the IV)</td>
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<tr>
<td>X</td>
<td>Y</td>
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<td>Stimulus</td>
<td>Reaction</td>
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<td>Experimental variable</td>
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<td>Explanatory variable</td>
<td>Explained variable</td>
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<td>Etc.</td>
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</tbody>
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**RESEARCH QUESTIONS (20 minutes)**

You can use science to understand the world around you (Worksheet pg. 13)

- A scientific research question can be boiled down into a simple formula.
  - Ask “What are three basic parts of a sentence?”
    - Subject -- the noun that is performing the action
    - Verb -- the action
    - Object -- what receives the action
  - In science, these components can be thought of as
    - Cause
    - Verb
    - Effect
  - How does ____ VERB ____?
    - Example: How does light affect plant growth?
    - Example: Does fishing reduce catch size?

- Have students identify the independent variable, dependent variable, and verb of the 5 published titles on the Science Is Simple worksheet (pg.14)
  - Circle the independent variable, box the dependent variable, and underline the verb

- Have students write out the research questions from the titles on the worksheets.
  - PPT example-- How does shoreline geomorphology influence success of restored oyster reefs?

- Generate your own research question
  - Provide potential variables on a PPT slide for students to choose from so it’s not as daunting, but encourage them to come up with their own!
WHAT IS STORMWATER?

TOPIC

Introduction to stormwater sources, impacts, and solutions. This lesson should be used with the Impervious vs. Pervious Surfaces Activity.

INTRODUCTION

This discussion-based lesson will teach students the basics of stormwater. The students will define stormwater, identify sources of stormwater, identify stormwater impacts on water quality, and discuss potential mitigation measures. Students will learn that stormwater is a problem for them, locally.

OBJECTIVES

- Discuss how humans have impacted the natural water cycle
- Hypothesize how stormwater influences water quality
- Identify stormwater prevention methods

MATERIALS:

- PowerPoint (PPT) slides to guide the lesson

NOTES:

_________________________________________________________________
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ACTIVITY PLAN (45 - 60 minutes):

The activity plan below provides background information for the PowerPoint slides and cues for student discussion. To start, ask students to define stormwater in their own words. Definition-- stormwater is water that occurs in abnormal quantities that results from rain or snowmelt. Remember to write key words and common themes from definitions on the board. Potential keywords include: runoff, pervious surface, impervious surface, pollution, non-point source, point source

Background information on each of the PowerPoint slides:

The natural water cycle slide

- Discuss the water cycle
  - Define evaporation, evapotranspiration, condensation, infiltration, runoff
  - Note the size of the arrows in the water cycle
- Think-Pair-Share
  - Give students several minutes to think about how humans have changed the natural water cycle
  - Pair off with another student and discuss
- Share with the class
  - Write key words and common themes on the board

The “urban” water cycle slide

- Ask students what has been altered with human development. Note the size of the arrows in the urban water cycle
- Definition: stormwater runoff is rainfall or snowmelt that flows over the ground surface. It is created when rain falls on roads, driveways, parking lots, rooftops, and other paved surfaces that do not allow water to soak into the ground.

Stormwater Runoff slide

- Show this slide and discuss the different types of runoff you see from roofs, gutters, yards, etc.

How does stormwater influence water quality? slide

- Think-Pair-Share
  - Give students several minutes to think about the environmental and human health impacts of stormwater
  - Pair off with another student to discuss
  - Share with the class
- Why is stormwater runoff bad?
  - It can harm fish and other wildlife, results in habitat change, reduces recreation, etc.
- Show a news headline of a waterbody near you to emphasize that this is a local problem
  - i.e. The Neuse River Is Sick, and Advocates Blame the Pork and Poultry Industries
- Give students a news article to read
  - Identify the location, source of the problem, and the impact

Prevention Methods slide

- Ask students if they can come up with ways to prevent or decrease stormwater runoff
- Discuss the various methods.
IMPERVIOUS VS. PERVIOUS ACTIVITY

INTRODUCTION

This hands-on activity is designed to reinforce the concepts of impervious surfaces and stormwater taught in the What is Stormwater? activity by letting students explore their schoolyard in order to make predictions about infiltration rates and test different surfaces.

OBJECTIVES

- Identify impervious and pervious surfaces
- Make hypotheses about how water will flow on different surfaces
- Test the hypotheses
- Develop actions the school can take to reduce stormwater runoff

MATERIALS:

- Bottles filled with water
- Timer

NOTES:

______________________________________
______________________________________
______________________________________
______________________________________

CLASS DISCUSSION: Class discussion on types of outdoor surfaces (i.e. impervious and pervious).

Define and list examples of each. Ask students to define stormwater in their own words.

- Impervious surface examples: Driveways, sidewalks, parking lots, roads
- Pervious surface examples: Gardens, wetlands, forests, yards

TESTING SURFACES

Take class outside to “test” their schoolyard surfaces. Locate an area of grass/vegetation.

- Pour about half a water bottle onto the ground and observe how the water infiltrates or seeps into the ground. If you want to quantify the observations, have students record how long it takes for the water to be absorbed.
- Explain how the soil absorbs the water, much like it would absorb rain or stormwater.

Locate area of impervious surface (parking lot, sidewalk) and pour about half a water bottle onto this surface and observe how the water flows across and does not infiltrate into the ground as easily.

- If you want to quantify the observations, have students record how long it takes for the water to be absorbed. Note: water may not be absorbed on impervious surfaces, so you may have to set a time limit (60-90 seconds).
- Explain the process of rain or storm water flowing across all impervious surfaces until it reaches a bigger body of water (stream, lake, estuary).

GRAPH

Once back in the classroom, create a class graph of the data on the whiteboard. Discuss the quantitative differences between the surface absorption times.

- Break students into small groups. Have students come up with lists of actions the school can take to decrease stormwater runoff and increase water infiltration.
- Write up actions in an informative text
- Share group’s ideas with class
COMMISSION SCIENCE FIELD RESEARCH

ADOPT-A-DRAIN TUTORIAL

INTRODUCTION

This Adopt-A-Drain project was created to quantify types of pollution that citizen scientists prevent from becoming marine debris through periodic clean-ups. It is also uses micro and meso plastic as a model to understand how non-visible parts of water pollution (i.e., pesticides, fertilizers, bacteria, etc.) enter our waters through storm drains.

OBJECTIVES

• Collect and record data
• Form hypotheses for sources of marine debris
• Identify and discuss patterns and trends in data

ACTIVITY PLAN: (45 - 60 minutes)

1. Before you jump into the tutorial, review what you’ve learned with your students
   a. What is stormwater?
   b. Compare/contrast pervious and impervious surfaces. List examples of each.
   c. What are the sources of marine debris? (or other pollutants to waterways)
   d. What are the impacts of marine debris? (or other pollutants to waterways)

2. Download the Adopt-A-Drain app from Anecdata.org (or from the Community Science website).
   a. Visit https://sites.duke.edu/communityscience/programs/water-quality/ and create an account!

3. Adopt your drain!
   a. Class Drain-- Teachers, identify an easily accessible drain ahead of time (perhaps in your school parking lot) to adopt with your students. If there is not an easily accessible drain to practice with your class, that’s ok (it’s pretty easy to get the hang of without class practice).
   b. Student Drains-- have students adopt drains, either individually or with a group.
      i. If working in a group, make sure each student has the login information for their selected drain.
      ii. Set expectations for how often to collect trash and record the data (once a week, every other week, or once a month).
   c. Competition
      i. Incentivize diligent drain upkeep with a friendly classroom competition for who can prevent the most debris from entering your local waterways.
COMMUNITY ENGAGEMENT

GIVING STUDENTS A VOICE IN THEIR COMMUNITY

INTRODUCTION

This community engagement section is centered around giving students a voice for their research and the data they collect in their community. One way to get their information out to the community is using social media to present local water quality issues to their community in a creative and informative manner. Let your students be creative -- they know, navigate and understand the ever-changing social media landscape; and likely will create inventive ways to share their data, their projects, and even extra research with the broader community. The goal of presenting their work to the public is to illustrate how our students are public stewards and to help illustrate how stormwater and water quality is affecting our community. Possibilities include presentations to school boards or community leaders on their water quality research (using your data & graphs), public service announcements about stormwater and water quality, social media posts about stormwater and water quality with graphs, pictures, videos or more (worksheet on pg. 15).

OBJECTIVES

At the end of this activity students will be able to:

- Develop talking points that aid in explaining the issues of stormwater and water quality to others.
- Describe and discuss the role of stormwater and water quality to their community.
- Use social media to increase the reach of their message.

ACTIVITY PLAN

How do you display data? How can you create an infographic about your work? How can you make a PSA? For all of these types of communication there are four main questions:

- What do we want the audience to KNOW?
- How do we want the audience to FEEL?
- What do we want the audience to SEE? (only if you are doing a presentation/video/social media piece)
- And after seeing/listening to your communication, what do we want the audience to DO?

RESOURCES:

Examples of Good PSAs:

- Kids Safety Internet PSA - (:37) (https://www.youtube.com/watch?v=PS-t78Z1exQ)
- Active For Life Public Service Announcement (PSA) (:33) (https://www.youtube.com/watch?v=2syJ1bAMOvc)
- Kids Ask the Candidates for President to Debate Science (:30) (https://www.youtube.com/watch?v=yvTr9z9e3MA)

TEACHER TIPS:

Have students use background information from the AP Environmental Studies class or Earth and Environmental Studies class. While students collect background information, have them keep track of evidence and statistics that shock and surprise them, and also explain the topic. Then, the students will be even more prepared to write a script or design their infographic. Let your students be creative -- help them with data, but then allow them to work in groups to create fun and interesting ways to communicate!
INDEPENDENT RESEARCH (OPTIONAL)

FERTILIZER AND PESTICIDE EXPERIMENTS

INTRODUCTION

This lesson was created to demonstrate that some types of pollution can’t be seen with the naked eye. Unlike marine debris, which is often in the form of large and visible garbage, there are many pollutants that dissolve in water. Examples of these “invisible” pollutants are fertilizers, bacteria from waste, and pesticides. While we cannot see these pollutants directly, we can often see their impacts!

OBJECTIVES:

At the end of the research project, students will:

- Discuss and describe different types of stormwater pollutants and hypothesize about their potential sources
- Generate and test hypotheses
- Conduct their own experiment
- Collect local environmental science data that is linked to their community
- Graph their data and interpret their graphs
- Discuss their results and show key findings of their research
- Discuss possible ways to control and reduce the sources of pollutants

END OF LESSON GOALS:

- Create figures to visually display the results of the water quality activity
- Generate plausible explanations for why the results look the way they do
- Discuss future research or how you would change your methods
- Think about how individuals, families, and communities can improve water quality
- Talk about the importance of good water quality for animals, pets, and recreation

MATERIALS FOR FERTILIZER EXPERIMENT:

- Recycled plastic containers (i.e. yogurt cups or water bottles with the top cut off) to use as sampling containers for rainwater and stormwater samples.
- Glove on one hand for sampling to prevent contamination by human hands (preferred).
- Fertilizers in Your Water Worksheets

MATERIALS FOR PESTICIDE EXPERIMENT:

- Pesticide tablets by Renekabio (can buy on Amazon)
- Recycled plastic containers (i.e. yogurt cups or water bottles with the top cut off) to use as sampling containers for rainwater and stormwater samples.
- Glove on one hand for sampling to prevent contamination by human hands (preferred).
- Dropper or disposable pipet
- Pesticides in Your Water Worksheet
ACTIVITY PLAN:

Teachers can choose their own adventure with this lesson. Options include: a) fertilizer activity, b) pesticide activity, or c) a combination of both.

1. Ask ‘is pollution always visible’
2. Discuss types of pollution found in water, and how they get into waterways
   - Marine debris
   - Nutrients like nitrogen (nitrate, nitrite, ammonia, and phosphate)
   - Bacteria (found in human and warm-blooded animal waste)
   - Chemicals (oils, materials from car tires, detergents, pesticides, fertilizers)
3. Define pesticides: A pesticide is any substance used to kill, repel, or control certain forms of plant or animal life that are considered to be pests.
4. If conducting the fertilizer activity, watch nutrient pollution video (https://www.youtube.com/watch?v=vCicSNnKvM), and identify sources of nutrient pollution.
   - What are the negative impacts of nutrient pollution?
   - Can you think of potential solutions?
5. If conducting pesticide activity, watch pesticides video (https://www.youtube.com/watch?v=TZlZluOyho&feature=youtu.be), and identify sources of pesticide pollution.
   - What are the negative impacts of pesticide pollution?
   - Can you think of potential solutions?
6. Run the experiment -- detailed instructions are found on the worksheets
   - Organize students into groups of 3-5 individuals
   - Assign each student group a treatment (i.e. rainwater or stormwater)
   - Have students work in small groups with their fertilizer or pesticide worksheets to identify the research question, hypotheses, and assigned treatment
   - Distribute sampling supplies
STUDENTS INVOLVE PARENTS IN SCHOOLWORK (SIPS)

ENGAGING YOUR FAMILY AND COMMUNITY

INTRODUCTION

The Students Involve Parents in Schoolwork (SIPS) assignment is an interactive homework assignment that allows students to share their work with family members and connect the issue of water quality back to their community.

OBJECTIVES

At the end of these activities students will:

- Explain the issues of water quality and storm water to their family.
- Connect the work they are doing at school to their home and community.

ACTIVITY PLAN

Go over the homework sheet in class, and have each student fill out the top section, with a due date. Remind students during class to return the SIPS Worksheets.

MATERIALS FOR SIPS ASSIGNMENT:

- SIPS Worksheet (pg. 30)
MAKING SCIENCE SIMPLE WORKSHEET

HOW TO FORMULATE A RESEARCH QUESTION

What is Science?

Identify synonyms for Cause and Effect

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</table>

Circle the independent variable, underline the verb, and box the dependent variable in the following article titles. Then rewrite the title into a research question.

*Parasites enhance resistance to drought in coastal ecosystems*

*Climate change and invasion may synergistically affect native plant reproduction*

*Soy consumption reduces risk of ischemic stroke: a case-control study in Southern China*

*The influence of antibiotics on gut bacteria diversity*

*The impact of shellfish farming on common bottlenose dolphins’ use of habitat*

Generate your own research question that includes an independent variable, verb, and dependent variable.
What is Science?

- Student answers
- Definitions from PowerPoint
- Similarities

### Identify synonyms for Cause and Effect

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variable</td>
<td>Dependent variable</td>
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<td>X</td>
<td>Y</td>
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<tr>
<td>Stimulus</td>
<td>Reaction</td>
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<td>Experimental variable</td>
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<tr>
<td>Explanatory variable</td>
<td>Explained variable</td>
</tr>
</tbody>
</table>

Circle the independent variable, underline the verb, and box the dependent variable in the following article titles. Then rewrite the title into a research question.

- **Parasites enhance** resistance to drought in coastal ecosystems
  
  How do parasites enhance resistance to drought?

- **Climate change and invasion may synergistically affect** native plant reproduction
  
  How does climate change and invasion affect native plant reproduction?

- **Soy consumption reduces** risk of ischemic stroke: a case-control study in Southern China
  
  How does soy consumption reduce risk of stroke?

- **The influence of antibiotics on** gut bacteria diversity
  
  How do antibiotics influence gut bacteria diversity?

- **The impact of shellfish farming on common bottlenose dolphins' use of habitat**
  
  How does shellfish farming influence dolphin use of habitat?

Generate your own research question that includes an independent variable, verb, and dependent variable.
PSA WORKSHEET – GENERATING IDEAS

PSA STEP TWO:

Analyze the PSA examples and then answer/discuss these questions on your own. After finishing this sheet, discuss with your partner.

PSA Title to Analyze______________________________

What did the PSA want the audience to KNOW?

What did the PSA want the audience to FEEL?

What did the PSA want the audience to SEE?
FERTILIZERS IN YOUR WATER

EXPERIMENT INSTRUCTIONS

FERTILIZER EXPERIMENT STEPS

1. Each treatment group (i.e. rainwater or stormwater) will need 5 recycled containers to collect samples (e.g. yogurt containers or plastic water bottles with the tops cut off). Label each sampling container with the treatment (e.g. Rainwater), location (e.g. Emma’s house), and sample number (e.g. Sample #1). Then collect your samples (one sample per container) using a gloved hand for collecting the samples. Each group should collect at least 5 samples from the chosen site within your treatment. Try to be very careful to only sample the rainwater or stormwater and not include soil in your sample collection.

   a. Rainwater sampling groups: In order to collect rainwater you will need a container with a large surface area to collect the rain more quickly (e.g. yogurt container or plastic water bottles with the tops cut off). Place your five containers on a flat surface during a rain event to collect rainwater. Be sure that the collecting containers are far enough off the ground so that they are not contaminated by floodwaters and/or dirt/debris bouncing up from heavy rain into the collecting bottles.

   b. Stormwater sampling groups: In order to collect stormwater you will need to find puddles, ditches, creeks, and/or storm drains with stormwater running into the drain. Place the container into the water and fill with at least a 1/2 cup of stormwater. Repeat this with the four containers at the same site. Make sure to scoop the water in a manner away from your hand (so as not to get contamination from your hands).

2. How to test each sample of rainwater or stormwater (collected in the recycled water bottles) for fertilizer:
   a. Use one nitrogen testing strip for each bottle of collected water. Dip the strip into the sample, wait two minutes, and then compare the color to the color gauge on the testing strip box to determine the amount of the nitrogen in your sample. Write down the corresponding nitrogen values (based on the color of your testing strip) on your data sheet. Try to have more than one person in each group look at the strip and determine the matching color to confirm the findings.

Figure 1. Example for how to label samples
Figure 2. Use one strip per sample container
FERTILIZER HYPOTHESES WORKSHEET

BACKGROUND

With an ever increasing global population, agriculture and the production of food have become very important. It is now common for us to use chemicals such as fertilizers and pesticides, along with other agricultural practices, to increase crop yields and make food more appealing, thus increasing the number of people fed. However, the use of fertilizers and pesticides does not come without consequences. Fertilizers are used to boost food production across most of farming (even fish farming!) and are not just used by major farms and growers. They are also used by small-scale farmers to boost the amount of food produced. When it rains, fertilizer that is not used by the plants or absorbed into the soil runs off into local waters (ditches, creeks, streams, and rivers). The fertilizers contain nitrogen and phosphorus which can cause an unnatural amount of algae to grow in the water. This is why you sometimes see algae floating at the top of a lake, ditch, or creek. The algae can make it difficult for fish and other animals to feed and can sometimes even be toxic to wildlife and pets using the water to drink.

Today, you will determine the presence or absence of fertilizers in your water samples! Identify the following:

Research question(s):

Null Hypothesis:

Alternative Hypothesis:
Record your Nitrogen results in the following table. Then record your classmates’ results.

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Rainwater</th>
<th>Stormwater</th>
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<tbody>
<tr>
<td>1</td>
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</table>

Calculate the mean Nitrogen value for the rainwater treatment and the stormwater treatment

\[
Mean = \frac{\text{sum of the values}}{\text{sample size}}
\]

Rainwater: ______________

Stormwater: ______________
FERTILIZER GRAPH WORKSHEET

Show the results of your experiment with a bar graph. Label the mean.

What will be your X-axis (independent variable)?

What will be your Y-axis (dependent variable)?

Discuss why your results look the way they do. Does your alternative hypothesis match your results? Where do you think fertilizer in your samples are coming from? How would your results change if you added more stormwater sites (e.g. stormwater near a lawn, vs. near a farm, vs. your school parking lot?)
BACKGROUND

With an ever increasing global population, agriculture and the production of food have become very important. It is now common for us to use chemicals such as fertilizers and pesticides, along with other agricultural practices, to increase crop yields and make food more appealing, thus increasing the number of people fed. However, the use of fertilizers and pesticides does not come without consequences. Fertilizers are used to boost food production across most of farming (even fish farming!) and are not just used by major farms and growers. They are also used by small-scale farmers to boost the amount of food produced. When it rains, fertilizer that is not used by the plants or absorbed into the soil runs off into local waters (ditches, creeks, streams, and rivers). The fertilizers contain nitrogen and phosphorus which can cause an unnatural amount of algae to grow in the water. This is why you sometimes see algae floating at the top of a lake, ditch, or creek. The algae can make it difficult for fish and other animals to feed and can sometimes even be toxic to wildlife and pets using the water to drink.

Today, you will determine the presence or absence of fertilizers in your water samples! Identify the following:

Research question(s):
- How does sample type (i.e., rainwater or stormwater) affect the amount of Nitrogen in the water?
- Does one sample type (i.e. rainwater or stormwater) have more or less Nitrogen than the other?

Null Hypothesis:
- There will be no difference in Nitrogen between the rainwater and stormwater samples.
- The mean Nitrogen value for rainwater will equal the mean Nitrogen value for stormwater.

Alternative Hypothesis:
- There will be a difference in fertilizer amount between the rainwater and stormwater samples.
- There will be more Nitrogen in the stormwater samples than in the rainwater samples.

(Some students may think there will be less Nitrogen in the stormwater, that is fine.)
Assign Treatment: Rainwater or stormwater (depending on what you have assigned)

Record your Nitrogen results in the following table. Then record your classmates’ results.

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Rainwater</th>
<th>Stormwater</th>
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<tbody>
<tr>
<td>1</td>
<td>0 ppm</td>
<td>2 ppm</td>
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<tr>
<td>2</td>
<td>0 ppm</td>
<td>5 ppm</td>
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<tr>
<td>3</td>
<td>0 ppm</td>
<td>2 ppm</td>
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<tr>
<td>4</td>
<td>0.5 ppm</td>
<td>10 ppm</td>
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<td>5</td>
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<td>5 ppm</td>
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</table>

Depending on the test strips you use, the units may be parts per million (ppm) or milligrams per liter (mg/L).

Calculate the mean Nitrogen value for the rainwater treatment and the stormwater treatment.

\[
\text{Mean} = \frac{\text{sum of the values}}{\text{sample size}}
\]

Rainwater: \(0.2\) ppm

Stormwater: \(5.5\) ppm
KEY: FERTILIZER GRAPH WORKSHEET

Show the results of your experiment with a bar graph. Label the mean.

What will be your X-axis (independent variable)?

Water Sample (e.g. rainwater)

What will be your Y-axis (dependent variable)?

Nitrate (ppm)

Discuss why your results look the way they do. Does your alternative hypothesis match your results? Where do you think fertilizer in your samples are coming from? How would your results change if you added more stormwater sites (e.g. stormwater near a lawn, vs. near a farm, vs. your school parking lot)?

The majority of our rainwater samples had 0 ppm of nitrate, with an average of 0.2 ppm for all of our rainwater samples. The stormwater samples had an average of 5.5 ppm of nitrate. These results match our alternative hypothesis that there is a difference between rainwater and stormwater in terms of fertilizer in the water. Fertilizer in our stormwater samples might come from lawn maintenance or nearby farms. If we collected stormwater from our school parking lot, we might not have any nitrate in our samples because I don’t think our school uses fertilizer. However, if we got more stormwater samples near the farm down the road, I think we’d see more nitrate in our stormwater due to the farm’s fertilizer use.
PESTICIDES IN YOUR WATER

EXPERIMENT INSTRUCTIONS

PESTICIDE EXPERIMENT STEPS

1. Each treatment group (i.e. rainwater or stormwater) will need 5 recycled containers to collect samples (e.g. yogurt containers or plastic water bottles with the tops cut off). Label each sampling container with the treatment (e.g. Rainwater), location (e.g. Emma’s house), and sample number (e.g. Sample #1). Then collect your samples (one sample per container) using a gloved hand for collecting the samples. Each group should collect at least 5 samples from the chosen site within your treatment. Try to be very careful to only sample the rainwater or stormwater, and not include soil in your sample collection.
   a. Rainwater sampling groups: In order to collect rainwater you will need a container with a large surface area to collect the rain more quickly (e.g. yogurt container or plastic water bottles with the tops cut off). Place your five containers on a flat surface during a rain event to collect rainwater. Be sure that the collecting containers are far enough off the ground so that they are not contaminated by floodwaters and/or dirt/debris bouncing up from heavy rain into the collecting bottles.
   b. Stormwater sampling groups: In order to collect stormwater you will need to find puddles, ditches, creeks, and/or storm drains with stormwater running into the drain. Place the container into the water and fill with at least a 1/2 cup of stormwater. Repeat this with the four containers at the same site. Make sure to scoop the water in a manner away from your hand (so as not to get contamination from your hands).

2. How to test each sample of rainwater or stormwater (collected in the recycled water bottles) for pesticides:
   a. Remove the protective film from the pesticide card.
   b. Use a dropper to fully cover the white disc of the pesticide card with your water sample.
   c. Make sure the white disc is fully covered with the sample solution.
   d. Let the pesticide card sit for 10 minutes.
   e. Fold the card in half, with the white and red discs facing each other.
   f. Pinch the white and red discs together for 3 minutes.
   g. Open the pesticide card and record the concentration results (negative, low, or high).
   h. Record the results in the data table.
PESTICIDES HYPOTHESES WORKSHEET

BACKGROUND

Farming and agricultural food production has never been more important. Unfortunately, feeding the growing population is becoming increasingly difficult due to pests and insects that damage the crops. Over the last few decades it has become common for most farmers to use pesticides to control insects and parasites that damage crops. Pesticides are any substance used to kill, repel, or control certain forms of plant or animal life that are considered to be pests. The application of pesticides, along with other agricultural practices, protects the plant and can actually increase crop yields, thus reducing economic losses and increasing the number of people fed! However, the use of pesticides does not come without consequences. Pesticides can cause serious short-term and long-term damage to animals, including humans. Pesticides can cause problems with reproduction, animal growth, and animal hormones. The effects of pesticides in water can sometimes be serious, and if seafood is grown in contaminated water, consuming the seafood can cause health problems.

Today, you will determine the concentration of pesticides in your water samples! Identify the following:

Research question(s):

Null Hypothesis:

Alternative Hypothesis:
## PESTICIDES DATA COLLECTION WORKSHEET

Record your pesticide concentration results in the following table. Then record your classmates' results.

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Rainwater</th>
<th>Stormwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

Use the data in the table to determine the number of times the class results showed the following:

- **Stormwater Negative:** ______
- **Stormwater Low:** ______
- **Stormwater High:** ______
- **Rainwater Negative:** ______
- **Rainwater Low:** ______
- **Rainwater High:** ______
PESTICIDE GRAPH WORKSHEET

Create a bar graph to show the frequency each concentration occurred for each treatment.

What will be your X-axis (independent variable)?

What will be your Y-axis (dependent variable)?

Discuss why your results look the way they do. Does your alternative hypothesis match your results? Where do you think pesticide in your samples are coming from? How would your results change if you added more stormwater sites (e.g. stormwater near a lawn, vs. near a farm, vs. your school parking lot)?
KEY: PESTICIDES HYPOTHESES WORKSHEET

BACKGROUND

Farming and agricultural food production has never been more important. Unfortunately, feeding the growing population is becoming increasingly difficult due to pests and insects that damage the crops. Over the last few decades, it has become common for most farmers to use pesticides to control insects and parasites that damage crops. Pesticides are any substance used to kill, repel, or control certain forms of plant or animal life that are considered to be pests. The application of pesticides, along with other agricultural practices, protects the plant and can actually increase crop yields, thus reducing economic losses and increasing the number of people fed! However, the use of pesticides does not come without consequences. Pesticides can cause serious short-term and long-term damage to animals, including humans. Pesticides can cause problems with reproduction, animal growth, and animal hormones. The effects of pesticides in water can sometimes be serious, and if seafood is grown in contaminated water, consuming the seafood can cause health problems.

Today, you will determine the concentration of pesticides in your water samples! Identify the following:

Research question(s):

- How does sample type (i.e., rainwater or stormwater) affect the presence (or concentration: low, medium, high) of pesticides in the water?
- Does one sample type (i.e., rainwater or stormwater) have pesticides more frequently than the other?

Null Hypothesis:

- There will be no difference in pesticides between the rainwater and stormwater samples.
- The mean number of times that pesticides are present in rainwater will equal the mean number of times that pesticides are present in stormwater.

Alternative Hypothesis:

- There will be a difference in pesticides between the rainwater and stormwater samples.
- There will be more pesticides in the stormwater samples than in the rainwater samples.
**KEY: PESTICIDES DATA COLLECTION**

Record your pesticide concentration results in the following table. Then record your classmates’ results.

<table>
<thead>
<tr>
<th>Sample #</th>
<th>Rainwater</th>
<th>Stormwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Negative</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>Negative</td>
<td>Low</td>
</tr>
<tr>
<td>3</td>
<td>Low</td>
<td>High</td>
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<tr>
<td>4</td>
<td>Negative</td>
<td>Negative</td>
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<td>5</td>
<td>Negative</td>
<td>Low</td>
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<td>6</td>
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<td>Low</td>
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<tr>
<td>15</td>
<td>High</td>
<td>Negative</td>
</tr>
</tbody>
</table>

Use the data in the table to determine the number of times the class results showed the following:

- Stormwater Negative: ___5____
- Stormwater Low: ______6_____
- Stormwater High: _____4_____
- Rainwater Negative: ___9____
- Rainwater Low: ______4_______
- Rainwater High: ____2_______
KEY: PESTICIDES GRAPH

Create a bar graph to show the frequency each concentration occurred for each treatment.

What will be your X-axis (independent variable)?
Sample Type (e.g. Treatment, Water Sample, Site, etc.)

What will be your Y-axis (dependent variable)?
Frequency of Occurrence

Discuss why your results look the way they do. Does your alternative hypothesis match your results? Where do you think pesticides in your samples are coming from? How would your results change if you added more stormwater sites (e.g. stormwater near a lawn, vs. near a farm, vs. your school parking lot)?

The majority of our rainwater samples showed negative results for pesticides. Our stormwater samples had a higher frequency of low and high concentration results than our rainwater samples. This matches our alternative hypothesis that there is a difference between rainwater and stormwater in terms of pesticide concentration. I'm surprised that rainwater had any pesticides at all. This may be a result of cross-contamination in our samples. Pesticides in our stormwater might come from lawn maintenance or nearby farms. If we collected stormwater from our school parking lot, we might not have any pesticides in our samples because I don’t think our school uses pesticides. However, if we got more stormwater samples near the farm down the road, I think we’d see more frequency of low and high concentration of pesticides.
Dear Parent/Family Partner,

We are currently incorporating our science knowledge into a creative community engagement product that incorporates classwork and research we have done about water quality and storm water in our community. In this assignment, I will describe to you what I created and then ask you questions about my work. I hope that you enjoy learning about our classwork! The assignment is due _________________.

Sincerely, ________________________ (Student’s signature)

Part 1: Describe your work

Family Partner: ____________________________________

Student: I will be describing the following community engagement product: ______________________

Describe (or show) your community engagement product to a family partner. Why did you create this work? What is the message of the work? What choices did you make in creating this work?

Part 2: Interview your family member

After describing your work, create two questions and interview your family partner to understand how your work made them feel.

Question 1: ___________________________  Question 2: ___________________________

Parent answer:  Parent answer:

Dear Parent/Family Partner,

Please share your reactions to this activity. Write YES or NO next to each statement.

_______ This assignment helped me know what my child is learning in class.

_______ I know more about water quality and storm water issues after listening to my child.

Other comments:

Parent Signature: ____________________________

STUDENTS INCLUDE PARENTS IN SCHOOLWORK

ASSIGNMENT INSTRUCTIONS

Dear Parent/Family Partner,

We are currently incorporating our science knowledge into a creative community engagement product that incorporates classwork and research we have done about water quality and storm water in our community. In this assignment, I will describe to you what I created and then ask you questions about my work. I hope that you enjoy learning about our classwork! The assignment is due _________________.

Sincerely, ________________________ (Student’s signature)

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After describing your work, create two questions and interview your family partner to understand how your work made them feel.

Question 1: ___________________________  Question 2: ___________________________

Parent answer:  Parent answer:

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Please share your reactions to this activity. Write YES or NO next to each statement.

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Other comments:

Parent Signature: ____________________________