



**MIAMI
WATERKEEPER®**

FERTILIZER USE LESSON PLAN

NUTRIENT POLLUTION & DECREASED WATER QUALITY

INSTRUCTOR BACKGROUND:

For this lesson, we will be learning about fertilizer use in South Florida. More specifically, we will be talking about nutrient pollution and the cumulative effects it has on the health of Biscayne Bay. This lesson is geared towards middle and highschool students in South Florida. Students should have a basic understanding of some biology and geography. They should be familiar with what algae are and the plant cycle, understand naturally occurring nutrients such as nitrogen and phosphorus and have a basic understanding of how algae grow and function. Students will learn about the extensive impacts of excess or improper fertilizer use, including decreased water quality, habitat loss, health impacts for humans and wildlife, as well as economic impacts on commercial fisheries and tourism. The objective of this lesson is to demonstrate how improper use of fertilizer has contributed to the diminishing health of South Florida's watershed, Biscayne Bay.

Age group: Recommended for grades 6-12

After using this lesson plan, we would love for you to write a short review using the following link to access a survey:

[Click here to review this lesson plan!](#)

Your responses will help make these resources and future ones better!

DOWNLOADABLE LESSON PLANS

MIAMI WATERKEEPER

Miami Waterkeeper's mission is to ensure swimmable, drinkable, fishable water for all.

Founded in 2010, Miami Waterkeeper defends everyone's right to use and enjoy clean water. Our scope of work is diverse, with focus areas including clean water, ecosystem protection, and sea level rise readiness

TIMELINE

ENGAGE (POWERPOINT PRESENTATION INCLUDED)	25 MINUTES
LAB ACTIVITY	20 MINUTES
DISCUSSION	5 MINUTES
HOMEWORK ASSIGNMENT	
NEXT-DAY DISCUSSION	10-15 MINUTES
TOTAL TIME	60-70 MINUTES

STATE STANDARDS

SC.68.CS-CS.1.2

Create or modify and use a simulation to analyze and illustrate a concept in depth.

SC.7.E.6.6

Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water.

HE.7.C.1.3

Analyze how environmental factors affect personal health.

SC.8.N.1.2

Design and conduct a study using repeated trials and replication.

HE.8.C.1.3

Predict how environmental factors affect personal health.

SC.912.N.1.1

Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science.

SC.912.L.17.4

Describe changes in ecosystems resulting from seasonal variations, climate change and succession.

SC.912.L.17.8

Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity.

SC.912.L.17.13

Discuss the need for adequate monitoring of environmental parameters when making policy decisions.

SC.912.L.17.20

Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.

STUDENTS BY THE END OF THE LESSON SHOULD BE ABLE TO:

Determine what is causing Biscayne Bay's water quality to become so poor regarding nutrient pollution.

Explain why fertilizer use is detrimental to water bodies.

Describe what a fertilizer ordinance is.

Synthesize why a fertilizer ban minimizes water quality degradation.

BACKGROUND

Located in South Florida, Biscayne Bay is an **estuary**, comprised of both fresh and saltwater. The freshwater inflow comes primarily from Lake Okeechobee. However, the quality of this freshwater has drastically changed over the last 100 years. As people started to settle around Lake Okeechobee they began to understand that the surrounding lands were fertile for development. Society started altering the freshwater flow by building intricate canal systems that took Lake Okeechobee's freshwater East, South, and West. As a result of creating these concrete-lined canals, freshwater was not able to naturally filter itself through soil and vegetation. South Florida is ultimately left with dirty freshwater entering our Bay. Dirty in the sense that it is filled with nutrients and pollution from its long journey, which are accumulating in Biscayne Bay and leading to nutrient pollution in our water, leading to **algae blooms** - an overgrowth of algae within a waterbody.

HISTORIC WATER FLOW



CURRENT WATER FLOW



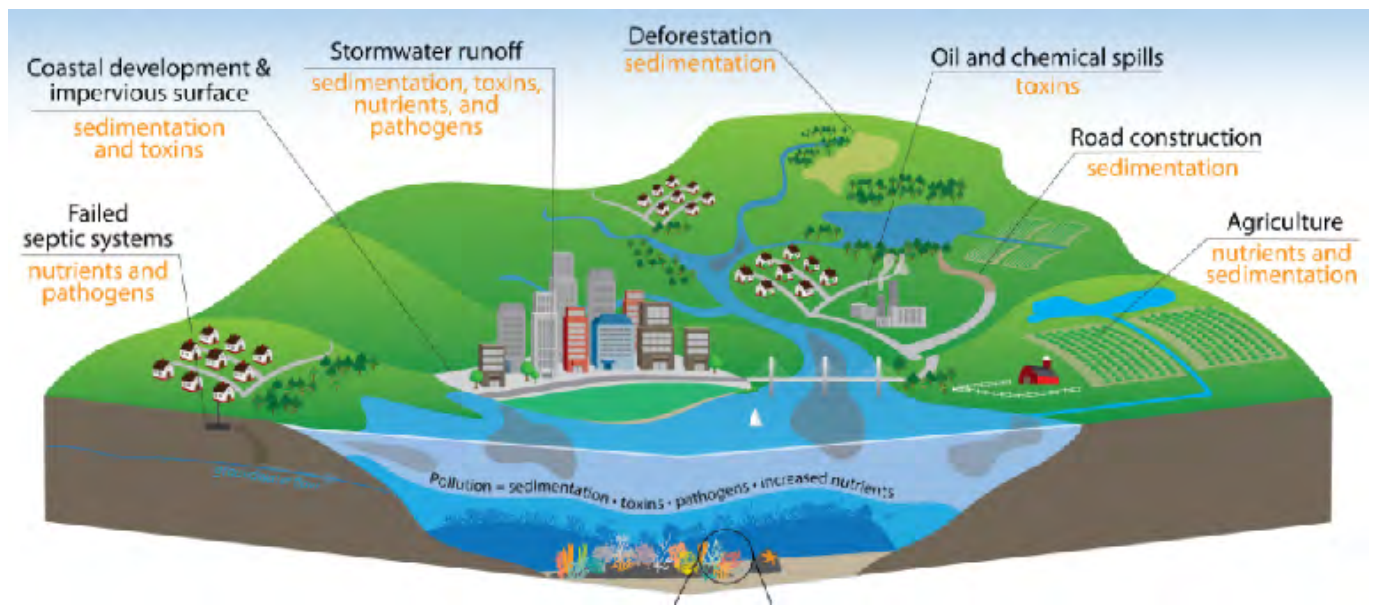
Taking a quick diversion from the topic of algae blooms, it is important to now introduce fertilizer. Fertilizer is food for plants. Plants, like any other living thing, need a variety of nutrients to grow and thrive. Humans and animals get their nutrients through the different foods they eat. Plants obtain their nutrients through the soil. However, some soils don't meet the nutrient requirements necessary for plants to grow optimally, or the nutrients are in forms that make it difficult for the plants to uptake. This is where fertilizer comes in.

Fertilizer is used as a nutrient supplement for plants. The nutrients found in fertilizers are primarily nitrogen, phosphorus, and potassium and are in a form that is easily absorbed by the plant's roots.

Nutrients, like nitrogen and phosphorus, are naturally occurring substances that provide essential nourishment to support life, but too much of these nutrients in our waterways can be harmful. Just as humans shouldn't eat 1,000 oranges to accumulate Vitamin C, the ecosystem shouldn't "consume" high levels of nitrogen and phosphorus. Too much of a good thing can be a bad thing.

Nutrient pollution, or when there are too many nutrients in a system, can contribute to a phenomenon called **eutrophication**. This event is characterized by the excess of nutrients in a waterway that leads to the dense growth of some plants, particularly algae blooms. Algae is a type of aquatic plant that also grows when it absorbs nutrients. Sometimes, this absorption takes in too much and happens too fast, creating an environmental effect called a "bloom". Algae blooms can be really problematic because they clog our waterways, turn the water green, smell bad, can kill fish and wildlife, may contribute to seagrass die-offs, and can also harm people.

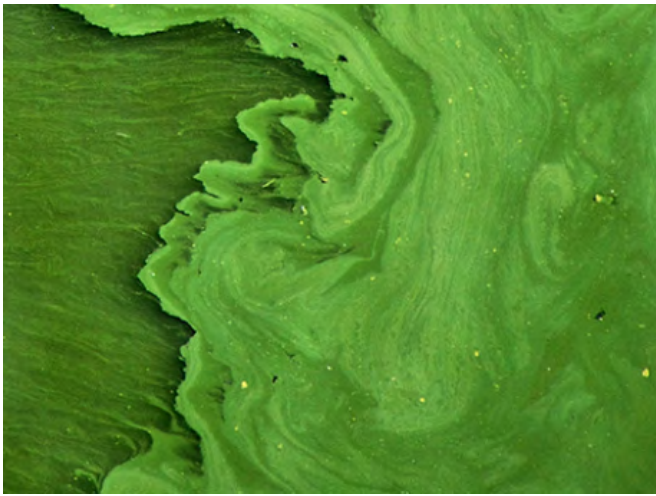
In addition to fertilizer, high concentrations of nutrients can also be found in sewage, septic tanks, and stormwater runoff. These are called **non-point sources of pollution** because we do not know where the source of the pollution originated exactly. If we are able to see and observe specific locations or causes of pollutants, like a specific factory or farm discharging pollutants into a stream, this is called **point source pollution**.



OTHER SOURCES OF LAND-BASED POLLUTION (SOURCE: [HTTPS://DCRM.GOV.MP/OUR-PROGRAMS/WATER-QUALITY-AND-WATERSHED-MANAGEMENT/](https://dcr.gov.mp/our-programs/water-quality-and-watershed-management/))

Explain how algae bloom growth can affect the marine ecosystem and habitats. Explain the life cycle of algae, precisely how it can contribute to a **hypoxic or oxygen-poor environment that impacts species' ability to breathe. Explain that the temperature of South Florida's waters is warm, and algae grow best and quickly in warmer waters. Proceed to explain how algae blooms pose a threat to public health. **

When algae grow out of control, they can create Harmful Algal Blooms (HABS). Some algae produce toxins which can be harmful to humans. These toxins may concentrate in seafood which, when consumed by humans, lead to gastrointestinal, cardiovascular, neurological, and respiratory issues in asthmatics, children, and elders.



****Ask students to think about whether further urban development will contribute to further nutrient pollution in Biscayne Bay. Why or why not? Give them a few minutes to think about the question. Explain that urban development is not necessarily a bad thing. Miami, in particular, is a very desirable place to work, live, and vacation. Explain the flip side of how increased pressure from more people will impact the water. More waste, more lawns being fertilized, for example.****

****As a class, watch the video on fertilizer use from the Miami Waterkeeper's website and follow up with questions before the breakout lab activity. Link is listed below****



[HTTPS://YOUTU.BE/BOFOTRGSNM](https://youtu.be/BOFOTRGSNM)

Locally, scientists and stakeholders are working together to pass fertilizer ordinances in municipalities across South Florida, banning fertilizer use during rainy summer months. This is important because nutrients we put on the ground in the rainy summer months don't get absorbed, they just get washed away before they are able to get taken up by plants.

****Explain what an ordinance is, and in particular, illustrate the importance of creating a fertilizer ordinance as it relates to the health of Biscayne Bay. Emphasize that Biscayne Bay is very sensitive to nutrient load and**



additional sources of pollution; it has already been receiving an abundance of nonpoint and point sources of pollution for over 100 years now. By increasing the amount of nutrients that enter the vulnerable Bay, we are creating a waterbody that will no longer be safe to use recreationally and threaten marine life further. But, there are things our government can do to help too! Non-point sources of pollution are difficult to trace. We can do our part to reduce nutrient pollution at home, but sometimes there are things we can inform our government to act on as well.**

EXPLORE (LAB) INSTRUCTOR GUIDANCE

The Fertilizer Footprint Lab

Materials

- Clear plastic container
 - Tap water
 - Blue food coloring (representing nitrogen)
 - Yellow food coloring (representing phosphorus)
 - Dish Soap (representing mystery pollutant)
 - STUDENT LAB WORKSHEET: “Fertilizer Footprint: Creating a Polluted Bay”
 - STUDENT HOMEWORK WORKSHEET: “Fertilizer & Nutrient Pollution”
 - Camera or Smartphone
1. Divide students into groups of 1-2 and distribute the STUDENT LAB WORKSHEET “Fertilizer Footprint: Creating a Polluted Bay” as well as a plastic container, blue food coloring, yellow food coloring, spoon and dish soap.
 2. Guide students through the activity, encourage them to follow directions on the worksheet, and work through it with classmates.
 3. When the students are done with the water activity, have them clean up their area. Compare and contrast students’ images of the “transformation of the water” and observations from the lab. See demonstrative photos below.



Explain that in the lab exercise, students created a marine environment that has been impacted by the human imprint. It will ultimately be hard to distinguish the colors and ingredients, simulating the difficulty in locating non-point sources of pollution. Nitrogen and phosphorus mix together with other mystery pollutants/nonpoint sources of pollution. Idea behind it is to illustrate how it’s hard to pinpoint the sources when there are so many different ones entering the Bay at one time

Extend

Distribute the STUDENT HOMEWORK WORKSHEET: “Fertilizer & Nutrient Pollution” to be completed individually at home.

Explain & Reinforce

Next day, discuss the findings of the lesson/lab. Have students break out into lab groups and list 5-6 bullet points highlighting what they found and take-home messages of the topic.

Discuss how increased fertilizer use during rainy summer months can affect the water quality of the Bay. Explain how fertilizer is not the only contributor to algal blooms. Illustrate how all sources of nutrient pollution combined will cause severe ecosystem damage.

GLOSSARY FOR TEACHER REFERENCE:

Estuary: a mixture of freshwater draining from the land and salty seawater

Algae: a simple, nonflowering and typically aquatic plant

Independent Variable: the variable you CAN control, and when you control or make changes to the variable, it affects what happens to the dependent variable.

Example: In an experiment on the effect of light on plant growth, you CAN control how much light the plant receives (putting it near a window or in a closet).

Dependent Variable: the variable you CANNOT control; it is the variable that you observe and measure.

Example: In an experiment on the effect of light on plant growth, you CANNOT control how much the plant grows as a result of light exposure. You can only measure how much the plant grows in the closet or by the window.

Eutrophication: excessive nutrients in a body of water, frequently due to runoff from the land, which causes a dense growth of plant life and decreases in oxygen levels

Nutrient: a substance that provides nourishment essential for the maintenance of life and for growth.

Point source pollution: the direct deposit of pollutants into a water body from an identifiable source such as a sewage treatment plant or a factory.

Non-point source pollution: a source of pollution which is not generated from a single entity rather from several sources, making it hard to distinguish its origin. (i.e. result of stormwater or fertilizer runoff).

THE FERTILIZER FOOTPRINT: CREATING A POLLUTED BAYName/s

This assignment will further your understanding as to how the quality of the water (specifically in Biscayne Bay) has changed as a result of human impact and nutrient pollution.

Materials

- Clear plastic container
- Water
- Blue food coloring (representing nitrogen)
- Yellow food coloring (representing phosphorus)
- Dish Soap (representing mystery pollutant)
- STUDENT LAB WORKSHEET: "Fertilizer Footprint: Creating a Polluted Bay"
- STUDENT HOMEWORK WORKSHEET: "Fertilizer Nutrient Pollution"
- Camera or Smartphone

Directions

1. Fill the container to the brim with water from the sink.
2. Take a photo of the water in the container. Make observations. What does the water look like?
3. Add (1) drop of blue food coloring to the water. Continue to document your observations under Trial I in the Observations section. How has it changed from the base water quality (the container with just water). Do not stir.
4. Take a picture of the water in the container.
5. Add (1) drop of yellow food coloring to the water. Continue to document your observations under Trial II. How has it changed from the base water quality? Do not stir.
6. Take a picture of the water in the container.
7. Repeat steps 3 through 6, 2 times.
8. Add (1) tsp. of dish soap. Stir gently.
9. Take a photo and document observations under Trial III..
10. Repeat steps 8 through 9, 2 times.
11. Collect photos and analyze the differences/similarities among group members.
12. Once questions are completed, hand worksheet in (1 per group) and email/show photos to the instructor.

Definitions for Reference

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Questions

1. Which material/s represent/s the independent variable/s? Explain.
2. Which material/s represent/s the dependent variable/s? What does this material represent in the real world?
3. Can you think of any other variables in Biscayne Bay that may also impact the quality of the water? What kind of pollutant could the “mystery pollutant” dish soap serve as?
4. How does this experiment represent what is happening in Biscayne Bay? How does this experiment fail to represent what’s happening in the Bay regarding fertilizer? Was this model too simplified?

Observations

Trial I.

Trial II.

Trial III.

THE FERTILIZER FOOTPRINT: CREATING A POLLUTED BAY (LAB QUESTIONS)

1. Which material/s represent/s the independent variable/s? Explain.
 - a. *Food coloring and dish soap.*
 - b. *These resemble Nitrogen, Phosphorus, and a mystery pollutant.*

2. Which material/s represent/s the independent variable/s? What does this material represent in the real world?
 - a. *Water. Biscayne Bay or other body of water.*
 - b. *“Water quality” is dependent on how much food coloring and dish soap is applied.*

3. Can you think of any other variables in Biscayne Bay that may also impact the quality of the water? What kind of pollutant could the “mystery pollutant” dish soap serve as?
 - a. *Plastic + marine debris, stormwater runoff, leaky sewage pipes, pet waste.*
 - b. *The dish soap could serve as any of the above.*

4. How does this experiment represent what is happening in Biscayne Bay? How does this experiment fail to represent what’s happening in the Bay regarding fertilizer? Was this model too simplified?
 - a. *There are so many different kinds of pollutants entering the Bay and other water bodies. While fertilizer is a significant contributor, it is not the only source. This makes the situation very complex and perhaps makes the model a bit simplified.*

FERTILIZER & NUTRIENT POLLUTION

1. What is the predominant nutrient that is making its way into the Bay?
 - a. Nitrogen
 - b. Phosphorus
 - c. Sulfur
 - d. Both A and B

2. What is/are the cause/s of nutrient pollution?
 - a. Pet Waste
 - b. Debris
 - c. Fertilizer overuse
 - d. All of the above

3. Circle the impacts improper fertilizer use has:
 - a. Algae blooms
 - b. Habitat loss
 - c. Increase in invasive species
 - d. All of the above
 - e. Both A and B

4. How can a single person take action to reduce nonpoint sources of fertilizer pollution? Hint: Watch Miami Waterkeeper's Mr. Fertilizer Video.

In this case, they could limit use of fertilizer during rainy summer months and would not apply fertilizer when you know it's going to rain.

**Any of the (4) action items at the end of the powerpoint would be appropriate answers.*

 1. Use less fertilizer, and use Phosphorus free fertilizer when you can.
 2. Make sure to apply fertilizer a minimum of 15 feet from drains or waterways.
 3. Only use fertilizer when you know it isn't going to rain.
 4. In fact, you should skip fertilizing entirely during the rainy summer months from June - September.

5. Do we need a fertilizer ordinance? What can we do (individually and as a community) do to restore and protect the future of Biscayne Bay?

Yes, we do! Fertilizers contain nutrients like nitrogen and phosphorus to make plants grow, but when too much fertilizer is applied to the land, it runs off into our waterways and can cause big problems like algae blooms. Algae blooms can kill wildlife, smother seagrass, turn our beautiful blue water green, and can become harmful to human health. Biscayne Bay is particularly sensitive to algae blooms, and data shows we are at a tipping point where more nutrients will start causing serious blooms.

You can make sure you and your family practice responsible fertilizer use (limiting use during rainy summer months, applying slow release, etc.).

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