



Lesson Plan

EARTHECHO
EXPEDITIONS

Dead Zones Around the World

Objectives

As a result of these activities students will be able to:

- utilize Google's My Maps to analyze complex data sets
- identify the factors that increase and decrease eutrophication around the country.

Next Generation Science Standards

- **MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem
- **MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services

Materials

- Computer or tablet with Internet access
- [Coastal Eutrophication Data Set \(http://bit.ly/WRIUS\)](http://bit.ly/WRIUS)

This is a Google Sheet, it can be downloaded as an Excel document or saved to your own Google Drive:

- o To download as an Excel document: File -> Download As -> Excel
- o To save to your own drive: File -> Make a Copy, the new file will appear in your Drive

Teacher Background

In *EarthEcho Expedition: Into the Dead Zone*, Philippe Cousteau Jr. examines the causes of *dead zones* within the Chesapeake Bay watershed. With more than 400 identified, recurring dead zones across the world this problem persists in many areas outside of the Chesapeake Bay Watershed.

Dead Zones are areas of water with very low to no levels of dissolved oxygen and are overwhelmingly the result of human activity. Dead Zones occur when the excess nutrients nitrogen and phosphorus from fertilizers, stormwater, sewage, and even air pollution run off of land and into the water. High nutrient concentrations spur the rapid growth of algae, creating large algal blooms. As these blooms die off they consume much of the available oxygen in the waterway, creating a *hypoxic* (low oxygen) or even *anoxic* (no oxygen) state. This process of algae growth and die off is known as *eutrophication*.

Dead Zones (hypoxic and anoxic events) are often seasonal, peaking during the warmest months of the year. This can be attributed to an increase of human activity in warmer months, higher fertilizer usage, and heavier rains. The warm temperature of waters also plays a role in dead zone formation, as warmer water holds less dissolved oxygen than cooler water.

In this lesson plan, you will use a data set compiled by the World Resources Institute. We have edited the data, for faster upload, to contain only data points of US Monitoring sites. If you are outside of the United States, there is data available for most coastal nations through the World Resources Institute. Download the complete data set [here](#) and explore data for countries near you.



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Vocabulary

Anoxia - Waterways with no dissolved oxygen, most often as a result of eutrophication.

Dead Zone - An area of water devoid of life due to low or no levels of dissolved oxygen.

Dissolved Oxygen - Oxygen that is dissolved within the water column and accessible to aquatic animals, measured in parts per million (ppm).

Eutrophication - The enrichment of bodies of water by inorganic plant nutrients (e.g. nitrate, phosphate). It may occur naturally but is often the result of human activity.

Hypoxia - Waterways with an extremely low dissolved oxygen concentration, less than 2-3 ppm. Excess nutrients and eutrophication promote algal growth; as algae die off and decompose, oxygen is consumed, resulting in low levels of oxygen.

Data Trend - A pattern observed in data points.

Engage

1. Have students watch [Expedition: Into the Dead Zone: What is a Dead Zone?](#) Paying particular attention to the causes of dead zones around the world.
2. The accompanying [worksheet](#) may be helpful to students as they practice their critical viewing skills.
3. Allow students time to walk through [this Eutrophication Model](#) from the Center for Ocean Sciences Education Excellence.
4. Ask students to hypothesize how common eutrophic and hypoxic events are around the United States.

Explore

Review definitions of hypoxia and eutrophication, ensuring that students can differentiate between the two. Ask students to identify what they believe are causes of eutrophication and, ultimately, hypoxia. Students do not need detailed explanations at this point, but they should be able to identify nutrient runoff as a major factor contributing to eutrophication.

Based on device availability, work together as a classroom or have students work in groups or independently.

Provide students with the Excel document or a link to the US Coastal Data for Eutrophic and Hypoxic event from the World Resources Institute. The Excel document is recommended if you are not a district that utilizes Google Drive and Google Apps for Education. Students will now import this data to create a map in My Maps.



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Directions for Inputting Data

1. Visit mymaps.google.com and sign in to a Google account.
2. Select “Create New Map” option.
3. Name the map by clicking on “Untitled Map.”
4. Select the “Import Data” option under “Layer 1.”
5. Upload the Excel file or import from the Google drive, depending on where your data set is saved.
6. Google will ask you to confirm the column being used for location data; “Lat” and “Long” should be preselected.
7. Choose which column to use for naming your placemarkers--we suggest “System.”

Allow students 10 minutes to explore the data visualization freely, suggest they:

- click on placemarkers
- exploring different locations
- sort or filter the data to make further observations.

Bring the class back together and ask students to color code their placemarkers by decade.

1. Click “Uniform Style” under the layer name in the left task bar.
2. In the “Group Places By” dropdown, select “Decade.”

Placemarkers will be colored by decade for each decade that there is data. This data set ends in 2009, so the most recent decade is listed as “2000.”

Explain

Be sure that all students can define eutrophication and hypoxia and articulate the difference between the two.

Engage the class in a discussion about the map with a focus on changes by decade.

What trends are you seeing in the map data? In which decades are eutrophic/hypoxic events most prevalent?

What factors are likely contributing to an increase in eutrophic/hypoxic events?

Are there other trends you noticed while exploring the map?

Elaborate

Have students sort the map data by “Hypoxic Current.” This will sort placemarkers by color based on how often they experience eutrophic or hypoxic events. Have students examine the different categories into which this sorts placemarkers . Focus specifically on sites noted as “improved.” Give students time to click on various improved placemarkers and read about their systems.

What factors are contributing the improvement of water systems nationwide?



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Now, bring the discussion closer to home. Ask students if they have any evidence that water systems near you experience eutrophic or hypoxic events. Based on what they have learned about eutrophication so far, *what activities in your region could contribute to eutrophication?*

Ask students,

Which watershed are we a part of? Where does our water ultimately end up?

If you or your students do not know your watershed, you can use this [interactive map](#) from USGS.

Have students return to the map with a focus on events located within your watershed. If your watershed does not end somewhere coastal (i.e. Great Lakes) the World Resources Institute does not have data for your area. Try doing some research on your own, as hypoxic and eutrophic events are not solely a coastal problem.

Are there eutrophic/hypoxic events in our watershed?

What is occurring within our watershed that could be causing or curbing hypoxic and eutrophic events?

What sort of effect are eutrophic and hypoxic events likely to have on local aquatic populations?

Evaluate

As a class, in small groups, or individually have students answer the following questions.

Are eutrophic events increasing or decreasing overall in the US? Why do you think that may be?

How can visualizing data in this way help you understand "trends"?

Why is it important to look at data over time? Over large geographic space?

Have students design simple watershed models highlighting the relationship between land use and potential eutrophication events. Models could be in the form of 2D drawings, computer-generated, or physical 3D models. Well-designed models will display the correlation between increased use of land for agricultural and urban purpose and eutrophic events. Get creative and place as many or as few restrictions on this project as you would like!

Extend: Additional Activities

Divide students into groups and have each group examine data from a different country or region (i.e. Chesapeake Bay, Gulf Of Mexico, Baltic Sea, etc).

What differences are seen in the distribution of eutrophic and hypoxic events worldwide?

Are there areas where they are more common? Why might this be?

Does the rest of the world follow a similar time pattern as the United States (more occurrences after 1980)?

Have students or groups of students chose an "improved" system (one that is experiencing less or no longer experiencing) eutrophic and hypoxic events. Students should research factors that have led to these improved conditions.

Were there laws or policies that were passed?

Were wetlands or large areas of riparian buffer restored?

Did business or industry move out of the system's watershed?