

OOI Data Lab Lesson Plan: Anoxic Events

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Time required: This lab requires a minimum of 1.5 hours. With additional optional discussions and demonstrations, this lab could take up to 2 hours.

Assumed prior knowledge: This lesson is appropriate for 100-level undergraduate students or advanced high school students who are taking or have completed an introductory oceanography course. Students should be familiar with the concepts of stratification, dissolved oxygen, Ekman transport, and coastal upwelling.

Equipment required: Access to computers with internet connection, preferably one computer per student or per pair of students.

Pre-class prep: Print out the Anoxic Events Worksheets

Pre-class assignment:

Assign students one of the following hypoxic locations. They will research their location and prepare a 1-3 minute informal overview for the next class. Locations: Gulf of Mexico, Lake Erie, Chesapeake Bay, Hood Canal, Baltic Sea

Lesson Overview:

Pre-class assignment review:

Mix groups so each has only 1-2 people per location. Have the students share information with each other for about 10 minutes. As a class, discuss:

- The difference between hypoxia and anoxia
- Why hypoxia/anoxia is important
- What causes hypoxia/anoxia. Make a list on the whiteboard, separated into biological and physical processes. Examples of biological processes include phytoplankton blooms and excess nutrient input. Examples of physical processes include stratification and upwelling. Make sure to mention upwelling and briefly explain what it is.

Part 1: Introduction

- Show students [this video](#) showing a crab kill due to hypoxia and propose the question – What is happening with hypoxia off the Oregon coast?
- Hand out Pages 1 and 2 of the worksheet. Have students complete Questions 1 and 2 in pairs, then discuss as a class.

Part 2: Data Exploration

Direct students to the [OOI Anoxic Events data lab website](#). Give them about 5 minutes to look through the graphs on their own.

- Explain that for the wind speed graph, when values are above zero the wind is blowing from the south to the north. When values are below zero the wind is blowing from the north to the south.
- In pairs, have students answer Questions 3 and 4, then discuss as a group.
- In pairs, have students answer Question 5. Students may be confused by the terminology (i.e., *southward* wind goes towards the south by a *southerly* wind comes from the south). Draw an example of a southward wind.
- In pairs, have students answer Questions 6 and 7. Do not go over Question 6 yet. Have student groups share their answers to Question 7, but do not give away the answer yet.

Part 3 – Putting It Together

- Hand out Page 3 of the worksheet
- Have students answer Questions 8 and 9 in pairs. Go over Question 8 and make sure all students got this correct. Discuss Question 9, but do not give the answer yet.
 - Option here to show a video of the Coriolis effect and/or discuss the Coriolis effect and Ekman transport in more detail.
- Hand out Page 4 of the worksheet.
- Have students answer Questions 10 and 11 in pairs, then discuss as a class. Make sure all students got the right answer.

Part 4 – Seasonal Patterns

- Hand out page two of the data lab worksheet. Give students 5-10 minutes to look at the <https://earth.nullschool.net> website before directing them to fill out the questions on page two in pairs.
 - If time, discuss why wind direction changes with seasons
 - Make sure to note that these seasonal wind directions are overall seasonal patterns. Wind direction does shift from northward to southward within a season as well.

Homework

Students will read an article on researching hypoxia off the Oregon Coast. They may either write a short summary of the article or answer the multiple-choice questions below.

Giles, N. 2011. [Hypoxia, How is It Affecting Our Ocean Life, and Why?](#) Oregon Sea Grant. Corvallis, OR.

1. What equipment did Francis Chan use to study fish populations during Oregon coast anoxic events?
 - a. **Remotely operated vehicle (ROV)**
 - b. Bottom trawling

- c. SCUBA surveys
 - d. Gillnet
2. What species did Lorenzo Ciannelli observe behavioral changes in during low oxygen events?
- a. **English sole**
 - b. Chinook salmon
 - c. Quillback rockfish
 - d. Halibut
3. Francis Chan found that the population size of one species has increased with hypoxic conditions. What is that species?
- a. ***Pisaster brevispinus*** – Pink sea star
 - b. *Parastichopus californicus* - California sea cucumber
 - c. *Sebastes maliger* – Quillback rockfish
 - d. *Parophrys vetulus* – English sole