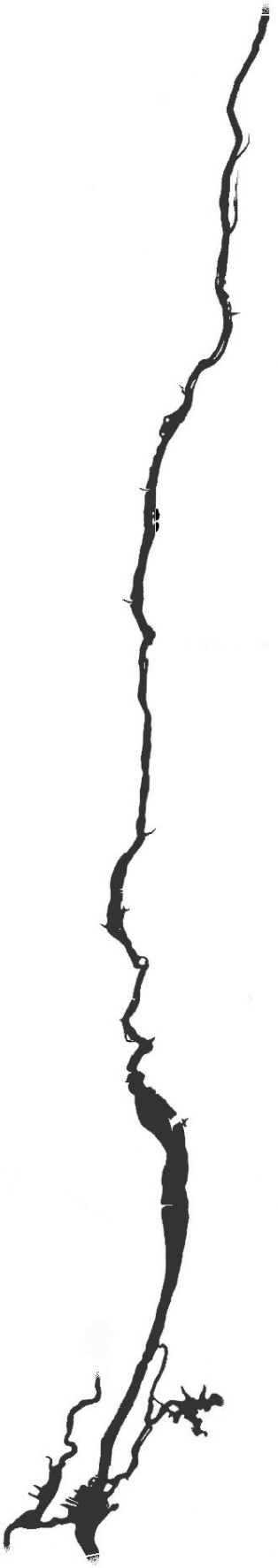


How Much Oxygen is in the Water?

Students will use real-time data posted on the World Wide Web to explore factors influencing the concentration of dissolved oxygen in Hudson River water.

Objectives: Using real time data from remote sensors in the Hudson River, students will:

- understand the critical role of dissolved oxygen in supporting aquatic life;
- observe and graph dissolved oxygen concentrations at sites along the Hudson River estuary;
- observe patterns of change in dissolved oxygen concentrations;
- identify environmental parameters correlated with dissolved oxygen concentrations
- suggest hypotheses to account for the observed changes in dissolved oxygen concentrations.

Grade level: Elementary (Grades 4-5)

Subject Area: Math, Science

New York State Learning Standards:
Mathematics, Science, & Technology Standards 1, 2, 3, 4

Skills:

- Describing how plants and animals depend upon each other and the nonliving environment;
- Analyzing problems by observing patterns;
- Analyzing problems by identifying relationships;
- Using charts, tables, and graphs as representations.

Duration:
Preparation time: 5 minutes
Activity time: 45 minutes

Materials: Each student or small group of students should have:

- ☐ Worksheet: How Much Oxygen is in the Water?
- ☐ Pencil
- ☐ A computer with Internet access

Background:
(This text is adapted from Chapter 9 of the U.S. Environmental Protection Agency's Volunteer Estuary Monitoring Manual, A Methods Manual, Second Edition, EPA-842-B-06-003. The full document be downloaded from: https://www.epa.gov/nep/volunteer-estuary-monitoring-methods-manual).

Of all the parameters that characterize an estuary, the amount of oxygen dissolved in its waters is one of the best indicators of the estuary's health. An estuary with little or no dissolved oxygen [DO] cannot support healthy levels of animal or plant life.

Animals and plants require oxygen for respiration—a process critical for basic metabolic processes. In addition to its use in respiration, oxygen aids decomposition. An integral part of an estuary's ecological cycle is the breakdown of organic matter by bacteria and other decomposers. Like animal and plant respiration, this process consumes oxygen.

Children sometimes assume that the oxygen being discussed here is the oxygen in the water molecule – H_2O. That is not the case; dissolved oxygen is in the same form as oxygen in the air – two atoms of oxygen attached to one another in the molecule O_2.

Oxygen levels may change slowly over the seasons or sharply in a matter of hours in response to physical, chemical, and biological factors. Water temperature is critical; cold water can hold more DO than warm water. Wave action due to winds and currents encourages oxygen in the air to dissolve in the water. Sunlight is very important; it drives photosynthesis, in which plants produce oxygen. As night falls, photosynthesis ceases and plants join animals and bacteria in consuming available oxygen, causing a drop in DO levels. Cloudy weather may also cause DO levels to drop; the reduced sunlight slows photosynthesis. Salt water absorbs less oxygen than fresh water; seawater at 10°C can hold a maximum DO concentration of 9.0 mg/l, while fresh water at the same temperature can hold 11.3 mg/l).

Most animals and plants can grow and reproduce unimpaired when DO levels exceed 5 mg/L. When levels drop to 3-5 mg/L, however, living organisms often become stressed. At levels below 3 mg/L, a condition known as hypoxia, many species will move elsewhere and immobile species may die. Anoxia occurs when the water becomes totally depleted of oxygen (below 0.5 mg/L) and results in the death of any organism that requires oxygen for survival.

Activity:
1. For the draft worksheet used in this teacher workshop, staff explored the HRECOS website to find examples of the phenomena being discussed. The teacher will need to do the same in preparation for doing the activity in the classroom, making appropriate choices for sites, units, and dates. In the worksheet, the points where the teacher should customize choices are shown in ***bold italics***. To become familiar with the HRECOS website, the teacher should review the HRECOS Scavenger Hunt activity.
2. This activity is best done in class (either on a Smartboard or using a projector to display the website on a large screen) or in a computer lab.
3. With the students, review the importance of DO concentrations to the river's health, and go over vocabulary terms as necessary.

Assessment:
Select data from other sites or dates that show the same patterns explored in this worksheet. Have students explain the resulting graphs in class or on a quiz.

Vocabulary:
concentration: the amount of an ingredient in a given volume of liquid or other substance
dissolve: to go into solution, as salt does in water
estuary: a body of water in which fresh and salt water meet
fresh water: water that is not salty
gill: in fish and other animals living in water, an organ used to draw oxygen from water
hypothesis: a possible explanation for why things happen in a certain way
oxygen: an element found as a tasteless, odorless gas in the air; it is vital to the survival of most forms of life
parameter: something that can be measured to provide information about the environment
photosynthesis: the process by which green plants use carbon dioxide, water, and the energy in sunlight to produce sugars and oxygen
station: in science, a place where measurements are made and recorded

Resources:
https://www.hrecos.orgThe Hudson River Environmental Conditions Observing System (HRECOS) is a network of real-time monitoring stations on the Hudson River Estuary. The stations are geographically distributed from Schodack Island to the New York/New Jersey harbor and monitor river conditions every quarter hour. This data is posted to a website that allows users to create graphs displaying trends in the parameters measured. HRECOS is operated by a consortium of many partners from government and the research community and is funded by the USEPA, NOAA, Hudson River Foundation, and the Hudson River Estuary Program of the NYS Department of Environmental Conservation.

https://lamont.columbia.edu/education-outreach/school-programs-day-in-life-hudson This site posts data gathered by students at sites from New York City to Troy during DEC's annual Day In the Life of the Hudson River event, including dissolved oxygen concentrations.

Students will be provided with a curated dataset of Norrie Point hydrological and meteorological data to complete the activity. Within the dataset, students will be able to select specific dates and parameters to create graphs that will answer the activity questions.

Name _____ Date_____

How Much Oxygen is in the Water?

Breathe in. Breathe out. Breathe in. Breathe out. We do this all the time, and scarcely ever think about it. When we do, we recognize that the air we breathe contains a substance vital to life – oxygen. Animals require oxygen to survive. So do plants, even though they produce oxygen through photosynthesis.

Fish and other animals that live in water also need oxygen. Like salt or sugar, oxygen dissolves in water. It is invisible in water, just as it is in the air. But when a fish opens its mouth, taking in water to breathe, dissolved oxygen enters the fish's body as the water passes over the animal's gills.

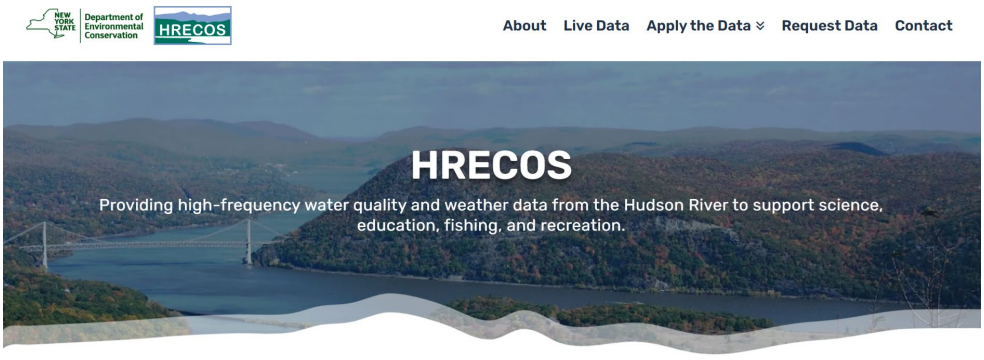
The amount of dissolved oxygen (often abbreviated as DO) present in water – its concentration - is an important measure of how healthy the water is. Scientists measure this concentration in units of milligrams per liter (mg/L), which is the weight of oxygen in a set volume—one liter—of water.

Most animals and plants in the Hudson River will be fine when DO levels are above 5 mg/L. When concentrations drop to 3-5 mg/L, however, they often become stressed. If levels fall below 3 mg/l, many animals will move elsewhere, while animals and plants that cannot move may die.

Dissolved oxygen concentrations may change slowly over the seasons or quickly in a few hours. These changes have many causes. Water temperature is one; cold water can hold more oxygen than warm water. Strong winds whip up waves that mix oxygen from the air into water near the surface of the river. Sunlight is very important; it is necessary for photosynthesis, in which plants produce oxygen. At night, photosynthesis stops and plants join animals in taking in oxygen, causing a drop in its concentration. Cloudy weather may lower DO levels; the reduced sunlight slows photosynthesis.

To keep track of these changes, scientists have placed instruments in the water to measure DO concentrations. That information goes to the website of the Hudson River Environmental Conditions Observing System, or HRECOS for short. You will use this website to explore how DO levels change in the Hudson.

Open your browser and type in the address for the HRECOS website: www.hrecos.org. Click on 'Live Data' to access live dashboards for several HRECOS sites.



A. Do dissolved oxygen concentrations change with the seasons?

1. **Parameter 1:** In the dataset, select the "Part A Parameter 1 & 2" tab. From the list of parameters, we will focus on temperature, or "Temp".
2. **Start Date:** August 1st, 2018.
3. **End Date:** *October 1, 2018.*
4. Before going any further, predict what will happen to water temperatures at ***Norrie Point*** between ***August 1*** and ***October 1***.
5. ***Create Graph***: Highlight columns A and B, go to the 'Insert' tab, then 'Charts' and create a 2D line graph to display the data.

6. Does water temperature do what you expected? Why or why not?

How might the changes in water temperature that you see from August 1 to October 1 influence dissolved oxygen levels? Let's find out.

7. **Parameter 2:** In the dataset, select the "Norrie Hydro" tab. From the list of parameters, we will focus on "Dissolved Oxygen", or "DO" in the dataset.
8. **Start Date:** August 1st, 2018.
9. **End Date:** *October 1, 2018.*
10. Before going any further, predict what will happen to dissolved oxygen concentrations at ***Norrie Point*** between ***August 1*** and ***October 1***.
11. **Create Graph**: Highlight columns A and B, then go to the 'Insert' tab, then 'Charts' and create a 2D line graph to display the data.
12. Does the dissolved oxygen concentration do what you expected? Why or why not?
13. **Challenge question:** Predict what would happen to water temperature and dissolved oxygen concentrations the Hudson between ***May 1 and July 1***. Then use the HRECOS site to see if your prediction is correct.

B. Do dissolved oxygen concentrations change during the day?

We've seen that there is a seasonal pattern in dissolved oxygen concentrations. Might there be a daily pattern in DO concentrations?

1. **Parameter 1**: In the dataset, select the "Norrie Hydro" tab. From the list of parameters, we will focus on "Dissolved Oxygen", or "DO" in the dataset.
2. **Start Date:** *September 15, 2018.*
3. **End Date:** *September 18, 2018.*

4. What happens to dissolved oxygen concentrations over 24 hours? Does this pattern repeat each day?

C. Why do DO concentrations follow this pattern?

1. **Station 2**: Select the 'Norrie Met' tab.
2. **Parameter 2**: Which two of the parameters in the data set are most likely to cause the pattern you see in dissolved oxygen concentrations? Why?

3. Select one of the two parameters and create a graph plotting DO and this parameter from September 15, 2018 to September 18, 2018.

4. Does this parameter have an effect on DO? If so, why?

5. Go to **Parameter 2** again. Select the other parameter likely to cause the pattern you see in dissolved oxygen concentrations. Leave other settings as they are.

6. Create a graph plotting DO and this parameter from September 15, 2018 to September 18, 2018.
7. Does this second parameter have an effect on DO? If so, why?

8. Which parameter has the greater effect on DO concentration? Hint: One of the parameters does the same thing every day; the other is stronger for the first two days and weaker for the second two. Does that change have any effect on DO concentrations?

9. Are any of the DO concentrations you've seen low enough to cause problems for fish and other organisms that live in the Hudson?