

**Lesson Summary:** The students will learn the importance of dissolved oxygen (DO) has in aquatic ecosystems and how to measure DO. They will also learn how climate change might cause DO levels to change. Finally, they will gain experience with the Water Atlas as a research tool.

**Grade Level:** Middle/High School (7<sup>th</sup> – 9<sup>th</sup> Grade)

**Time Allotted:** Two class periods (approximately 50 minutes each)

## Performance Objectives

*References are to the Next Generation Sunshine State Standards (2007).*

### 7<sup>th</sup> Grade Science

- SC.7.E.6.6 Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.
- SC.7.L.17.1 Explain and illustrate the roles of and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.
- SC.7.L.17.2 Compare and contrast the relationships among organisms such as mutualism, predation, parasitism, competition, and commensalism.
- SC.7.L.17.3 Describe and investigate various limiting factors in the local ecosystem and their impact on native populations, including food, shelter, water, space, disease, parasitism, predation, and nesting sites.

### 8<sup>th</sup> Grade Science

- SC.8.L.18.1 Describe and investigate the process of photosynthesis, such as the roles of light, carbon dioxide, water and chlorophyll; production of food; release of oxygen.

### 9<sup>th</sup> Grade Science

- SC.912.L.17.4 Describe changes in ecosystems resulting from seasonal variations, climate change and succession.
- SC.912.L.17.7 Characterize the biotic and abiotic components that define freshwater systems, marine systems and terrestrial systems.
- SC.912.L.17.13 Discuss the need for adequate monitoring of environmental parameters when making policy decisions.
- SC.912.L.17.15 Discuss the effects of technology on environmental quality.
- SC.912.L.17.16 Discuss the large-scale environmental impacts resulting from human activity, including waste spills, oil spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.

- SC.912.L.17.18 Describe how human population size and resource use relate to environmental quality.
- SC.912.L.17.20 Predict the impact of individuals on environmental systems and examine how human lifestyles affect sustainability.

### **Prior Knowledge**

None. A basic understanding of cellular respiration and the use of oxygen by living organisms will be helpful, but is not required.

### **Overview**

One source of water degradation is increased water temperature. High water temperatures can lead to a bloom in microbial populations, which can have a negative impact on human health. Additionally, the rise in water temperature can adversely affect different inhabitants of the ecosystem due to a species' sensitivity to temperature. The health of an aquatic ecosystem is dependent upon its ability to effectively self-purify through biodegradation, which is hindered when there is a reduced amount of dissolved oxygen. When water warms, its ability to hold oxygen decreases.

### **Key Vocabulary**

#### **Climate**

The long-term average of conditions in the atmosphere, ocean, and ice sheets and sea ice described by statistics, such as means and extremes.

#### **Climate change**

A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic (human-caused) changes in the composition of the atmosphere or in land use.

#### **Dissolved oxygen**

The oxygen freely available in water that is vital to the existence of fish and other aquatic life. It is considered the single most important indicator of a water body's ability to support desirable aquatic life.

#### **Hypothesis**

A testable explanation for observed phenomena. A scientific hypothesis should be testable and measurable; if a hypothesis states "If A happens, then B will occur," then you will need some way to quantify A and measure B as it happens.

## Pollution

Generally, the presence of matter or energy whose nature, location, or quantity produces harmful or undesired environmental effects on humans, animals, or plants.

## Materials

- Fresh water sample from a local lake or pond
- Assorted beakers and other glassware (each group will need 3 beakers and they should be at least 200 ml in size, though 500 ml would be even better, and they will need graduated cylinders and funnels to measure the water)
- Dissecting microscope and hand lenses
- Dissolved Oxygen test kit, like the one found here:  
<http://www.hach.com/hc/search.product.details.invoker/PackagingCode=146900/NewLinkLabel=Dissolved+Oxygen+Test+Kit,+Model+OX-2P,+Drop+Count+Titration,+100+tests>
- Petri dishes
- Pipettes
- Fish tank pumps and tubing with a t-connection so the tubing can provide air to 2 beakers
- Air regulators for Beaker #2 (or a paper clip to crimp tubing)
- Computer with internet access.

## References

*These references are available on the Orange County Water Atlas:*

[A Beginner's Guide to Water Management](#): Oxygen and Temperature. 2004. Florida LAKEWATCH, University of Florida Institute of Food and Agricultural Sciences.

[Climate Literacy: The Essential Principles of Climate Sciences](#). 2009. U.S. Global Change Research Program.

[Learn More: Dissolved Oxygen](#). Orange County Water Atlas.

*Other references:*

[Climate Institute Topics/Core Issues: Water](#). 2007. The Climate Institute.

Cook, John. [Skeptical Science: Getting Skeptical About Global Warming Skepticism](#). Website. Accessed June 2011.

[Hey, It's Your Backyard](#) (Curriculum website). 2001. MIT Center for Environmental Health Sciences and the National Institute of Health Sciences.

[Intergovernmental Panel on Climate Change](#). Website. Accessed June 2011.

[Orlando Wetlands Park](#). City of Orlando website. Accessed June 2011.

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[Power Up Florida](#) (Orlando/Orange County web portal to sites for electrical efficiency, solar usage, electric vehicles, clean technology, Climate Change Education Center, etc.). Accessed July 2011.

Stanton, Elizabeth K., and Frank Ackerman. [Florida and Climate Change: The Cost of Inaction](#). 2007. Tufts University Global Development and Environment Institute and Stockholm Environment Institute—US Center.

[A Student's Guide to Climate Change](#). Website. Environmental Protection Agency. Accessed June 2011.

[Water Properties: Dissolved Oxygen](#) (webpage). 2011. U.S. Geological Survey Water Science for Schools.

## Procedure – Day 1

### Engage/Elicit

Begin by asking the students if they have ever wondered how different pollutants affect the water quality of a lake or a pond? How do they think we might determine if a water body is healthy? After some brainstorming, tell the students that one measure of a lake or stream's health and productivity is the amount of dissolved oxygen (DO) in the water.

Tell the students that DO is vital to the health of a water ecosystem. Aquatic plants and animals require oxygen for their cellular respiration the same way that most terrestrial plants and animals require oxygen, and aquatic life gets its oxygen from the DO. DO can range from 0-18 parts per million (ppm), but most natural water systems require 5-6 parts per million to support a diverse population: too little DO and the aquatic life can't extract enough oxygen from the water to survive; too much and the oxygen can actually be toxic (kind of like when we hyperventilate).

Measuring DO levels in a body of water can give us an idea of how polluted the water might be. For example, when pollutants heavy in organic matter (like sewage) enter a body of water, the DO drops because as the organic material decomposes, microbes are eating away at the organic matter and increase in population due to abundant food supply. These microbes then, in turn, tend to use up more and more DO, causing the overall level of DO in the water to drop, decreasing the health of the water.

### Explore

After discussing DO and pollution, have the students go to the [Orange County Water Atlas](#) and look up lakes and streams near their school. They can either enter known names directly into the search box or you can direct them to click on certain names in the Water Resource Search list. On each body of water's page, they can look up the size and other salient feature of their lake (and you should encourage them to explore a little), but in particular they should look for the tab labeled "Water Quality" and once they click on that, they should click the Dissolved Oxygen link. Some bodies of water will not have DO levels available, so you may wish to look at the nearby lakes before class so that you can direct the students to the ones with the most complete information. The goal here is to give the students a sense of what the DO levels are like in the nearby bodies of water so that they have a point of comparison for the experiment that they are about to perform.

After students have looked up and recorded the DO for some nearby lakes and streams, tell them that you have collected some water from Lake X (whatever body of water is most convenient for you to reach) and that they will attempt to measure the DO in this water as well as see what they might be able to do to change the DO levels in water that is running low. (You may also wish to explain that the procedure they will use is not the only method of measuring dissolved oxygen; a sensor that uses electrodes at the water body also may be used.) Divide the students into groups of 4-5 and then have

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them conduct the following experiment (adapted from the [Hey, It's Your Backyard](#) website).

Instructions for students:

1. Your group will receive ~1000 ml sample of the water sample from Lake X.
2. Add a small amount of the sample to a petri dish (use a dropper for this to avoid making a mess) and observe the sample with a hand lens or dissecting microscope.
3. Provide a detailed description of the water sample. What types of organisms are found? Are the organisms living? Draw pictures and write descriptions as necessary.
4. Test the dissolved oxygen levels of the water sample in the petri dish using the kit provided to you (make sure to follow the instructions in the kit). What is the dissolved oxygen level? How does this compare to the value you found in the Water Atlas? If there is a difference between your results and the Water Atlas value, what are possible causes?
5. Separate the remaining water sample into the three beakers and label as follows:
6. Beaker #1—Control. No aeration.
7. Beaker #2—Slight aeration.
8. Beaker #3—Increased aeration.
9. Place Beaker #1, the control, in an area where it will not be disturbed for a 24-hour period. What do you expect will happen to the amount of DO in this container?
10. Connect three pieces tubing to the t-connector, and connect the base of the T to the outlet of the fish tank pump.
11. Plug in the fish tank pump and place the tubing in Beakers #2 and #3, with one tube end in each beaker.
12. To reduce the amount of air reaching Beaker #2, the tubing may be crimped slightly with a paper clip, or a regulator may be used.  
*Note: Beaker #2 should be receiving less air than beaker #3.*
13. Place Beakers #2 and #3 in an area where they will be undisturbed for a 24-hour period, and the air pump can remain plugged in and running.

If any time remains in the class period, allow the students to refine their hypotheses in class, or you can assign that as homework. They must each have a hypothesis prepared before completing the experiment tomorrow.

### Explain

Based on the initial levels of dissolved oxygen, hypothesize how the biological activity of each water sample will change over the 24 hour period. Will the number of organisms increase or decrease? Make sure your hypothesis includes a statement about the dissolved oxygen levels. Write your hypothesis in a journal.

### Extend

See Procedure—Day 2.

**Exchange/Evaluate**

See Procedure—Day 2.

**Procedure - Day 2**

**Engage/Elicit**

Begin by reminding the students what they did on Day 1. Ask them to share their hypotheses with their group before you finish the experiment and discuss any problems or questions they may have concerning their hypotheses.

**Explore**

Finish the experiment your class began yesterday.

1. After the 24 hour period, place a portion of each of the water samples from beakers 1, 2 and 3 in a petri dish and examine each under low and high power on a dissecting microscope. Provide a detailed description of each sample. Record your description in a journal.
2. Test the dissolved oxygen level of each sample and record it.

**Explain**

Now ask the students to consider the data they collected in light of their hypotheses. Does the data collected support the hypothesis? Why or why not? Have them write a short paragraph explaining how each water sample changed based on the dissolved oxygen levels and what they can conclude about the dissolved oxygen levels and biodiversity based on these observations.

Now have the students research the effects of decreased levels of dissolved oxygen on aquatic plants and animals. Begin by having them go to the Water Atlas and, under the Topics button on the navigation bar near the top of the screen, click on Water Quality. On the Water Quality screen, scroll down to Dissolved Oxygen and click on 'Learn More' to the right. Once they have read this section, they may continue to search the Water Atlas and any other resources you deem appropriate (see the list of references given earlier in this document for other potential sources). Have the students describe the causes of decreased oxygen levels and determine how these causes can be reduced or eliminated.

Finally have the students research what effects climate change might have on DO and water quality. They can use the Water Atlas and any other resources they deem appropriate.

**Extend**

Plan a class visit to the Orlando Wetlands Park in Christmas, Florida. How do the ponds there remove nutrients from the water? Write a story about your trip and what you saw and learned while there. Post it on the [Orange County Water Atlas Watershed Excursion](#).

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### Exchange/Evaluate

Have the students hand in their final lab report, including hypothesis, written observations, comparison to Water Atlas DO levels, and what they learned about DO and water quality. You will grade for completeness, accuracy (did they perform the test correctly), and if the hypothesis was reasonable/testable.

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