When the Oxygen is Gone

Adapted from: Activity 24 "When the oxygen is gone" in Living in Water. The National Aquarium in Baltimore. 1997

Grade Level: Intermediate

Duration: 1 class period

Setting: classroom

Summary: Students learn how oxygen levels affect behavior in goldfish.

Objectives: Students list ways animals respond to low oxygen environments.

Related Module Resources:
- Books: Aquatic Life

Vocabulary: thermal pollution, eutrophication

Materials (Included in Module):
- 2 – 1.7 quart containers filled with water boiled 10 minutes and then sealed; must be at room temperature before placing goldfish in jar
- 2 – 1.7 quart containers of aged tap water unsealed at room temperature
- Stopwatch
- Small fish net

Additional Materials (NOT Included in Module):
- 2 goldfish of the same size, approx. 1 inch (do **not** substitute other fish)

ACADEMIC STANDARDS: ENVIRONMENT & ECOLOGY

7th Grade

4.6.A Explain the flows of energy and matter from organism to organism within an ecosystem.
- demonstrate the dependency of living components in the ecosystem on the nonliving components
- identify the relationship of abiotic and biotic components and explain their interaction in an ecosystem

4.7.B Explain how species of living organisms adapt to their environment.
- explain how living things respond to changes in their environment

10th Grade

4.6.A Explain the biotic and abiotic components of an ecosystem and their interaction.
- describe how the availability of resources affects organisms in an ecosystem

4.7.C Identify and explain why adaptations can lead to specialization
- explain factors that could cause the size of a species' population to increase or decrease

12th Grade

4.1.C Analyze the parameters of a watershed.
- interpret physical, chemical and biological data as a means of assessing the environmental quality of a watershed

4.6.A Analyze the interdependence of an ecosystem.
- analyze the relationships among components of an ecosystem

BACKGROUND: Aquatic animals need oxygen to live. However, they do not get their oxygen the same way we do. Most aquatic organisms have specialized gills, which can remove dissolved oxygen from the water column. Others absorb the oxygen through their skin. Unfortunately, there are times when there is not enough dissolved oxygen in the water. When this occurs it is important that these animals respond in a way that will provide them the oxygen they need. Some fish will attempt to fan more water over their gills to get more oxygen. An even simpler response is for the animals to relocate to a place with more dissolved oxygen.

There are many factors, which affect the amount of dissolved oxygen in water. The most basic of these factors is the temperature of the water. Cold water can hold more oxygen than warm water. At lower temperatures, more oxygen can be dissolved in the water because the water molecules are moving slower and are more compact. When water is heated, the water molecules spread further apart and oxygen is released into the air.

Also at higher temperatures, the water molecules may move faster and bump out oxygen. Think of how the gases (carbon dioxide or the fizz) in soda pop eventually escape as it warms up.

The temperature of a waterway can be changed by both natural and unnatural causes. The varied amount of energy arriving from the sun at different times of year causes seasonal fluctuations in waterway temperatures. Even the change from day to night will cause natural changes in the water temperature. **Thermal pollution** is an unnatural change in water temperature caused by human actions. Discharge of water from industrial plants that is used to cool machinery is a major source of thermal pollution. Runoff from the hot pavement of parking lots and highways creates thermal water pollution as well. Removal of riparian forests that shade streams and rivers from the sun also causes temperature increases. Other actions of man such as building dams and lowering of water levels due to urban withdrawal result in warming of waterways. Urban areas may pull water out of nearby rivers for industrial use and human consumption, thus lowering the water level, which results in increased water temperature; shallow water heats up more quickly than deep water.

There are other factors besides temperature that effect the amount of dissolved oxygen that is in water. The addition of excess nutrients to a waterway can result in decreased dissolved oxygen levels by a process called **eutrophication**. Then these nutrients, often from agricultural fertilizers and lawn care products, are introduced into a waterway they cause rapid and excessive plant growth. Once these plants die they are decomposed that require large amounts of oxygen. Addition of other organic wastes such as human and livestock excrement, food processing waste, and industrial byproducts also result in decreased oxygen levels in the water, because the organic decomposition consumes oxygen.

OVERVIEW: Students will observe the different actions exhibited by fish in a low oxygen and normal oxygen environment.

PROCEDURE:

Teacher Preparation:

1. A few days prior to class, age a large volume of tap water (letting it set out for 48 hours) to rid chlorine from the water. You could use purchased spring water or gathered creek water instead.

2. Well before class, boil ½ of the above mentioned water. Boiling it will remove dissolved oxygen. After boiling for a few minutes, place water in a sealed container so that oxygen cannot enter. Do not shake containers. Allow containers to cool to room temperature. These containers are referred to as WATER WITH LOW OXYGEN in the experiment.

3. With the other ½ of the water, you should attempt to add extra oxygen to the water. Either add an aquarium aerator or have students mix the water. This water will also be placed into similar sealable containers as the boiled water using the same volume

of water (keeping experimental conditions similar). Students may shake these containers to add extra oxygen as well. These containers are referred to as WATER WITH OXYGEN in the experiment.

4. How many experimental sets you want to make and have students work with is up to you and depends on the number of fish you have or the number of sealable containers you have.

Student Experiment:

1. Students should work in groups because there are many observations that need to occur for this experiment.

2. Students will be placing a fish in a container of WATER WITH OXYGEN for <u>one</u> minute and making observations. Make sure some students are observing the number of times the fish opens its mouth or gill covers. Other students should count the number of times the fish rises to the surface for air. The amount of time for the experimental trial may be altered, but the teacher should determine if the amount of time is to change.

3. Carefully place a fish into the WATER WITH OXYGEN and record your observations on the data sheet.

4. Remove the fish and place it in the WATER WITH LOW OXYGEN container for <u>one</u> minute, making the same observations as before and recording them on the data sheet. Do not let fish stay in this low oxygen water for more than a few minutes – remove it and place it in an aquarium.

5. Repeat the above steps with a new fish (#2) and new containers of water.

<u>DISCUSSION</u>:

Place all observations on the board and discuss the different responses observed in the low oxygen environment as compared to the oxygen rich environment.

What did the goldfish in the low oxygen do to try and get the oxygen it needed? *The fish may have started swimming more quickly, may have kept going to the surface for air.*

Did the goldfish move around more when in one jar as compared to the other? *The fish in the low oxygen jar moved more than the fish in the normal water jar.*

What might other aquatic organisms do to try to get more oxygen? *They may increase the movement of water across their gills or move to an area of the water that has a higher oxygen concentration.*

EVALUATION:

- Describe how fish react to low oxygen concentrations in the water.

EXTENSIONS AND MODIFICATIONS:

- It is also possible to complete this activity by placing one goldfish in each of the different jars and placing them side by side to observe differences in activity.
- You may want to do this experiment with stonefly nymphs, who display a "push-up" action when they need more oxygen to flow over the gills (which are under their legs). You could see which jar causes the push-ups to occur first or more frequently.

NOTES (TEACHERS, PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

Activity Version*: March 2002*

DATA SHEET: WHEN THE OXYGEN IS GONE

Name_____Date_____

Amount of time for fish to be in the water: _____ minutes (keep consistent between all trials)

	Water with oxygen			**Water with LOW oxygen**		
	Number of times the mouth or gill covers open	Number of times fish rises to surface for air	Other observations	Number of times the mouth or gill covers open	Number of times fish rises to surface for air	Other observations
Fish #1						
Fish #2						
Average						

Other notes: