Mother Nature's Respirator

This activity is part of the Water Science theme

Purpose of this activity:

This activity teaches water science and discusses the physics of how oxygen (and gases) becomes dissolved in water for animal and plant life. It encourages students to evaluate the structure of habitats and the aquatic ecosystem and how impacts of their everyday actions have on the natural environment.

Key Messages:

- Learn how plants and animals respire.
- Understanding the physics of natural gas diffusion
- Understanding that even small changes in how we do things can conserve a lot of water.

Materials

- Aeration Tower
- Biomedia balls
- 5 perforated buckets, 1 non-perforated bucket
- Water Fall model
- Pump and air lines
- O_2 meter

Set Up Instructions

Model will be set up for volunteers. Instructions on how to use the Dissolved Oxygen meter will be provided. You will measure the dissolved oxygen in both the two different flows of water. Hang the bucket, containing the aeration balls, from the top of the frame of the aeration tower, creating a hanging chain.

What will I be doing?

You will be explaining how O_2 and gases become dissolved in water, how plants and animals respire, and how changing habitat can have a large impact on O_2 levels in water.

1. When the students arrive, have a discussion with them about the principles behind the respirator by asking questions and provoking thoughtful answers.
   Q: How do you think O_2 and other gases get into water?
   A: O_2 is dissolved into water through diffusion at the water surface as well as converted from carbon dioxide during photosynthesis of plants. In still water, the surface area for O_2 diffusion is much smaller than flowing water with ripples or waterfalls. Also, the energy created by waterfalls increases the ability of the water to accept O_2 molecules.
   Q: How does the level of O_2 in the water affect the animals and plants living in it?
   A: All living organisms need O_2 to live. The lower the levels the harder it is for plants and animals to breathe.
   Q: How can the environment and the weather affect the amount of O_2 in the water?
   A: High temperatures in the summer decrease the amount of dissolved O_2 in the water, meaning that there is more in the winter. Low air pressure, at high altitudes, also decreases the amount of dissolved O_2. Salt water cannot hold as much O_2 as fresh water.
   Q: What do these balls represent in nature?
   A: They represent the rocks that are found at the bottom of waterfalls. They increase the energy of the falling water to increase the amount of dissolved O_2 in the water.
   Q: Do you think that adding more buckets will increase, or decrease the amount of O_2 found in the water?
   A: More buckets should increase the O_2 levels.
2. Allow a student to measure the dissolved O_2 concentrations and temperature in the holding tank. Replace the empty bucket with the second bucket; turn on the pump until it is half full. Allow the students to measure the levels of the water and the holding tank.
3. Repeat the experiment by replacing the second bucket and placing the empty bucket with the forth bucket; turn on the pump until it is half full. Allow the students to measure the water and the holding tank.
4. Finally, put all the buckets into place and repeat the experiment. Again, allow the students to measure the O_2 concentrations of the water and the holding tank.
5. Have the students compare the values and facilitate a discussion of the results.

Background Information

Most living creatures require oxygen (O_2) to survive. This is true in an aquatic ecosystem as well. Aquatic plants and animals obtain O_2 that is dissolved in the water. Fish use their gills to extract O_2, and plants have special organs called stomata to extract O_2 from the water. Therefore, it is important that there is a lot of O_2 in a lake or river for these plants and animals to survive.

There are two basic ways for O_2 to become dissolved in water. The first is a result of photosynthesis by aquatic plants; these plants convert carbon dioxide to O_2. When the O_2 is released into the water, it becomes dissolved.

The second process is natural gas diffusion. Rivers run along the earth's surface creating channels. These channels are littered with rocks, plants and dirt. At the base of a waterfall, the water has eroded away all the soil, leaving a lot of large boulders and rocks. As the water crashes on top of the rocks, the impact splits the energy of the water droplet, breaking it apart. At this point, gases that are dissolved in water like nitrogen, hydrogen and carbon dioxide leave the water and enter the air. In response, O_2 can be dissolved in the water.

In the models, as water flows from one bucket to the next, you can see the water droplets bouncing off the rocks in each tank. You may even feel them. At this point the water is becoming more oxygenated, by absorbing O_2 out of the air.

Clean Up procedures

Tidy site/turn off pump/DO meter returned to centre.