Name _____ Date _____

Analyzing Watershed Health: Dissolved Oxygen Answer Key

Dissolved oxygen is the concentration of oxygen—the amount that is present in the water for a given volume of water. Scientists monitor the health of the Chesapeake Bay watershed by measuring the concentration levels of dissolved oxygen in the water. Dissolved oxygen is a water quality measurement that changes over time and depends on the temperature of the water and other factors. It is measured in mg/L. Scientists have determined that most living aquatic organisms need levels of 5 mg/L and above to survive.

- Levels above 5.0 mg/L are considered healthy for the Chesapeake Bay.
- Levels below 5.0 mg/L can create stress on the aquatic organisms.
- Levels between 0-0.2 mg/L are measures of a "dead zone" where no plants or animals can survive.

Underwater ecosystems are sensitive to changes in dissolved oxygen levels, and these levels can fluctuate greatly and be affected by human activities on land.

Part 1. Explore levels of dissolved oxygen in the Chesapeake Bay.

You will use FieldScope to analyze dissolved oxygen level data from the Chesapeake Bay. The data on the map has been collected from the Chesapeake Bay Interpretive Buoy System (CBIBS). These are 11 buoys around the bay that provide reliable information to scientists, boaters, and students. You will explore the average dissolved oxygen levels reported by CBIBS at each of these sites during the past 2-3 weeks.

1. Open the dissolved oxygen map in FieldScope: http://chesapeake.fieldscope.org/v3/maps/307

a. Which colors represent low dissolved oxygen? reds and oranges

b. Which colors represent high dissolved oxygen? blues and greens

Analyzing Watershed Health: Dissolved Oxygen Answer Key, continued

2. Where in the Chesapeake Bay watershed do you observe low dissolved oxygen levels? Why might this happen? Low dissolved oxygen levels can be observed near cities like Washington D.C. and Norfolk/Virginia Beach and up some of the tributaries. Urban centers have more impervious surfaces, so more nutrients may be entering the waterways, which could lower the levels of dissolved oxygen. Some of the tributaries could be closer to cropland or pastures where runoff could carry pollutants that lower the levels of dissolved oxygen. Also, this water is likely warmer (in summer) than oceanic water, reducing the amount of oxygen it can contain.

3. Where in the Chesapeake Bay watershed do you observe high dissolved oxygen levels? Why might this happen? High dissolved oxygen levels are observed in the center of the bay and at the mouth of the bay. Water in this area is a little farther from runoff from cities or farmland. It also is a little farther from land, so it may be cooler.

4. How do dissolved oxygen levels in the Chesapeake Bay vary? What is the range? From the average dissolved oxygen levels reported from the CBIBS buoys, it looks like there is a low of 7.87 mg/L near Norfolk and a high of 11.96 mg/L in the center of the bay. (NOTE: These values will vary depending on when the activity is completed.)

5. When dissolved oxygen is low, how do you think aquatic life is affected? When dissolved oxygen is low, organisms cannot get the oxygen they need to survive. Algal blooms may occur that block sunlight and prevent bay grasses from photosynthesizing, thus putting less oxygen into the water. This affects the organisms that feed on or nest in the bay grasses—either causing the organisms to die or relocate.

Analyzing Watershed Health: Dissolved Oxygen Answer Key, continued

Part 2. Examine data for dissolved oxygen at the selected sites.

❶ Go to the FieldScope map for dissolved oxygen: http://chesapeake.fieldscope.org/v3/maps/307

❷ Zoom in to the selected sites to identify levels of dissolved oxygen. An easy way to do this is to click on the search box (indicated by the magnifying glass icon) in the bottom right of the FieldScope screen. Enter the six sites, one at a time, in the search box.

When you click on the average dissolved oxygen circle, you will see a Data Summary table that includes the minimum and maximum dissolved oxygen levels for that site. Record your findings.

Site	Average Dissolved Oxygen (mg/L)	Minimum Dissolved Oxygen (mg/L)	Maximum Dissolved Oxygen (mg/L)
Annapolis, Anne Arundel County, Maryland	10.95**	8.61	13.89
Havre de Grace, Harford County, Maryland	8.79	5.60	13.60
Scotland, St. Mary's County, Maryland*	11.49	10.26	12.92
Alexandria, Alexandria County, Virginia	8.74	7.78	9.85
Norfolk, Virginia	7.87	5.98	11.13
Jamestown, Virginia	8.75	7.76	10.16

*Enter "Scotland, Maryland" in the Search box and select St. Mary's County.

** These levels will vary depending on time of year, weather conditions over the past 2-3 weeks, and other factors. However, students within the class should have similar values.

Analyzing Watershed Health: Dissolved Oxygen Answer Key, continued

3. Click on the average dissolved oxygen circle for Annapolis, Maryland. You should see a Data Summary table that includes the minimum and maximum dissolved oxygen levels for that site. In the table above, record the levels for Annapolis, Maryland. Do the same for the remainder of the sites.

4. In which sites that you have examined are the average dissolved oxygen levels healthy?

   Answers will vary. The data indicate that all sites have healthy levels of dissolved oxygen.

5. Are there sites where the average dissolved oxygen levels are unhealthy? What are they?

   Answers will vary. With this data, all sites have dissolved oxygen levels above 5 mg/L, which is considered healthy. However, two sites have minimum data points that are close to 5 mg/L. Havre de Grace, Maryland, has a minimum reported value of 5.60 mg/L, and Norfolk, Virginia, has a level of 5.98 mg/L.

Part 3. How does temperature affect dissolved oxygen?

1. Label each of three beakers:
   a. Beaker #1 (control)
   b. Beaker #2 (cool water)
   c. Beaker #3 (hot water)

2. Predict which beaker will have the most dissolved oxygen (DO) and which one will have the least.
   a. Most: Answers will vary.
   b. Least: Answers will vary.

3. Put several ice cubes in Beaker #2 and heat Beaker #3 on a hot plate until it is just about to boil. (Make sure you have your goggles on.)

Analyzing Watershed Health: Dissolved Oxygen Answer Key, continued

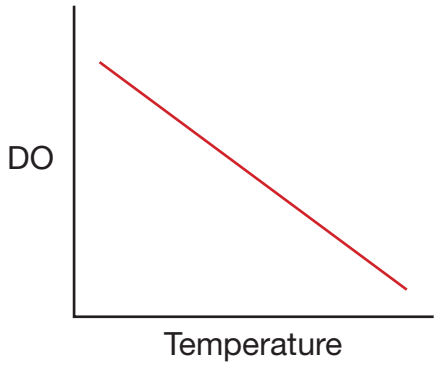
4. Remove the beaker from the hot plate and using a dissolved oxygen probe or test kit, measure the DO levels of all three beakers. Record your observations and data below.

Water Temperature	Dissolved Oxygen (mg/L)
Beaker #1 (control)	Answers will vary. (should be middle of range)
Beaker #2 (cool water)	Answers will vary. (should be highest)
Beaker #3 (hot water)	Answers will vary. (should be lowest)

5. Explain your observations. What do these investigations tell you about dissolved oxygen levels in the Chesapeake Bay watershed? Dissolved oxygen levels are lower in hot water and higher in cooler water. This means that we could observe higher levels of dissolved oxygen in areas where water in the Chesapeake Bay watershed is cooler and vice versa.

6. Finish the following sentence:
As temperature increases, dissolved oxygen decreases.

7. Draw a sketch of a line graph relating DO and temperature.



Analyzing Watershed Health: Dissolved Oxygen Answer Key, continued

8. Go to the graph Dissolved Oxygen (DO) vs. Water Temperature: http://chesapeake.fieldscope.org/v3/graphs/281 in FieldScope. Explore the relationship between DO and temperature for the Chesapeake Bay watershed. Does the graph in FieldScope match the sketch you drew in #7? Why or why not? Answers will vary. The graphs should be pretty similar because the Chesapeake Bay follows the same pattern as the lab experiment—as temperature increases, dissolved oxygen levels decrease.

Answer the following questions:

1. Where does oxygen in the water come from? From the air, due to surface exchange and from the products of photosynthesis through algae and marine plants.

2. How can we use DO to help describe water health? High levels of DO indicate healthy water for aquatic organisms. Low levels of DO indicate unhealthy water. If levels are too low, a dead zone could result.

3. Why is water with a low DO level considered unhealthy? High levels of DO are needed for aquatic wildlife to survive. If levels are too low, living organisms will not be able to survive, algae may increase, and plants will not be able to complete photosynthesis.

4. Most aquatic organisms require oxygen in the water column. All else being equal, where would you expect to find more stream organisms—in warm streams or cool streams? Why?

   More organisms are likely in cooler streams because there is probably a higher level of dissolved oxygen than in warmer streams.

Analyzing Watershed Health: Dissolved Oxygen Answer Key, continued

Part 4. Chesapeake Bay Action Plan Connection

❶ On your **Project Data Table,** record the average dissolved oxygen levels for each site. (Go back to Part 2, #2 of this worksheet, and copy the average levels of dissolved oxygen from the first column of this table to your larger Project Data Table.)

❷ Complete the first box on your **Decision Statement Planning Sheet** to identify the best site for an action plan based on levels of dissolved oxygen. Refer to your Stakeholder Table as well to help you make this decision.