Activity: Water Quality

Summary: In this activity, students will test water from Upper Newport Bay or other wetlands for dissolved oxygen, temperature, nitrate, phosphate, pH, and turbidity. Students will analyze the data from their experiments and discuss how various types of pollution affect Upper Newport Bay and other wetlands.

California State Content Standards

SCIENCE

Chemistry
- **Acids and Bases 5a**. Students know the observable properties of acids, bases, and salt solutions.
- **Acids and Bases 5d.** Students know how to use the pH scale to characterize acid and base solutions.

Biology/Life Sciences
- **Ecology 6b**. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.

Investigations & Experimentation
- **1a.** Students will select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data.
- **1b.** Students will identify and communicate sources of unavoidable experimental error.
- **1c.** Students will identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

ENGLISH-LANGUAGE ARTS

Grades 9-10

Reading Comprehension
- **Comprehension and Analysis of Grade-Level-Appropriate Text 2.6.** Demonstrate use of sophisticated learning tools by following technical directions (e.g., those found with graphic calculators and specialized software programs and in access guides to World Wide Web sites on the Internet).

Objectives:

Students will be able to:
- Perform various water quality tests
- Relate abiotic and biotic parameters
- Interpret data and results of tests

Materials:
- Water samples from various areas in Upper Newport Bay or other source (run-off, tap water, etc.)
- Map of sampling locations (for UNB, suggested collection sites include: Shellmaker Island dock, Back Bay Drive pipe, Back Bay Drive bend, Big Canyon bridge, Big Canyon outfall)
- Dissolved Oxygen TesTabs (2 for each test)
- Nitrate Wide Range CTA TesTabs (1 for each test)
- Phosphorus TesTabs (1 for each test)
- pH Wide Range TesTabs (1 for each test)
- Turbidity test kit (secchi disk)
- Test tubes (1 for each test) labeled:
  - ✓ DO
  - ✓ Nitrate
  - ✓ Phosphate
  - ✓ pH
  - ✓ Salinity
- Distilled water
- Gloves for each group
- Liquid waste container
- Handout
  Testing Procedures

Preparation:

- Apply for permission to collect water samples at your selected site. For Upper Newport Bay, call 949-640-0286 or 949-640-9956.
- Obtain water samples (approximately one liter from each location) and label them to indicate their origin. Keep samples in a cooler until testing.
- Indicate on a map the location for each of the water samples
- Make a copy of the *Testing Procedures* for each student or group.
- Set up a testing station for each water quality test. (See *Testing Procedures*.) Try to have at least two samples—each from a different part of the Bay—for each test.

Time Required:

- Approximately 1 hour

Note: Kits containing materials to conduct the tests are available in scientific supply catalogs as well as online. Earth Force Low Cost Estuary and Marine Kit (Product #5911) can be ordered from www.green.org.

Procedures:

(Note: You need to determine how you want the testing to be carried out. Preferably, set up enough materials at each station so that student pairs can perform each test. Alternatively, divide the class into six groups, have each group perform a different test, and then share results with the class.)

1. Hand out a copy of the *Testing Procedures* to each student or group.

2. Tell students that they are going to be performing various water quality tests. Show students a map indicating where each sample was obtained. Discuss the differences among the sampling locations.

3. Have students read the background for each test and discuss.

4. Point out the six stations and explain the testing procedures. For each test, ask students to predict results before beginning.

5. Have students conduct the tests and record their observations. Remind them to handle all materials carefully.

6. When students have finished their tests, have them dump all test liquids into the liquid waste container. Ask them why the waste liquid should be diluted before disposing of the waste.

Follow-up:

Have each group present their results and discuss their findings.

1. What test results indicated "poor" water quality?

2. What might be the source of that type of pollution in Upper Newport Bay? *(for example, phosphate from soaps and pet waste, nitrate from fertilizer)*

3. How do water samples from various areas in the Bay differ? Why do they differ?

4. What sources of error might have affected your results? How could you reduce these errors?

5. What organisms may be affected by poor water quality?

6. How will those effects influence ecosystem balance and function?

7. What might remedy some of the pollution problems?
   (for example, farming organically, using a basin to "catch" some pollution before it enters the Bay, dredging contaminated sediment, keeping waste materials off the street)

8. What could you do to make a difference?

Extensions:

1. Have students research the organisms on the *UNB Inhabitant Cards* (Appendix A) to determine the ideal conditions for each.

2. Record your results in Microsoft Excel and start a water quality log that will track changes over time.

3. Volunteer to be a citizen monitor with your local Surfrider Foundation or borrow their video *Sea to Summit*, which features surf and skate celebrities.
   Visit www.surfrider.org or call 949-492-8170 for more information.

4. Have a speaker from the Municipal Water District of Orange County come to your classroom to discuss local water quality issues. Call the MWDOC Education Department 714-593-5017 for more information.

5. Send students on a "phosphates hunt" to determine what products contain phosphates.

6. Have students do some research to find out what water quality problems have existed historically and how some of those problems have been resolved.

Adapted from "Water Quality Testing" from *Save San Francisco Bay Watershed Education Program*, www.saveSFbay.org

Testing Procedures

Dissolved Oxygen

Dissolved Oxygen (DO) is important to the health of aquatic ecosystems. All aquatic animals need oxygen to survive. Water with consistently high dissolved oxygen levels most likely provides a healthy and stable environment and is capable of supporting a diversity of aquatic organisms. Natural and human-induced changes to the aquatic environment can affect the availability of dissolved oxygen.

Dissolved Oxygen % Saturation is an important measurement of water quality. Cold water can hold more dissolved oxygen than warm water. For example, water at 28°C (82°F) will be 100% saturated with 8 ppm dissolved oxygen. However, water at 8°C (46°F) can hold up to 12 ppm before it is 100% saturated. High levels of bacteria from sewage pollution or large amounts of decaying plants can cause the percent oxygen saturation to decrease. For example, runoff containing nutrients from pet waste or fertilizer can cause algal blooms, which, during decomposition, use up oxygen in the water (eutrophication). This can cause large fluctuations in dissolved oxygen levels, which can affect the ability of plants and animals to thrive.

Testing Procedure

1. Record temperature of the water sample in °C and °F in the space to the right.
2. Rinse the tube labeled "DO" with distilled water and fill it to the top with the water sample.

°C °F

3. Drop two *Dissolved Oxygen TesTabs* into the sample. Water will overflow when the tablets are added.
4. Screw the cap on the tube. More water will overflow as the cap is tightened. Make sure no air bubbles are present in the sample.
5. Gently shake the tube until the tablets have disintegrated. This will take approximately 4 minutes.
6. Wait five more minutes for the color to develop.

% Saturation Chart
Dissolved Oxygen

TEMP °C	0 ppm	4 ppm	8 ppm
2	0	29	58
3	0	31	61
6	0	32	64
8	0	34	68
10	0	35	71
12	0	37	74
14	0	39	78
16	0	41	81
18	0	42	84
20	0	44	88
22	0	46	92
24	0	48	95
26	0	49	99
28	0	51	102
30	0	53	106

Conversion: °F = (°C x 1.8) + 32

7. Compare the color of the sample to the Dissolved Oxygen Color Chart. Record the result in the space to the right as ppm dissolved oxygen.

Result: ppm

8. Locate the temperature of the water sample on the % Saturation chart. Locate the dissolved oxygen result of the water sample at the top of the chart. The % Saturation of the water sample is where the temperature row and the dissolved oxygen column intersect (e.g., if the water sample temperature is 16°C and the dissolved oxygen result is 4 ppm, then the % Saturation is 41). Record this number as % Saturation in the space to the right.

Result: % Sat

Ranking the Test Results

91 - 110% Sat	Excellent
71 - 90% Sat	Good
51 - 70% Sat	Fair
< 50% Sat	Poor

TEMPERATURE

Temperature is very important to water quality. Temperature affects the amount of oxygen in the water and the rate of photosynthesis by aquatic plants. Most aquatic plants and animals are adapted to a specific temperature range and may die if the temperature of the water changes. An example of thermal pollution is hot water from an industrial plant being emptied into a body of water – such as cooling water from a power plant or a refinery. Also, rivers with channelized banks experience higher temperatures because of the lack of shading from vegetation.

Testing Procedure (for field study only)

1. Place the thermometer 4 inches below the surface of the water for one minute.
2. Remove the thermometer from the water and read the temperature. Record the temperature in °C and °F in the space to the right.

°C °F

Ranking the Test Results	
Temp < 26 °C	Good
Temp > 26 °C	Poor
Conversion: °F = (°C x 1.8) + 32	

NITRATE

Nitrate is a nutrient needed by all aquatic plants and animals to grow. Dead plants and animals and animal wastes naturally release nitrate into the aquatic system. High levels of nitrate can lead to overgrowth of plants, increased bacteria, and decreased oxygen levels. Human sewage, fertilizer, and agricultural runoff all contribute to high levels of nitrate.

Testing Procedure

1. Rinse with distilled water and then fill the test tube labeled "Nitrate" to the 5 mL line with a water sample.
2. Add <u>one</u> *Nitrate Wide Range CTA TesTab* to the sample.
3. Cap the test tube and gently shake it until the tablet has disintegrated. Bits of the material may remain in the water sample.
4. Wait five minutes for the color to develop.
5. Compare the color of the sample to the Nitrate color chart. Record the result in the space as ppm Nitrate.

Result: % Sat

Ranking the Test Results	
0 – 5 ppm	Good
5 – 20 ppm	Poor
20 – 40 ppm	Very Poor

PHOSPHATE

Phosphate is a nutrient needed by plants and animals to grow. Like nitrate, high levels of this nutrient can lead to overgrowth of plants, increased bacteria, and decreased oxygen levels. Phosphate comes from several sources, including soaps, human and animal waste, industrial pollution, and agricultural runoff.

Testing Procedure

1. Rinse with distilled water and then fill the test tube labeled "Phosphate" to the 10 mL line with a water sample.
2. Add one *Phosphorus TesTab* to the sample.
3. Cap the test tube and gently shake it until the tablet has disintegrated. Bits of the material may remain in the water sample.
4. Wait five minutes for the blue color to develop.
5. Compare the color of the sample to the Phosphate Color Chart. Record the result in the space as ppm phosphate.

Result: ppm

Ranking the Test Results	
0 – 1 ppm	Excellent
2 – 4 ppm	Good
4+ ppm	Poor

pH

pH is a measurement of the amount of acid or alkaline (base) in the water. The pH scale ranges from a value of 0 (very acidic) to 14 (very basic), with 7 being neutral. The pH of tap water is usually between 6.5 and 8.2. Most aquatic plants and animals are adapted to a specific pH level and may die if the pH of the water changes even slightly. pH can be affected by industrial waste and agricultural runoff.

Testing Procedure

1. Rinse with distilled water and then fill the test tube labeled "pH" to the 10 mL line with a water sample.
2. Add one *pH Wide Range TesTab* to the sample.
3. Cap the test tube and gently shake it until the tablet has disintegrated. Bits of the material may remain in the water sample.
4. Compare the color of the sample to the pH color chart. Record the result in the space as pH.

Result: pH

Ranking the Test Results	
6 – 8	Good
4 – 5	Poor
9 – 10	Very Poor

TURBIDITY

Turbidity is the measure of the clarity of water. Turbid water is caused by suspended matter such as clay, silt, and microscopic organisms. Turbidity should not be confused with color, since darkly colored water can still be clear and not turbid.

With decreased clarity, aquatic organisms receive less sunlight, affecting the food chain from the bottom up.

Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances, which can be caused by dredging, wave action, boat traffic and abundant bottom feeders.

Testing Procedure

1. Fill the tube with the secchi disk on the bottom with the water sample.

2. Look down into the tube and compare the appearance of the secchi disk to the Turbidity Chart. Record the result in the space below as Turbidity in Jackson Turbidity Units (JTU).

Result:

JTU

Ranking the Test Results	
0	Excellent
0 – 40	Good
40 – 100	Fair
> 100	Poor