BACK BAY SCIENCE CENTER

Water Quality Module

ACTIVITY: WHAT'S WITH THIS WATER?

TIME: 40-50 minutes
GRADE LEVEL: 7th-12th
GROUP SIZE: 8-10

Activity at a Glance: Students will test multiple water parameters of the Bay and learn what factors can contribute to healthy or unhealthy conditions.

NEXT GENERATION SCIENCE STANDARDS:

PERFORMANCE EXPECTATIONS

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4) **Constructing Explanations and Designing Solutions** • Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3) **Engaging in Argument from Evidence** • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MESS3-4) • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS2-6)	**Ecosystem Dynamics, Functioning, and Resilience** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) **ESS3.C: Human Impacts on Earth Systems** • Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)	**Stability and Change** • Small changes in one part of a system might cause large changes in another part. (MS-LS2-4) • Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), **Cause and Effect** • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3) • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-4)

Ocean Literacy 1: The Earth has one big ocean with many features
E- Most of Earth's water (97%) is in the ocean. Seawater has unique properties. It is salty, its freezing point is slightly lower than fresh water, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic.

Balance of pH is vital for the health of marine ecosystems, and important in controlling the rate at which the ocean will absorb and buffer changes in atmospheric carbon dioxide.
Ocean Literacy 6: The ocean and humans are inextricably interconnected
E- Changes in ocean temperature and pH due to human activities can affect the survival of some organisms and impact biological diversity (coral bleaching due to increased temperature and inhibition of shell formation due to ocean acidification.

BACKGROUND INFORMATION

Earth is known as the water planet. Our bodies are mostly water and we need to drink water daily to keep from dehydrating. But is the water life-sustaining or dangerous? World-wide, only one in eight people have access to clean water. But what about aquatic plants and animals? It is imperative to determine the quality of our water. By monitoring water quality, we are better able to connect environmental challenges with likely causes. When we determine causes, we can develop personal, industrial and governmental changes in our behaviors and policies.

Humans have chosen to live beside water for a variety of reasons. Early settlements were established close to the trade routes along rivers and oceans. Access to irrigation for crops and drinking water was essential for developing cultures. Milder weather was a bonus for many, but necessary for those with certain health problems.

As the population density grew, the consequences of human behavior began to accumulate: litter on the streets; pesticides and fertilizers used to maintain non-native gardens; pet wastes; car, cleansers, industrial and air pollutant residues. On land this may be unsightly, have an unpleasant odor, or be unnoticeable, but when washed into our streams by seasonal rains or summer watering it seriously impacts the quality of our water. Every year, there are beach closures because of high coliform bacteria counts. Rivers and streams are visibly and also chemically polluted - endangering the health of those seeking respite. Drinking polluted water is the cause of many diseases. Eating fish caught in these waters is also dangerous because the toxins bioaccumulate (build up).

Aquatic plants and animals have no escape. The chemicals in the water are absorbed into their tissues. The often invisible and toxic chemicals can have life-threatening consequences. Some are changing the pH level and can dissolve the calcium present in mollusk and crustacean shells, killing the animal. Some (hormones) change reproductive ability, while others (neurotoxins) attack an organism's ability to move. Nitrates are considered nutrients for non-native plants but result in massive "die-offs" downstream. Eutrophication occurs when the proliferating bacteria feeding on the decomposing algal blooms pull oxygen out of the water. One of the challenges is that the longer plants and animals live in polluted waters, the more toxins bioaccumulate in their tissues. Since predatory animals ingest many of these plants and animals, the toxins Within them are biomagnified (intensified).

Scientists have developed a variety of tests that allow us to detect the presence of specific chemicals in water. By monitoring the levels of

chemicals present in the water, and also tracking the overall viability of the ecosystem with population counts of local species, we can get a sense of how the levels of chemicals are impacting the biome.

Although we likely will not achieve "zero pollution", we can determine optimum levels, carrying capacity and danger levels for the variety of plant and animal species.

By testing the water, we can connect problems within an ecosystem to the causative agents. When we identify causative agents, we can put our energies into creating solutions. On a Federal level, we have the Clean Water Act. State-wide, we have the California Coastal Commission and the Water Quality Control Board that addresses water quality. Local municipalities, realizing its importance, have established Best Management Practices for industry. The Municipal Water District of Orange County has an active outreach 'Project Pollution Prevention' program.

We have learned that most of the pollutants entering our local waters are from non-point sources. Although the products we use are not intended for aquatic dispersal, this is how they end up via storm drain run-off. Cigarette butts leech chemicals, as do plastic bottles, animal waste, fertilizers, pesticides and the cleansers that we regularly use. Because so much of the problem originates in our neighborhoods, individual responsibility and action are critical to solving the problem. Citizen advocacy groups work to increase public awareness and offer steps we can take in our daily lives to ameliorate the severity of the problem. Local stream "watches" and clean-ups are being conducted. Monthly population counts at the Back Bay Science Center and activities with the Newport Bay Conservancy monitor the health of our waters.

RESOURCES:

http://coastalscience.noaa.gov/stressors/pollution/
http://www.usc.edu/org/seagrant/
http://www.cacoastkeeper.org/programs/mapping-initiative/mmp4west/
http://www.scientificamerican.com/article.cfm?id=plastic-not-fantastic-
www.thankyouocean.org/threats/water-pollution/
http://www.healtheocean.org/
http://www.healthebay.org/get-involved/ways-heal/home
http://newportbay.org/

TEACHER GUIDE – Water Quality

ACTIVITY: Water and Nutrient Testing

OBJECTIVES:

Students will be able to:

1. Identify at least 3 ways that water quality is related to ecosystem health.
2. Conduct at least 3 water quality assessments.
3. Explain the 'life-friendly' pH zone.
4. Detail at least 5 ways that their personal activities impact water quality.

MATERIALS:

Water Quality Field Observation Sheets, with Analysis Questions
Pencils
Air and Water Thermometers
Calculators
Secchi disc
Water Quality Lab Observation Sheets, with Analysis Questions

Water Samples, taken at various depths in water column, Source Labelled
Water Quality Test Kits:
- Dissolved Oxygen
- Salinity
- Nitrates
- Phosphates
- Ammonia
- pH

KEY TERMS:

Algal Bloom Biome Coliform Carrying Capacity Decomposition Die-off Ecosystem Estuary Eutrophication Food-web Micro-habitat Niche Non-native Non-Point Source Pollution Neurotoxin Nutrient pH Sediment Toxic Turbidity Upstream Urban Run-Off Water Column

METHOD:

Engage (3 minutes) Introduce the Back Bay ecosystem and then ask the students why they think it might be important to monitor our bays and oceans water sources? What measurements could Scientists take to determine its health? Explain the concepts of water clarity versus turbidity as a function of sediment in suspension and how we measure that with the use of a Secchi Disc.

Explore (20 minutes) Distribute the handouts to the students and the thermometers and 2 calculators to selected students. Instruct one student to take an air temperature measurement and one student to take the water temperature measurement. Have the two students with the calculators calculate the conversions and record these results on the board. Have the rest of the students record these values on their worksheets. Then, have the students circle any terms that describe the appearance of the water and discuss their observations with their group members. **Use the iPads to access the HOBO app on the Back Bay Science Center website to gather weather information**. Have one or two students to help lower the Secchi Disc into the water. ***Ask the students what sources could cause an increase in turbidity/decrease in water clarity? What types of organisms might be affected by less sunlight? (A: eelgrass, algae, phytoplankton).***

Explain that the variables the students will be testing include: pH, dissolved oxygen, salinity, ammonia, nitrates and phosphates. Describe where these nutrients come from
Ammonia: pet waste
Nitrate: fertilizers
Phosphate: household and commercial cleansers

Collect a sample of the harbor water and break the students up into small groups to test the nutrient levels, pH, oxygen, and salinity. Instruct the students to follow their laminated instruction sheets to perform their test(s).

Explain & Expand (5 minutes) Have the students explain the importance of water clarity (i.e. why the secchi disk test is important), and what environmental complications could be caused by fluctuating water quality. Discuss how levels of pH, oxygen, salinity, and nutrients can affect organisms living within the bay.

Evaluate (2 minutes) Students should fill out the Testing for Toxins Worksheet and answer the analysis questions while on site or back in the classroom.

WATER QUALITY ANALYSIS QUESTIONS

Use this data sheet to make connections between what is going on in the water and the overall activity and health of the habitat.

1. What factors cause higher amounts of suspended sediments and how might this affect the growth and survival of eelgrass and other estuary species?

2. How would you describe the level of human activity in the bay? How might this be related to the quality of water?

3. What does pH measure, and why is that an important factor for aquatic animals?

4. Identify at least one human source for each of the nutrients listed which may enter a waterway:
   Ammonia: _____
   Nitrate: _____
   Phosphate: _____

5. What is the most significant result of too many nutrients entering a body of water such as Newport Bay? How might this affect the growth and survival of eelgrass and other aquatic organisms?

6. How does weather effect the water quality?

WATER QUALITY ANALYSIS QUESTIONS – KEY

Use this data sheet to make connections between what is going on in the water and the overall activity and health of the habitat.

1. What factors cause higher amounts of suspended sediments and how might this affect the growth and survival of eelgrass and other estuary species?
Increased wave action stirs up fine particles of sediment that have settled. This can be caused by heavy winds, rain, and tides. It can also be caused by dredging, large motor boats.
Increased amounts of suspended sediments creates a higher turbidity level. With move particles floating in the water column, the amount of sunlight that can reach submerged plants, algae and protists is diminished,. This diminishes the amount of photosynthesis, which impacts not only the growth and survival of eelgrass, but all the other aquatic species on higher trophic levels.

2. How would you describe the level of human activity in the bay? How might this be related to the quality of water?
Range of possible answers depending on what is seen. Answers to include: Increased boating, dredging - increased turbidity in water. Humans off-trail compromises nesting sites. Pets increases raw wastes in water. Humans leaving litter negatively impacts water quality and clarity.

3. What does pH measure, and why is that an important factor for aquatic animals?
pH measures the amount of Hydrogen ions in a range from extreme acidity (0) to extreme alkalinity (14). It is important because most species function best in the "life-friendly" zone of pH 6 - 8. pH levels lower than 6 indicate water that is acidic enough to dissolve shells of mollusks, crustaceans and eggs in general - this is perilous to aquatic animals and the ecosystem.

4.Identify at least on human source for each of the nutrients listed which may enter a waterway:
Ammonia: pet waste
Nitrate: fertilizers
Phosphate: household and commercial cleansers

5.What is the most significant result of too many nutrients entering a body of water such as Newport Bay? How might this affect the growth and survival of eelgrass and other aquatic organisms?
The most significant result of too many nutrients is that the aquatic plants, including eelgrass, will have a growth spurt or "bloom." When the increased bloom dies, the rapidly increasing bacteria population that are decomposing the organisms will increasingly use up the oxygen in the water. This process of Eutrophication is responsible for "fish kills," and die-offs of the aquatic organisms that must have oxygen to live.

6.How does weather effect the water quality?

Heat waves, wildfires, cold waves, and flooding can all affect water quality. During heat waves, the air becomes stagnant and traps emitted pollutants, often resulting in increases in surface ozone. Heat

waves and drought also dry out vegetation and provide more fuel for wildfires whose smoke is a serious medical hazard. One type of cold wave also allows air pollution to accumulate.

Floods resulting from increases in heavy precipitation events or from snowmelt can cause combined sewer overflow systems, which are designed to discharge excess wastewater when under extreme duress, to overflow more often into nearby lakes, rivers, or other bodies of water, causing water quality challenges in these typically urban areas. Flooding of industrial areas or agricultural chemical storage locations can cause chemicals to move into nearby watersheds, also degrading water quality and even contaminating some residential areas.

BACK BAY SCIENCE CENTER
MARINE LIFE INVENTORY

WEATHER AND WATER DATA

Date:_____ **Time:** _____ **Tide time:**_____**low** _____**high**

Tide height @ low: _____ **@ high:** _____ **Tidal range:** _____

Location: ***Circle one*** **Dock** **Mid-Channel** **Other**_____

WEATHER:
Data can be found at ***www.Backbaysciencecenter.org*** ***homepage HOBO icon (right sidebar)***

Water Content:_____ **m^3/m^3** **Rain:**_____**in** **Wind Speed:**_____**mph**

Gust speed: _____**mph** **Temperature:** _____**°F** **Relative Humidity (RH):**_____**%**

Dew point: _____**°F** **Wind direction:**_____

Rain in past week *circle one:* **Heavy downpour** **Lengthy shower** **Intermittent shower** **Sprinkles**

Cloud cover *circle one:* **Sunny** **Mostly sunny** **Mostly cloudy** **Cloudy** **Rainy** **Foggy** **Hazy**

WATER QUALITY:
Turbidity (Sechhi disc): _____**m**

Forel Ule: # _____

WATER PARAMETERS:	***Surface water (Group 1)***		***Surface water (Group 2)***		***Surface water (Group 3)***	
	Hand Held devices	**YSI probe**	**Hand Held devices**	**YSI probe**	**Hand Held devices**	**YSI probe**
Temp (°Celsius)						
Salinity (ppt)						

pH			
Dissolved Oxygen (ppm)			