Island STYLE

Water Quality of Galveston Bay

SUBJECT:

Science

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Fully-Stocked Water Quality Testing Kit
  - Waterproof storage case
  - Disposable gloves
  - Small trash bag
  - Pipettes
  - Sample jars
  - Nitrate supplies
  - Dissolved Oxygen supplies
- Thermometer
- Turbidity tube
- White bucket for large water sample
- Refractometer

ACTIVITY SUMMARY:

Students will use scientific equipment to gather data on the water quality of the Galveston Bay while participating in Citizen Science

LEARNING OBJECTIVES:

- Students will investigate the question, "Why does Galveston have murky water?"
- Students will understand temperature, salinity, turbidity, pH, dissolved oxygen, and nitrates as it pertains to the overall quality of the water system
- Students will learn how to use various scientific testing equipment in the field and record data

VOCABULARY:

- **Water Quality** - Physical, chemical, thermal, and/or biological properties of water
- **Exothermic** - Accompanied by the release of heat
- **Endothermic** - Requiring the absorption of heat
- **Phytoplankton** - Plankton consisting of microscopic plants
- **Zooplankton** - Plankton consisting of small animals and the immature stages of larger animals
- **Dissolved Oxygen** - The amount of oxygen available to living aquatic organisms
- **Hypoxic** - Deficiency in the amount of oxygen reaching the tissues
- **Salinity** - The quality or degree of being saline
- **Refractometer** - Instrument for measuring a refractive index, ours measures salinity
- **Turbidity** - The quality of being cloudy, opaque, or thick with suspended matter
- **Nitrates** - Useful for plant growth, part of natural or non-natural fertilizers
- **Algal Bloom** - A rapid growth of microscopic algae in water
- **Byproduct** - An incidental or secondary product made in the manufacture of something else
- **Citizen Science** - The collection and analysis of data related to the natural world by members of the general public

ALIGNMENT:

TEKS:

6.1. (A) - Demonstrate safe practices during laboratory and field investigations as outlined in Texas Education Agency-approved safety standards;
6.1. (B) - Practice appropriate use and conservation of resources, including disposal, reuse, or recycling of materials.
6.2. (A) - Plan and implement comparative and descriptive investigations by making observations, asking well defined questions, and using appropriate equipment and technology;
6.2.(B) - Design and implement experimental investigations by making observations, asking well defined questions, formulating testable hypotheses, and using appropriate equipment and technology;
6.2.(C) - Collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
6.2.(D) - Construct tables and graphs, using repeated trials and means, to organize data and identify patterns;
6.2.(E) - Analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
6.3.(A) - Analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;
6.4. (A) - Use appropriate tools, including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, balances, microscopes, thermometers, calculators, computers, timing devices, and other necessary equipment to collect, record, and analyze information;
6.4. (B) - Use preventative safety equipment, including chemical splash goggles, aprons, and gloves, and be prepared to use emergency safety equipment, including an eye/face wash, a fire blanket, and a fire extinguisher.
6.5.(A) - Know that an element is a pure substance represented by a chemical symbol and that a compound is a pure substance represented by a chemical formula;
6.5.(B) - Recognize that a limited number of the many known elements comprise the largest portion of solid Earth, living matter, oceans, and the atmosphere;
6.7. - Matter and energy. The student knows that some of Earth's energy resources are available on a nearly perpetual basis, while others can be renewed over a relatively short period of time. Some energy resources, once depleted, are essentially nonrenewable.
6.9. (A) - Investigate methods of thermal energy transfer, including conduction, convection, and radiation;
6.9.(B) - Verify through investigations that thermal energy moves in a predictable pattern from warmer to cooler until all the substances attain the same temperature such as an ice cube melting;
6.12.(E) - Describe biotic and abiotic parts of an ecosystem in which organisms interact;

Ocean Literacy Principles:

1 Earth has one big ocean with many features.
2 The ocean and life in the ocean shape the features of Earth.
4 The ocean makes Earth habitable
6 The ocean and humans are inextricably interconnected.

PREPARATION:

Prepare all water quality testing equipment and safety supplies

INTRODUCTION:

When you look at the water, what do you think about? (Give wait time for students to answer) What would a scientist be thinking about? (Give wait time for students to answer) According to the NOAA Office for Coastal Management, water quality is one of the most important components of a healthy ecosystem. Clean water provides drinking supplies for communities, supports diversity of plants and wildlife, and enhances recreation and tourism. Understanding the types of data, and actions that can address areas of concern, helps the communities better understand the condition of their water and the threats.

NOAA gathers data on many categories of water quality including the ones Artist Boat collects as part of their kayak adventures. The NOAA data is available to anyone who would like to know about the health of their waterway through their website and includes historical data that can be used for Citizen Science projects like the ones you will be doing later this year.

Today, at the Artist Boat Coastal Heritage Preserve, we will be exploring the salt marsh ecosystem via kayak vessel while also participating in some Citizen Science activities as we measure the water quality of the Galveston Bay by using real scientific equipment.

We will be taking today's current **temperature** and **salinity** measurements, as well as testing to see what the current level of **pH, dissolved oxygen,** and **nitrates** are in the water supply. These measurements will give us an indication of the overall health of the Galveston Bay.

Both photos below show portions of the Gulf of Mexico, but why are they visually so different?

Galveston, Texas

Clear Water Beach, Florida

Is Galveston's water dirty?
Why is it brown?

While places like Florida have plentiful sea flora on the floor of the ocean to help trap loose sediment and make the water appear clear, places along the Texas coast such as Galveston Island have a significant amount of loose sediment that gets churned up and mixed in with the water, creating the brown discoloration. Where did this sediment come from? In 1901, the massive dredging project that created the deep-water Houston Ship Channel also created both planned and unplanned islands, and forever altered the bay currents. This new deep channel altered the salinity balance of the shallow watered bay by allowing for a greater amount of saltwater to enter the bay. The average depth of the bay changed forever, increasing wave energy along shores and islands in the bay. Since the ship channel's creation, islands have disappeared and land has slowly eroded from shorelines. Today, people living on shorelines create bulkheads to protect their homes. These dement structures decrease the number of marshes along shorelines and further decrease the amount of habitat on our shores.

Construction of oil refineries along the Houston Ship Channel and to the southwestern shore of the bay at Texas City after 1930 began the trend toward the highest concentration of petrochemical plants and refineries in the world. The drilling for oil, along with groundwater removal for drinking water, has caused **subsidence** (the sinking of our bay bottom). This subsidence altered the average depth of the Galveston Bay, and over 30,000 acres of saltwater marshes have disappeared.

GUIDED PRACTICE:

Data Sheets

- An important part of data collection is getting complete data with units. Always start by writing the date, the time, and the location where you are testing on your data gathering sheet. When you forget to include this information and come back to your data later to input and compare your data will be incomplete without this information and often not usable. Recording the measurement units is important. There is a vast difference between 100*C and 100* F!

Water Gathering

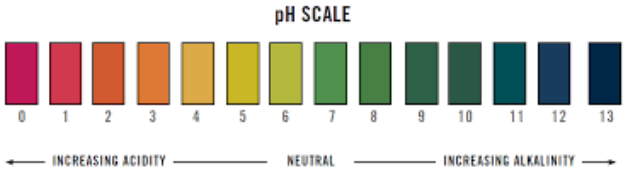
- To acquire a water sample, take the white bucket toss the bucket into the middle part of the channel, making sure to hold on to the rope attached to the bucket. Allow the water to fill the bucket from the surface and quickly pull the bucket back to the surface, being careful not to allow the bucket to scrape the bottom of the water channel. We want a full bucket of water with no mud or sediment. (Show the students how to throw and collect)

Temperature

- Fish, shrimp and crabs are exothermic (cold-blooded), which means that they cannot keep their own bodies warm like humans (and other mammals) can. If they are in air or water that is 32* F they will freeze very quickly, where as a mammal that is endothermic (warm blooded) will be very cold, but will not freeze for many hours. Along our Gulf of Mexico coastline, we might see a fish kill or die off after a sustained cold snap. The temperature of the water helps to tell aquatic animals what season it is and what they need to do next in life. For example, if the coastal water is growing steadily warmer the animals may begin to migrate to deeper waters where it is cooler. Temperature is the determining factor for when eggs hatch, not necessarily the time the has elapsed since the eggs were laid.

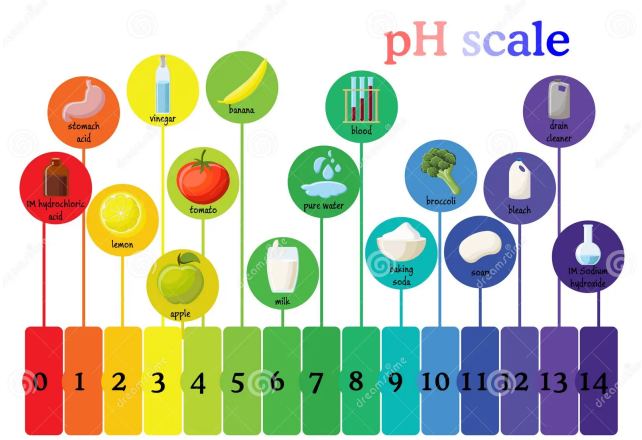
- When testing for temperature you want to take it as soon as you pull your sample because the temperature of the water in the bucket will be affected by the temperature of the air.

- To test for temperature, hold the thermometer by a string and submerge it in the middle of the bucket so it does not touch the bottom or the sides. Wait 30 seconds and then pull the thermometer out by the string and hold it by the top of the thermometer, not the bottom where the bulb is located, to read. (demonstrate how to use a thermometer)



pH:

- Testing for pH (potential of hydrogen) is testing to see how acidic (0-6) or basic (8-14) the water is. Pure water has a pH of 7, but Galveston Bay is not pure H_2O, it has salt dissolved in it (as well as other things) and usually has a pH near 8. The pH of the water doesn't change only because of hydrogen ions. When CO_2 builds up in the atmosphere, more and more of it will dissolve into the ocean. When this happens, it changes the pH of the water to be more acidic. Saltwater's pH will still be above 7, but the closer it gets to neutral the harder it is for snails and corals to find the calcium carbonate or $CaCO_2$ needed to build their shells.
- pH is an easy test to do using the litmus paper test strips. Take a clean sample of water and dip the test strip in (avoiding getting your hands wet) and compare the color to the bottle to get the pH number and record it.



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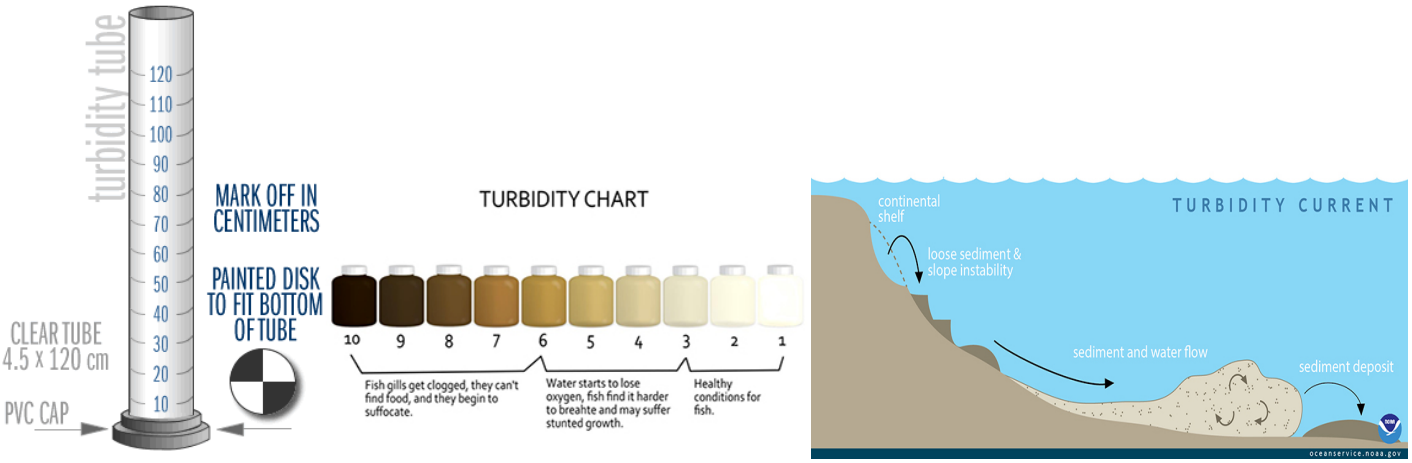
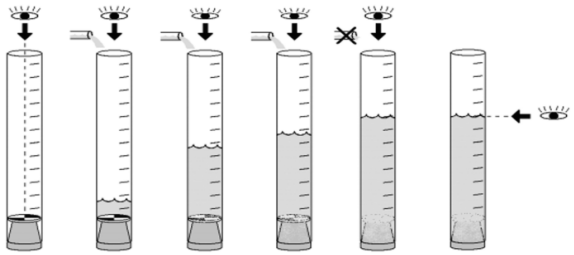


Turbidity

- Can you see your feet when you are standing in shallow water? How about in deeper water? Turbidity is the measurement of how murky the water is, which is what makes our feet disappear in the water column. Galveston water can look very murky due to the soils that make up the bottom of our bay. A lot of our mud is made up of clay, which has a very small particle size. This allows it to stay in the water column for a long time. What might make those clay particles leave the bottom and get mixed into the water column? Wind, wave action from a storm or from a boat, fish swimming near the bottom, even the microscopic organisms like zooplankton and phytoplankton that live near the edge. Turbid water is natural, especially in the Gulf of Mexico.
- This water quality test is important for our sea grasses that grow entirely underwater. Sea grass is a plant and plants need sunlight for photosynthesis. If the plant is under water that is very murky, they will not get enough sunlight to survive.
- For this measurement we will use a turbidity tube. Draw a new water sample from an area that is undisturbed- nobody just walked through it or dug around in the bottom. Fill the tube up all the way and look into it from the top. Can you see the black and white disk at the bottom? Slowly let out water until you can see the disk.



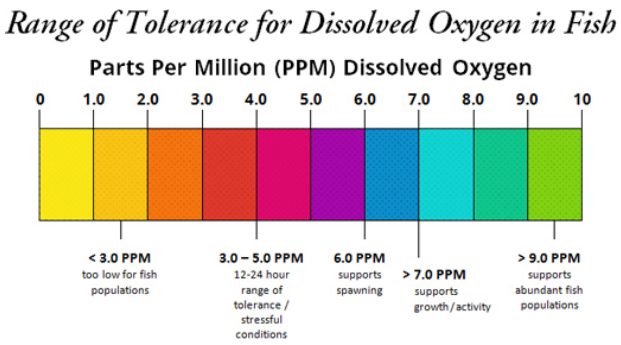
Salinity

- Salinity tells us how much salt is in the water. Remember that freshwater should have no salt, salt water has salt and brackish water is a mixture of the two. It will vary depending on how close it is to the saltwater source and how close it is to the freshwater source. The Coastal Heritage Preserve is much closer to the Gulf of Mexico than it is to the Trinity River so our numbers should be closer to the pure saltwater than the pure freshwater. Our salinity numbers could fluctuate based on the weather. Lots of rain recently? Lower salinity. Lots of onshore wind? Higher salinity.

Pure salt water ~37ppt
Pure freshwater ~0 ppt
Brackish water is anything in between.

- Salinity is measured using a refractometer in parts per thousand. That means that we are counting the number of salt particles in one thousand water particles. To find salinity you add a few drops of our sample water to the refractometer lens and look through the eyepiece towards the sun. When looking into the eyepiece you will see a line that intersects with the scale on the right. This scale should go from 1-100. Read the sale and write down your measurement.

GUIDED PRACTICE:



Dissolved Oxygen

- Oxygen is what we take out of the air when we breath. It is the same type of oxygen that birds and dolphins use. Fish, shrimp and other animals living in the water also need oxygen, but not in air bubble form, their oxygen needs to be dissolved for them to use it for respiration.
- **Dissolved oxygen is affected by temperature**. **Cold water can hold more oxygen than warmer water can.** The oxygen in the water comes from two main sources: air and photosynthesis. Oxygen is the byproduct of photosynthesis meaning the plant takes in carbon dioxide and water in the presence of sunlight to make sugar and energy that it needs with leftover O2 that it gives off (a byproduct).

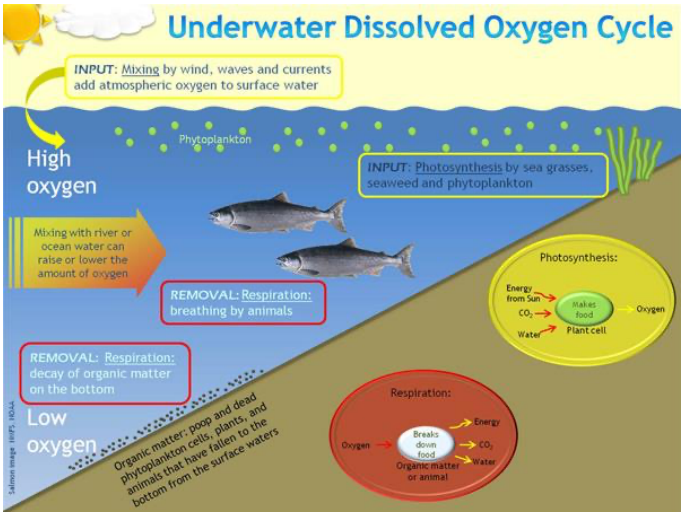
$$CO_2 + H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + O_2$$

- All aquatic plants like sea grasses, algae and phytoplankton make oxygen under water. Plants on land make oxygen in the same way and release it into the air.
- The other source of oxygen in the water is the air. At the surface of the water, oxygen from the air equilibrates with oxygen in the water. This is a dynamic equilibrium with oxygen molecules moving both into and out of the water. When the water temperature warms up it cannot hold as much oxygen and so the oxygen will leave the water, moving into the air. This leaves less oxygen in the water for the animals.
- Dissolved oxygen is important for other reasons. Oxygen is an aggressive element that helps to break down other compounds. The more oxygen you have, the quicker things will break down. Here in the marsh, most of the soil doesn't have any oxygen in it. This is important because all the carbon that the plants are absorbing through photosynthesis breaks down at a very slow rate once it is stored in the soil. This is why coastal wetlands are good at holding carbon. It can be trapped for hundreds of years.

Follow the directions for your specific DO test kit making sure to use a new water sample for each test and using it right away as the DO level will go up as the oxygen from the air will diffuse into the sample bucket water surface.

Measurements:

- Under 3 mg/L = hypoxic and often fatal to organisms that cannot move away from this area.
- 3-5 mg/L = organisms will be stressed to the point that growth and reproduction are hampered
- 5-6 mg/L = "just right" for many of our bay animals to be successful
- Above 10 mg/L = super saturated
- **Galveston is normally between 6 and 7 mg/L**



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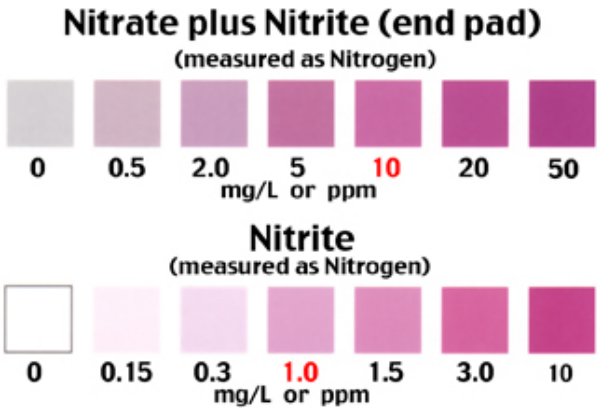
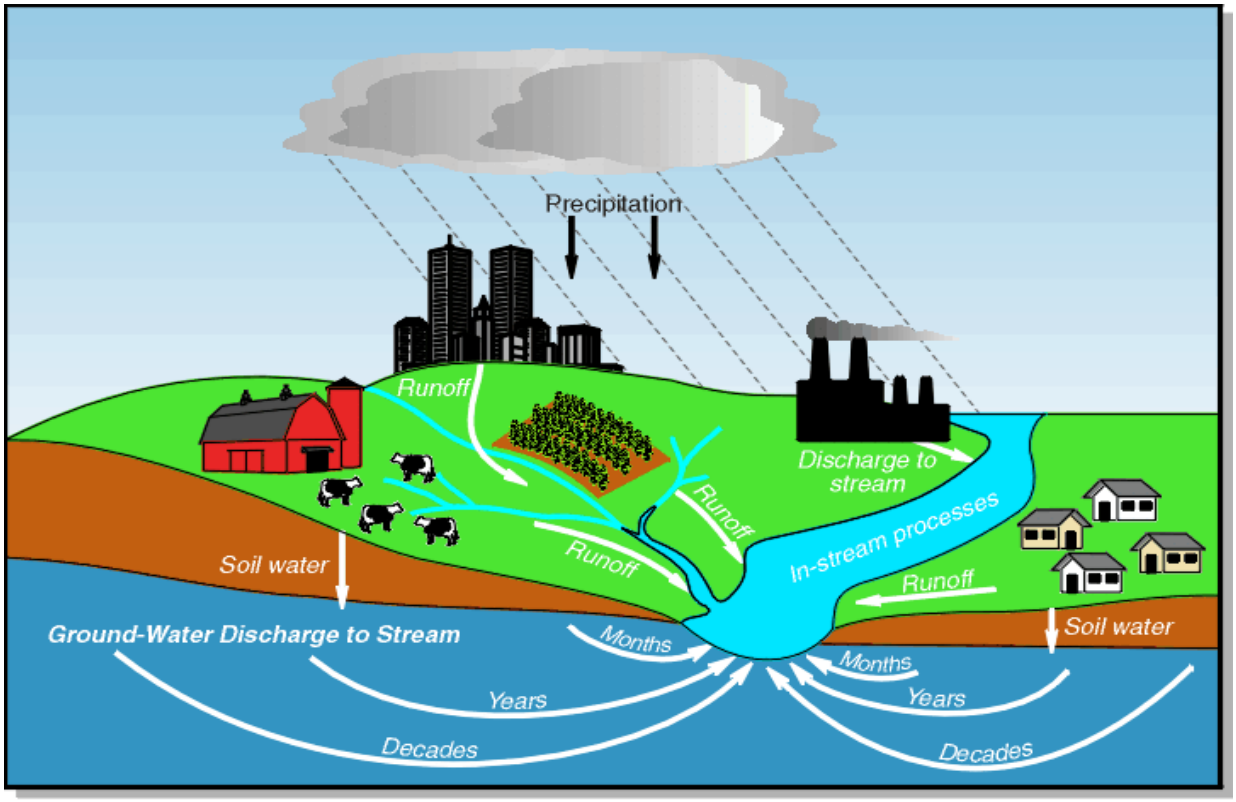


Nitrates:

- Nitrogen is found in the air we breathe and as a component of all proteins and DNA. Nitrates are nitrogen containing nutrients that help plants and algae grow. They are found in the fertilizer we use in our yards and in the plant matter growing in our water. Having the appropriate amount of nutrients is important for plant growth. Too few nutrients and the plants won't grow to their full potential and will look sickly. Too many nutrients and the algae will grow out of control. When we have too many nitrates in the water from sources like yard runoff, farm animals, and other non-point source pollution, the algae use them to grow quickly into what we call an algal bloom. When the algae use up these nutrients and die off, they sink to the bottom and become food for bottom dwellers. The bacteria at the bottom now have lots of food so they grow quickly. But, unlike plants that use CO_2, the bacteria use O_2 found dissolved in the water. As they grow they use up ALL the O_2 in an area and cause dead zones where fish cannot survive.



ASSESSMENT OF LEARNING:

Allow each student to participate as they are able in learning the data collection methods and reporting. Prompt as needed for reminders of directions and units.

CLOSING:

As you teach lessons linked to the Galveston Bay Watershed and the Gulf of Mexico, you can use the "I Wonder" Board as a closure assignment.

You might remind them that they are stakeholders in these water quality topics and in many more island centric issues. You might ask them what other island topics they might be concerned about. Students may ask about dune restoration, beach renourishment, sea level rise, fisheries manufacturing, or even about the laws concerning other species of fish. All of their questions (even the ones asked multiple times) will go on the "I Wonder" Board. If a question was answered in the lesson, it can still be placed on the board.

Students may even have follow-up questions after these lessons that could be added to the board. The goal is to have a place for all questions about the Galveston Bay and the Gulf of Mexico in one place.

EXTENSION:

NOTES:

www.galvbaygrade.org

https://coast.noaa.gov/digitalcoast/data/nerr.html

Citizen Science Water Quality
Data Gathering
Coastal Heritage Preserve

Date:_____

School Assisting:_____

Air Temperature:_____

General Weather Today:

_____

_____

_____

	Measurement 1	Measurement 2	Measurement 3
Temperature			
Dissolved Oxygen			
Salinity			
Turbidity			
pH			
Nitrates			