Island STYLE

Connection to the Gulf of Mexico and the Galveston Bay

SUBJECT:

ELA

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Computer
- Access to Google Earth
- Projector
- Screen
- Article
- Sticky notes
- Laminated/magnetized word and definition strips
- Blank strips for additional words
- Paper
- Pencils

TIVITY SUMMARY:

ents of Galveston Island often hear Galveston Bay and assume it is the water touching their d. Through this lesson they will learn the location of Galveston Bay and the Gulf of Mexico, and those bodies of water are important to them.

ARNING OBJECTIVES:

ents will build background knowledge to make connections to the Gulf of Mexico through ing scientific text.

GNMENT:

S:

6.5 (A) - Establish purpose for reading assigned and self-selected text
6.5 (B) - Generate questions about text before, during, and after reading to deepen understanding and gain information
6.5 (E) - Make connections to personal experiences, ideas in other text, and society
6.5 (I) - Monitor comprehension and make adjustments such as rereading, using background knowledge, asking questions, and annotating when understanding breaks down.
6.5 (H) - Synthesize information to create new understanding.

n Literacy Principles:

1 Earth has one big ocean with many features
5 The ocean supports a great diversity of life and ecosystems

VOCABULARY:

Use the stop-sign method to have students pull words they do not know. May include these science words and others.

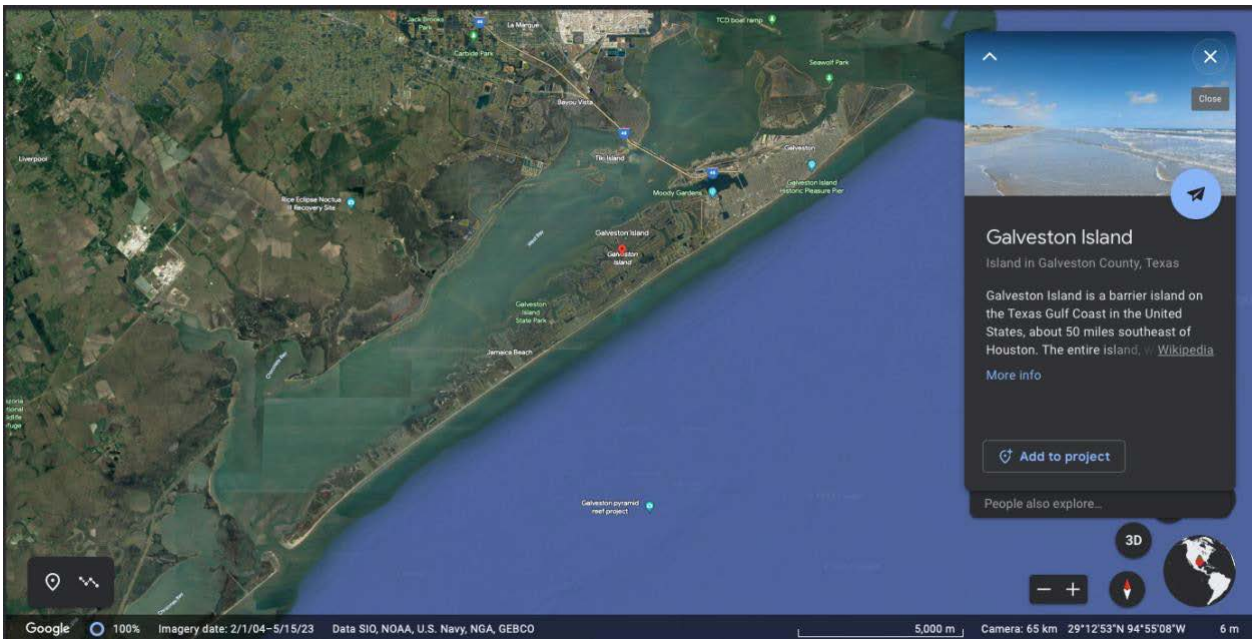
- **Bay** - A broad inlet of the sea where the land curves inward
- **Bayou** - A marshy outlet of a lake or river
- **Ecotourism** - Tourism directed toward exotic, often threatened, natural environments intended to support conservation efforts
- **Estuary** - The tidal mouth of a large river, where the tide meets the stream
- **Fauna** - Animals of a particular region, habitat, or geological period
- **Inflow** - A large amount of money, people, or water that moves or is transferred to a place
- **Marsh** - An area of low-lying land which is flooded in wet seasons or at high tide, and typically remains waterlogged at all times
- **Megafauna** - Animals that are large enough to be seen by the naked eye
- **Microfauna** - Small, often microscopic animals
- **Nursery** - A place or natural habitat that breeds or supports animals
- **Outlet** - A pipe or hole through which water or gas may escape
- **Prairie** - A large open area of grassland
- **Spawning** - To release or deposit eggs for reproduction
- **Terrestrial** - Of, on, or relating to the earth
- **Upwelling** - A rising of seawater, magma, or other liquid
- **Watershed** - The area that channels rainfall and snowmelt to creeks, streams, and rivers and eventually to outflow points like rivers, bays, and oceans

PREPARATION:

Access Google Earth or other navigation site to show a zoomed in area of the school. Print articles for each student to read.

INTRODUCTION:

Students will look at Google Earth on the projector. The teacher will zoom out slowly to talk about areas they see and know.



GUIDED PRACTICE:

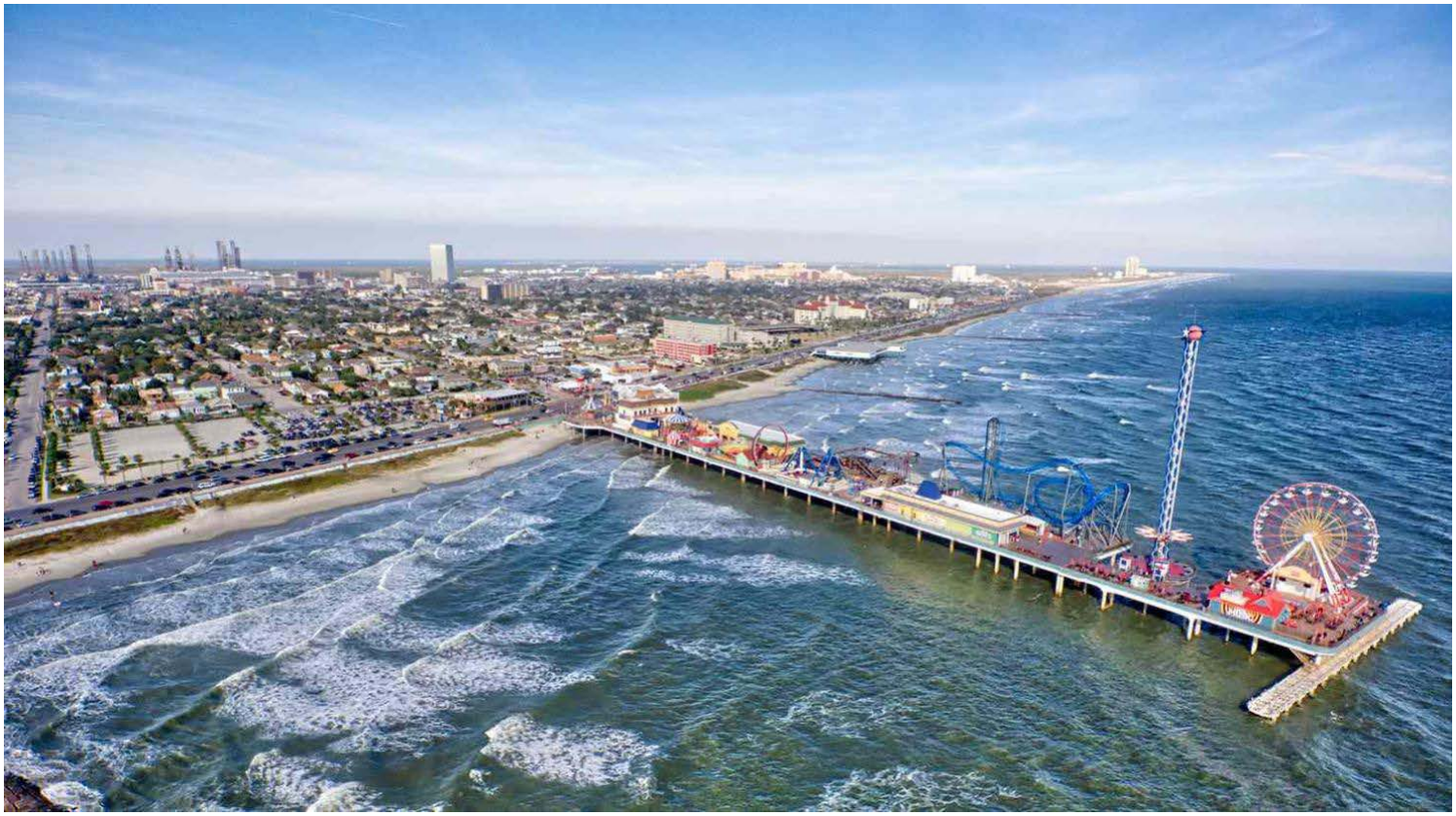
Students will read a short-leveled document on the Galveston Bay and the Gulf of Mexico, circling words they do not know the meaning of along the way. Students will transfer these words to a sticky note and hand it to the teacher. Teacher will compile the list and go through vocabulary words that need defining. Teacher will use the prepared word and definition strips as they are going through the stop sign word list. Two columns should be created on the board, relevant vocabulary and other words that need defining.

INDEPENDENT / GROUP PRACTICE:

Students will write a paragraph explaining one area of the Galveston Bay or Gulf of Mexico that they would like to learn more about using academic and lesson vocabulary.

DISCUSSION QUESTIONS:

- Who uses these areas?
  - Refer to the areas that the students recognized in the Google Earth introduction activity
- What types of activities happen in these areas?
  - Recreation, nature, business
- Poll the class on their topics using categories such as those that wanted to learn more about plants, animals, or geography.



Getting to Know the Galveston Bay and the Gulf of Mexico Quick Facts		
Location	North of Galveston Island	South of Galveston Island
Primary Inflow	Trinity River + San Jacinto River	Rio Grande + Mississippi River
Ocean Connection	Gulf of Mexico	Atlantic Ocean
Maximum Length	30 miles	559 miles
Maximum Width	17 miles	932 miles
Surface Area	600 sq miles	600,000 sq miles
Average Depth	6 ft	5,299 ft
Maximum Depth	10 ft	17,070 ft

BACKGROUND INFORMATION:

THE GALVESTON BAY

Galveston Bay is a bay in the western Gulf of Mexico along the upper coast of Texas. It is the seventh-largest estuary in the United States, and the largest of seven major estuaries along the Texas Gulf Coast. It is connected to the Gulf of Mexico and is surrounded by marshes and prairies on the mainland. The water in the bay is a complex mixture of sea water and fresh water, which supports a wide variety of marine life. With a maximum depth of about 10 feet and an average depth of only 6 feet, it is unusually shallow for its size.

Features

The Galveston Bay system consists of four main bodies of water: Galveston Bay proper, Trinity Bay, East Bay, and West Bay. Galveston Bay has two outlets to the Gulf of Mexico: Bolivar Roads between Galveston Island and the Bolivar Peninsula and San Luis Pass at the west end of Galveston Island. A majority of the bay's inflow comes from the Trinity River, which contributes 7,500,000 acre-feet of freshwater annually. The San Jacinto River contributes another 500,000 acre-feet. Local coastal watersheds contribute the remainder.

Plants and Animals

This mixing of waters from different sources provides nursery and spawning grounds for many types of marine life including crabs, shrimp, oysters, and many varieties of fish, thereby supporting a substantial fishing industry. The deeper navigation channels of the bay provide suitable habitats for bottlenose dolphins, which feed on the abundant fish varieties. Additionally, the bayous, rivers, and marshes that ring the bay support their own collection of ecosystems, containing diverse wildlife and enabling freshwater farming of crawfish. The wetlands that surround the bay support a variety of fauna. Notable terrestrial species include the American alligator and the bobcat, while bird species include the roseate spoonbill, great and snowy egret, white-faced ibis, and mottled duck.

Industry

Today, Galveston Bay is encompassed by Greater Houston, the fifth-largest metropolitan area in the United States. The Port of Houston, which has facilities spread across the northwestern section of the bay, is the second-busiest port in the nation by overall tonnage. The Houston Ship Channel, which connects the Port of Houston to the Gulf, passes through the bay. It is a partially man-made feature created by dredging.

A large commercial fishing industry has grown around Galveston Bay, with significant production of shrimp, blue crab, eastern oyster, black drum, flounder, and sheepshead. With its diverse marine life, Galveston Bay produces more seafood than any estuary in the United States except the Chesapeake.

Galveston Bay supports a significant recreation and tourism industry. Over 40% of Greater Houston residents participate annually in hiking and swimming along the bay, while 20% go fishing and 15% go boating. The recreational fishing industry supports over 3,000 jobs in the bay area.

With over 600 species of birds, Galveston Bay is a popular destination for birdwatching. This sort of ecotourism generates millions of dollars in annual revenue for Chambers County, which is home to the Anahuac National Wildlife Refuge and High Island.

THE GULF OF MEXICO

The Gulf of Mexico is an ocean basin of the Atlantic Ocean, mostly surrounded by the North American continent. It is bounded on the northeast, north and northwest by the United States; on the southwest and south by Mexico, and on the southeast by Cuba.

Features

The Gulf of Mexico basin is roughly oval in shape and is approximately 932 miles wide. It is connected to part of the Atlantic Ocean through the Florida Straits between the U.S. and Cuba, and with the Caribbean Sea via the Yucatán Channel between Mexico and Cuba. Because of its narrow connection to the Atlantic Ocean, the Gulf experiences very small tidal ranges. The Gulf of Mexico is 41 percent continental slope, 32 percent continental shelf, and 24 percent abyssal plain with the greatest depth of over 17,000 feet in the Sigsbee Deep.

The US portion of the Gulf coastline spans 1,680 miles, receiving water from 33 major rivers that drain 31 states. The land that forms the gulf's coast, includes many long, low-lying narrow barrier islands, and are characterized by marshes and swamps as well as stretches of sandy beach.

Plants and Animals

The outer margins of the wide continental shelves receive cooler, nutrient-enriched waters from the deep by a process known as upwelling, which stimulates plankton growth. This attracts fish, shrimp, and squid. River drainage and storm runoff from coastal cities also provide nutrients to the coastal zone.

Deep sea organisms include hydrogen vent communities with bacteria and microfuana. Megafauna (larger organisms) such as crabs, fish, and cetaceans also live in the deep waters. Recently, resident Bryde's whales within the gulf were reclassified as Rice's whales, a separate endemic (native to this area only) subspecies, making them one of the most endangered whales in the world.

Industry

The Gulf of Mexico supports major American, Mexican, and Cuban fishing industries along the wide continental shelf. Major catches include red snapper, amberjack, tilefish, swordfish, and various grouper, as well as shrimp and crabs. The Gulf of Mexico yields more finfish, shrimp, and shellfish annually than the rest of the Atlantic coast combined. The shelf is also where offshore drilling rigs are placed, most of which are situated in the western gulf. Other important industries along the coast include shipping, petrochemical processing and storage, military use, paper manufacture, and tourism.

ASSESSMENT OF LEARNING:

Students should use the vocabulary introduced in the article in their paragraphs correctly.

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 ask what else the students want to learn about the Galveston Bay and the Gulf of Mexico. Students may ask about the ocean floor, water depth, food chain related questions, or even how boats anchor in places with corals. All 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:

Students can research their chosen topic to learn more about Galveston Bay and the Gulf of Mexico.

NOTES:

https://www.fws.gov/doiddata/dwh-ar-documents/1187/DWH-AR0005539.pdf

https://www.eia.gov/special/gulf_of_mexico/

https://web.archive.org/web/20061003033047/http://www.epa.gov/gmpo/about/facts.html

https://www.noaa.gov/information-technology

https://www.epa.gov/gulfofmexico

Island STYLE

How Can You Save a Town from a Hurricane?

SUBJECT:

Social Studies

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Copies of *Galveston and the 1900 Storm: Catastrophe and Catalyst* by Bixel and Turner
- Other physical books showing Galveston before/after the Great Storm
- Reference images of Galveston before/after
- Job descriptions for "Expert Groups" - one copy per group
- Budget worksheet - one copy per group
- Model town
- Homes
- Sponges
- Play-Doh
- Clothes Pins

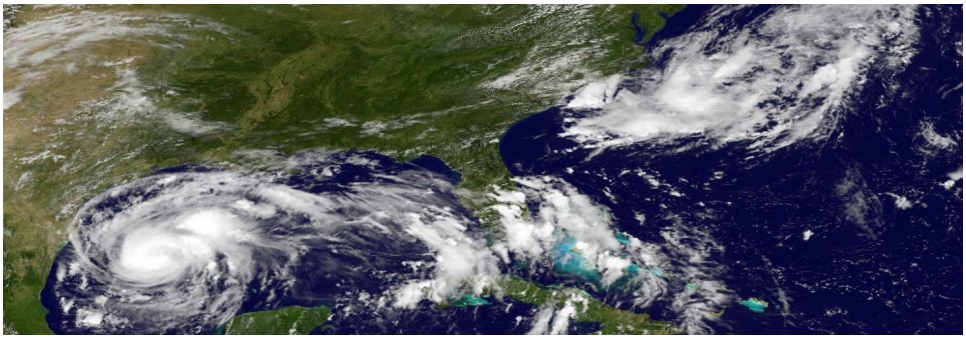
IVITY SUMMARY:

ents will learn about how Galvestonian's adapted the physical environment of the island after

RNING OBJECTIVES:

- The student will learn about how Galvestonian's adapted the physical environment of the

Evacuate - Remove (someone) from a place of danger to a safer place
Hurricane - A storm with violent wind, in particular a tropical cyclone in the Caribbean
Levee - An embankment built to prevent the overflow of water



ALIGNMENT:

TEKS

Geography

(3) The student understands the factors that influence the locations and characteristics of locations of various contemporary societies on maps and/or globes. The student is expected to:

6.3 (A) - Identify and explain the geographic factors responsible for patterns of population in places and regions
6.3 (C) - Identify and locate major physical and human geographic features such as landforms, water bodies, and urban centers of various places and regions

(5) The student understands the impact of interactions between people and the physical environment on the development and conditions of places and regions. The student is expected to:

6.5 (A) - Describe ways people have been impacted by physical processes such as earthquakes and climate
6.5 (B) - Identify and analyze ways people have adapted to the physical environment in various places and regions
6.5 (C) - Identify and analyze ways people have modified the physical environment such as mining, irrigation, and transportation infrastructure

Social Studies

(18) The student understands the influences of science and technology on contemporary societies. The student is expected to:

6.18 (A) - Identify examples of scientific discoveries, technological innovations, and scientists and inventors that have shaped the world

(19) The student applies critical-thinking skills to organize and use information acquired through established research methodologies from a variety of valid sources, including technology. The student is expected to:

6.19 (A) - Differentiate between, locate, and use valid primary and secondary sources such as oral, print, and visual material and artifacts to acquire information about various world cultures

6.19 (B) - Analyze information by sequencing, categorizing, identifying cause-and-effect relationships, comparing, contrasting, finding the main idea, summarizing, making generalizations and predictions, and drawing inferences and conclusions
6.19 (D) - Identify different points of view about an issue or current topic

(20) The student uses geographic tools to collect, analyze, and interpret data. The student is expected to:

6.20 (A) answer geographic questions, including: Where is it located? Why is it there? What is significant about its location? How is its location related to the location of other people, places, and environments? Using latitude and longitude, where is it located?

(21) The student communicates in written, oral, and visual forms. The student is expected to:
6.21 (A) - Use social studies terminology correctly
6.21 (C) - Express ideas orally based on research and experiences

(22) The student uses problem-solving and decision-making skills, working independently and with others. The student is expected to:

6.22 (A) - Use problem-solving and decision-making processes to identify a problem, gather information, list and consider options, consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of the solution.

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
3 The ocean is a major influence on weather and climate
6 The ocean and humans are inextricably interconnected

Trinity Episcopal Church

120 years after the Great Storm of 1900

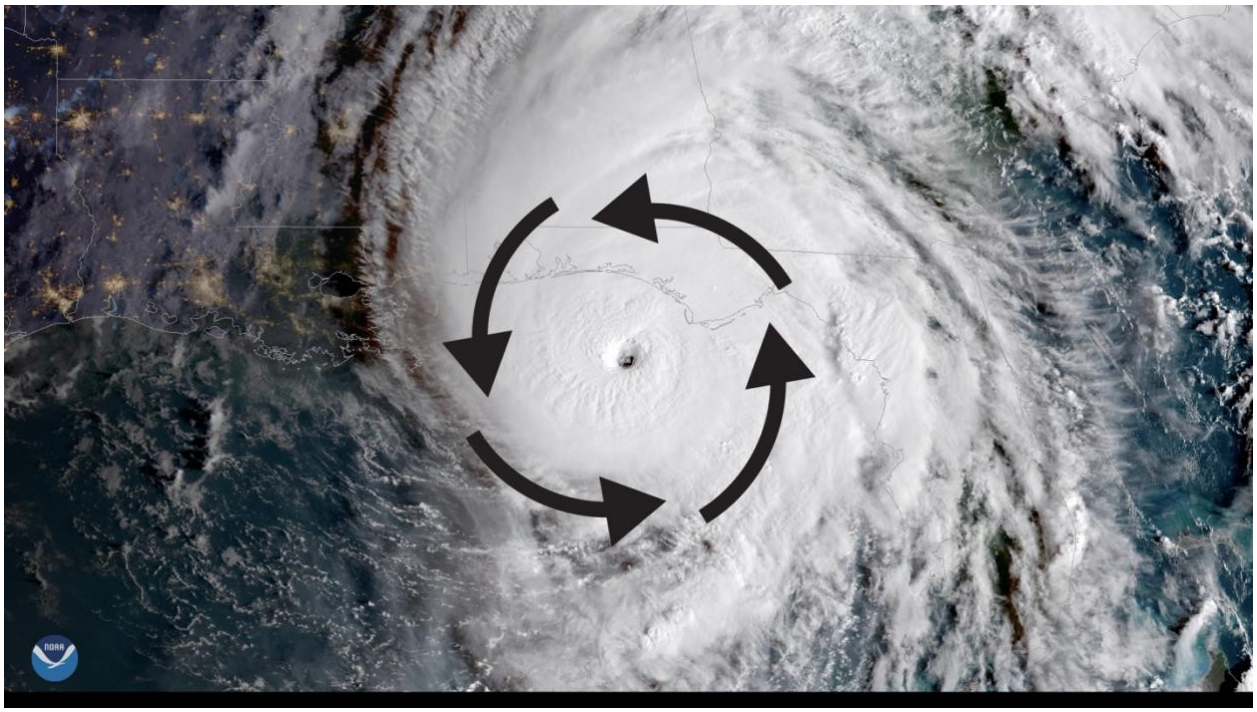
Notice the color difference of the bricks at the bottom of the building.
Compare the steps to the door in this picture with the historical photos.

BACKGROUND INFORMATION:

What is a hurricane?

Hurricanes, known generically as tropical cyclones, are low-pressure systems with organized thunderstorm activity that form over tropical or subtropical waters. They gain their energy from warm ocean waters.

As storm systems strengthen into hurricanes, the surface winds move continuously in a circular motion. Meteorologists refer to this pattern as “closed circulation." The direction of circulation is different depending on where the storm is located: it is counter-clockwise in the Northern hemisphere and clockwise in the Southern hemisphere.



This satellite image of Hurricane Michael from October 10, 2018 has arrows superimposed on top to show the closed circulation wind pattern that is characteristic of a hurricane. (NOAA Satellites/NOAA Office of Education)

These rotating winds lead to the development of the characteristic “eye” of the hurricane, the calm, clear center of the storm. The eye is surrounded by the eyewall, where winds are strongest.

Tropical cyclones are classified by their maximum wind speed.

- Winds less than 39 mph: Tropical depressions
- Winds 39-73 mph: Tropical storms
- Winds 74 mph or greater: Hurricanes
- Major hurricanes have winds of at least 111 mph and can reach speeds of over 180 mph, with gusts of 200 mph.

How does the storm get its name?

Once a storm escalates to tropical storm-level winds, it is given a name. The names are chosen by an international committee of the World Meteorological Organization. Names are reused every six years, although the WMO may retire the name of a particularly deadly or costly storm.

How do tropical cyclones form?

Tropical storms form from an atmospheric disturbance like a tropical wave or group of thunderstorms. For these disturbances to grow into a tropical cyclone, the following environmental conditions must be in place:

- Warm ocean waters (at least 80°F/27°C).
- An unstable atmosphere driven by differences in temperature, where temperature decreases with height.
- Moist air near the mid-level of the atmosphere.
- Must be at least 200 miles (with rare exceptions) north or south of the equator for it to spin (due to the Coriolis effect).
- Little change in wind speed or direction with height (known as low vertical wind shear).

Hurricane safety

Hurricanes, tropical storms, and tropical depressions pose a variety of threats to people and property. Storm surge and inland flooding have historically been the number one and two causes of loss of life during hurricanes. Hurricanes can also bring strong winds, tornados, rough surf, and rip currents. The time to prepare for a hurricane is before hurricane season begins, June 1 in the Atlantic.

Hurricane categories only tell part of the story

Hurricanes are categorized using the Saffir-Simpson Hurricane Wind Scale, which addresses wind speed on a scale from one to five. However, a tropical storm or category one or two hurricane can cause as much overall damage as a major hurricane.

The Saffir-Simpson Hurricane Wind Scale

The scale was created by wind engineer Herb Saffir and meteorologist Bob Simpson to help explain damage that buildings will sustain under different wind speeds. Importantly, the Saffir-Simpson scale does not include hazards from rain, flooding, or storm surge.

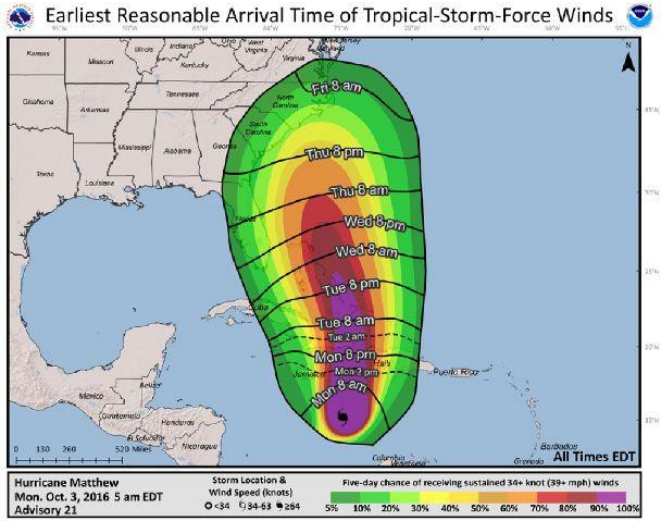
Every storm is different

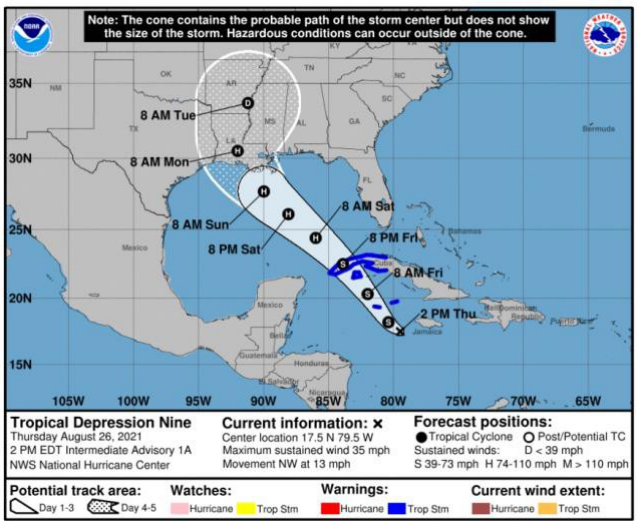
Each tropical system can bring a variety of unique, life-threatening hazards to a given location. It's critical to know your risk, especially if you live in a storm surge evacuation zone or in an area where flooding could occur. Even if you've previously survived a storm in your area, future hurricanes may bring different hazards.

Local officials may issue evacuation orders before storm or storm surge watches or warnings are issued for your area. Evacuation orders are released to ensure residents have enough time to leave vulnerable areas before the first hazards from the storm arrive.

Hurricanes bring extreme rainfall

Warm air can hold more moisture than cool air. In tropical cyclones, the air is particularly warm and can hold a tremendous amount of moisture. The moisture cools as it rises and condenses into heavy rain, often much more than a typical low-pressure system. These rains can occur not only at the coast, but many miles inland, causing flooding that can continue for days or even weeks after a storm.





The state of hurricane forecasting

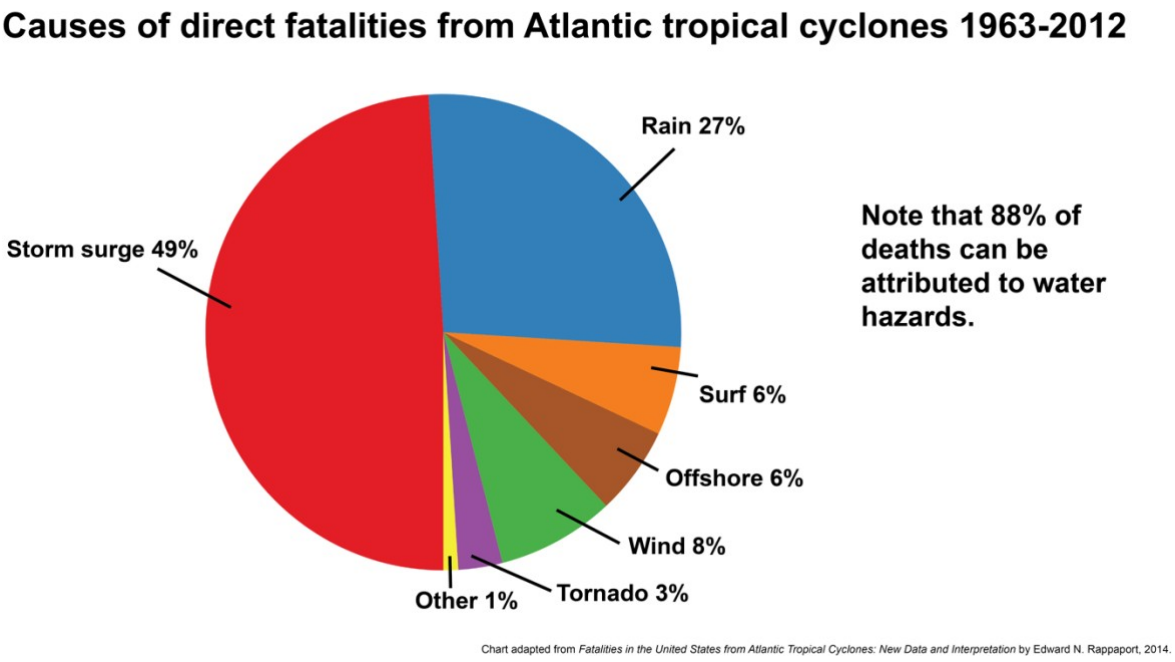
The National Hurricane Center has a long history of issuing tropical cyclone advisories, with the first known recorded forecast being in 1954, when 24-hour predictions of a storm's track were made. Since then, forecasts have been expanded out in time and added predictions of intensity, size, and associated hazards, such as wind, storm surge, and rainfall.

Water, not wind, is the biggest threat

Though hurricanes are well known for strong and destructive winds, hurricane storm surge is the greatest threat. Storm surge is water that is pushed toward the shore by winds swirling around the storm. This rise in water level can cause severe flooding in coastal areas. With much of the United States' densely populated Atlantic and Gulf Coast coastlines less than 10 feet above mean sea level, the danger from storm surges is tremendous. Historically, about half of direct fatalities from hurricanes that make landfall in the U.S. are from storm surge.

Run from the water, hide from the wind

When you're at risk from flooding, it's important to get to high ground away from bodies of water and any flood-prone areas. When there are high winds, but no danger of flooding (rare in hurricanes, but also important during any storm), it's important to shelter in place in a sturdy structure, away from doors and windows. This is why most evacuation orders are given for water, not wind.



PREPARATION:

Divide students into groups of 4 people

INTRODUCTION:

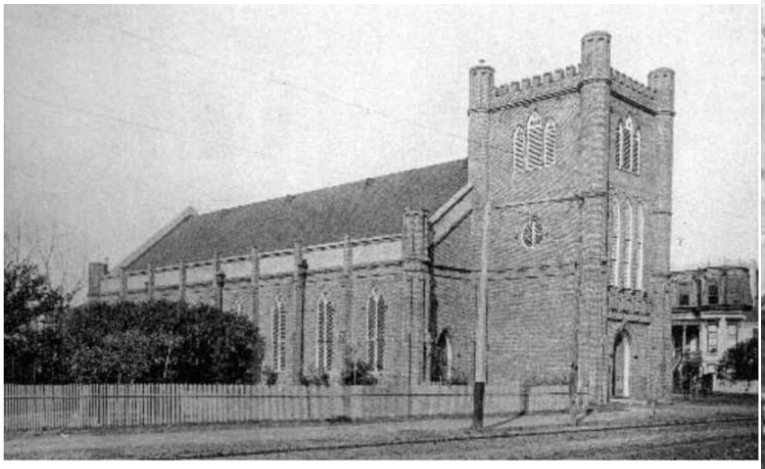
Have students talk to their elbow partner about their experience with hurricane preparedness.

Have you been a part of a hurricane evacuation? What did your family do to prepare before the storm hit? Did you help others prepare? How? How did you feel during the preparation? Did you actually evacuate? What was it like when you returned?

Show pictures of Galveston Island from before and after the 1900 Storm. Point out as many locations as can be identified that students would know today. Compare the Trinity Episcopal Church before, during, and after the storm using the photos below.

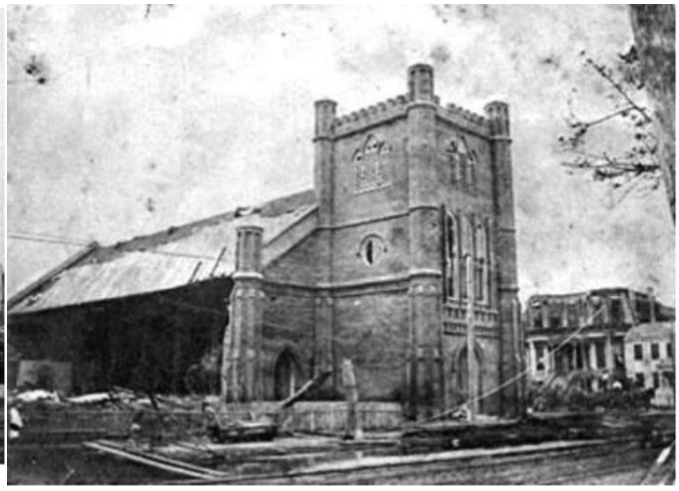
Trinity Episcopal Church

Before the 1900 Storm



- **Accession Number:** AW-50(b)
- **Date:** 1894
- **Description:** "Trinity Episcopal Church." Art Work of Galveston, 50 (bottom view).
- **Format:** Sepia print; 10.9 x 17.8 cm

After the 1900 Storm



- **Accession Number:** G-1771FF3.3-1
- **Date:** Sep 1900
- **Description:** Trinity Episcopal Church
- **Format:** Print from newspaper photograph; 13.5 x 17.5 cm

- **Accession Number:** G-1771FF3.3-2
- **Date:** Sep 1900
- **Description:** "Trinity Church"
- **Format:** Sepia photograph, mounted; 8.5 x 9.0 cm

After the 1900 Storm

Notice the pilings under the church and the height of the people

GUIDED PRACTICE:

People have been changing their environment throughout history to make where they live and work better for them. They dug ditches to bring water to their fields and homes. They dredged harbors to allow bigger ships in. They even built up the land to protect themselves from flooding.

Let's look at the model town (allow for students to gather around the model town or show it under a projector).

- **Where should the city go and why?** (Near the river outflow into the ocean for best connection to a harbor and transportation. *Place the buildings where the students decide).*

- **What if it rains upstream from the town?**
  - *(Pour water into the river to show the flow)* The rain will fill up the lakes, rivers, and canals throughout the city. Many canals have barriers around them, called levees, which are walls made of concrete and soil. A levee keeps water in the waterway and out of the city. Sometimes there is so much water that it starts flowing over the top of the levees. A boat or other large marine debris washed from upstream could actually smash into a levee during a storm, creating a hole where water could rush out. Water would then spill into the city. You know that water flows from high places to low places. Places that are low elevation get more flooding because water naturally flows downhill and collects there. Just like puddles forming in a low spot. **What could our townsfolks do to stop that flooding?** (allow students time to think and answer)

- **What if a hurricane came ashore in our town?**
  - Hurricanes form over the ocean in late summer when the water is warm. Warm water evaporates more easily than cold water does to form rain clouds. So as a hurricane moves over the warm ocean, its rain clouds get bigger and bigger as more and more ocean water evaporates. As a hurricane hits the coast, all the water that had evaporated from the ocean falls as rain onto the land. But the rain from a hurricane isn't the only problem. There's something else about a hurricane that causes flooding: ocean waves. Remember, hurricanes aren't just rainclouds. They're also super strong windstorms. The winds of a hurricane push on the surface of the ocean, creating waves that can come all the way up onto the shore. That causes flooding. When this happens, it's called a storm surge. Storm surge waves can be incredibly destructive. Some people who live near the ocean have to build their houses up on stilts to protect them from getting flooded in a storm surge. The stronger the winds in a hurricane, the higher the storm surge. Together, the storm surge and the rain both add water to the city.

- **What could our townsfolks do to deal with the ocean waves and flooding from the storm?**
  - After the Great Storm in Galveston in 1900, engineers had to come up with ideas for how to make sure the city wouldn't flood in the future if another hurricane hit. The first thing engineers had to figure out was how to protect the city from a storm surge. They figured out that one way to do that would be to build a seawall, a giant cement wall along the ocean shore to block the storm surge waves. Now suppose you were an engineer.

- **What would you do if you were in charge of protecting a town from flooding during a hurricane?**
  - You'll get a chance to figure that out in today's activity!

INDEPENDENT / GROUP PRACTICE:

Prompt:

In today's activity, you're going to protect Modeltown from flooding during a hurricane. The town is located along the Gulf of Mexico and has great beaches and many historic buildings. Tourists come from all over to relax on the beaches and visit the town's old buildings. Unfortunately, Modeltown is in the path of hurricanes. When the last hurricane swept through Modeltown, it caused a lot of problems. The storm surge sent ocean water into many buildings near the shore, flooding them. Water from the heavy rains made the river overflow, flooding buildings nearby. It took months to clean out the water and rebuild all those historic buildings. Before another hurricane comes along, the town council wants to add some kind of flood protection to the town. Your job is to find a solution to Modeltown's flooding problem.

Roles:

Split your class into teams of 4 four engineers and assign a type of engineer to each person in the group. Using Jigsaw, split into Expert groups so each engineer type can learn what they can do to help save our town.

Each expert group of engineers should read through their information and ask any questions they have. They should look at the town model or their drawing and discuss where their type of construction could best work to help save the town.

Return to the home group with the new found expertise. Have each engineer explain their expertise, what buildings their flood solutions can protect and how they could help the town.

These home groups should then work together to solve Modeltown's flooding problems. This could be done with a paper drawing or around the actual model.

Once you have completed the final plan, prepare to explain your plan to the other groups and discussing why they made the decisions that they did. There's more than one solution to Modeltown's problem!

ASSESSMENT OF LEARNING:

Discussion -

- Were the people of Galveston Prepared for the Great Storm to hit the island?
  - No they were not prepared!
-
  - Build the Seawall to keep back waves and raise the height of the island to help drain the water off if waves did come onshore.

  How are different parts of Galveston Island protected from hurricanes?
  - The sections of Galveston that are directly behind the seawall art protected due to the tall wall preventing waves fro coming up high enough to flood the city
  - Roads such as 9-Mile and 11-Mile Road allow for a direct pathway back into the salt marsh ecosystem where the wat is absorbed back into the watertable through the grasses and soil like a sponge
- Did other teams have ideas you didn't think of?
- Did any plan save all the historic buildings and come in under budget?
- What was the most convincing reason for why a team's plan was best?
- Are there things to consider other than cost?

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 ask what else the students want to learn about hurricane recovery and safety. Students may ask about specific named storms, the I Dike/ Coastal Spine, seawall expansion related questions, or even how the people of Galveston Island lived through the raising. 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:

Tell your students that the people of Modeltown had a meeting to discuss the proposals your class came up with. Ask your students how they would answer their questions or address their issues.

Remember: There are no right answers and it may be difficult to make everyone happy.

- Mrs. Green doesn't like the plans that include wetlands because she thinks wetlands have lots of mosquitoes. What would you say to convince Mrs. Green that wetlands are a good idea?
- Mr. Crawford's great-great-grandfather owned a historic general store near the River and the Ocean front. He says that stilts are not historically accurate and does not want them on his building. Can you protect that building without using stilts?
- Mr. Hunter is a bird watcher. He thinks you should make a paved nature trail and parking lot through the wetlands for bird watchers. Would these structures affect the wetlands ability to act like a sponge?

Environmental Engineers can solve the flooding problem by planting wetlands. A wetland is a swampy area between the ocean and dry land with plants that slow down the storm surge and land that acts like a sponge to absorb the extra water. They only protect the areas directly behind them however. Wetlands protect against storm surge but they don't protect against river flooding.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your sponge wetlands to the city model where they would protect the city the best

Seawall Engineers can solve the flooding problem by building seawalls. A seawall is a strong concrete wall built to stand between the ocean and the town. A seawall can stop storm surge from approaching the city from the beach side, but it won't protect from river flooding.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your seawall pieces to the city model where they would protect the city the best

Levee Engineers can solve the flooding problem by building levees. A levee is a wall of earth or stone built between the river and the town to prevent rainwater from overflowing into the city. Levees protect against a flooding river, but don't protect against storm surge from the ocean. Figure out which historic buildings you can protect by putting in levees.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your levee pieces to the city model where they would protect the city the best

Structural Engineers can solve the flooding problem by putting buildings on stilts. Each set of stilts lifts a building above flood waters so the flood waters will go under the buildings instead of through them. Stilts protect from both river flooding and storm surge.

- As an expert group, figure out which parts of town your solution would be best for and which historic buildings you can protect.
- Add your stilts to the city model where they would protect the city the best

Galveston Bay Watershed: An Eco-Art Workshop by Artist Boat

SUBJECT:

Science

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Introduction to Galv Bay
  - Map of Galv Bay
  - Colored dry markers (3 colors)
- Demonstrating Brack Water
  - Cups
  - Food colori
  - Salt
- Threats to Galveston
  - NPS kit
  - Watershed poster
- Importance of the Es
  - Spartina gra root system model
- Reference Materials
  - Guidebooks
  - Reference s
  - Posters
  - Figurines

'IVITY SUMMARY:

Students will be learning about environmental awareness, observational skills, and biological knowledge, which will result in informed decision making, responsible behavior, and constructive actions concerning wildlife and the environment.

.RNING OBJECTIVES:

- Differentiate salt/fresh/brackish water characteristics
- Understand threats to Galveston Bay due to pollutants

ALIGNMENT:

TEKS

Science -

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
6.3 (B) – Use models to represent aspects of the natural world
6.3 (C) – Identify advantages and limitations of models such as size, scale, properties, and materials
6.3 (D) – Relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content
6.7 (A) – Research and debate the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources

Ocean Literacy Principals

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
5 The ocean supports a great diversity of life and ecosystems
6 The ocean and humans are inextricably interconnected

VOCABULARY:

- **Biomagnification** – the concentration of toxins in an organism as a result of its ingesting other plants or animals in which the toxins are more widely disbursed
- **Brackish water** – A mixture of salt and fresh water
- **Erosion** – the wearing away of the Earth's surface by wind, water, or energy
- **Estuary** – a partially enclosed, coastal body of water where freshwater from rivers and streams mixes with salt water from the ocean
- **Hypoxia** – a state in which oxygen is not available in sufficient amounts at the tissue level to maintain adequate homeostasis
- **Non-point source pollution** – pollution that comes from many different sources, including storm water runoff and agricultural runoff; origins cannot easily be identified or regulated
- **Pelagic** – relating to the open sea
- **Point Source Pollution** – pollution that comes from definite sources, such as wastewater treatment plants, industry, or large chemical or oil spills
- **Salinity** – dissolved salt content of a body of water; measured in ppt (parts per thousand)
- **Wetland** – the place where water meets land and the land is saturated with water at some point during the year

BACKGROUND INFORMATION:

What are the 4 functions of the wetlands?

1. Flood prevention
2. Water filtration
3. Erosion prevention
4. Nursery habitat

The Galveston Bay Watershed

Galveston Bay is an estuary located in between Houston and Galveston along the upper Texas coast. The Galveston Bay connects the Trinity River and the San Jacinto River to the Gulf of Mexico. Galveston Bay is the seventh largest estuary in the United States, covering 600 square miles and is the second most productive fisheries in the United States.

Brackish Water

Due to the combining of the Trinity River, the San Jacinto River, and the Gulf of Mexico, the Galveston Bay consists of brackish water. The salinity, or amount of salt in the water, of an estuary can greatly influence the species present. Due to our growing need of fresh water, many estuaries are threatened to become too salty for many of these estuarine dependent animals to complete their lifecycles. Salinity is measured in parts per thousand (ppt). The average salinity of ocean water is 35 ppt, while brackish water is somewhere between 5 and 30 ppt. Freshwater stays below 5 ppt.

The Value of Estuaries

Estuaries are important because 90% of all fish, shrimp, and crabs need estuaries to complete their lifecycle. Besides providing food and income for many local people, pelagic, or ocean dwelling animals like tuna, red snapper, and marine mammals, depend on the food created from the estuary. Without the large amount of food created in the estuary, our oceans would be devoid of life.

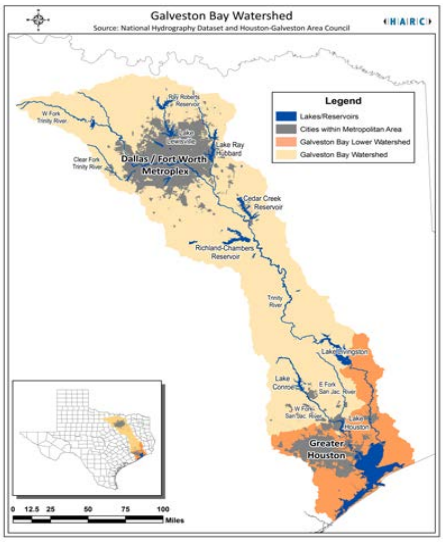
Estuaries are also home to a certain type of habitat called wetlands. A wetland is any area that has vegetation adapted to living in the water, soils that chemically and physically show they have been inundated with water, and water present for at least part of the year.

In Galveston Bay, there is a certain type of wetland called salt marsh wetlands. These wetlands are characterized by plants, such as cordgrass (Spartina spp.) that live in the shallow waters along the shoreline. These areas are important for many reasons, the main one being providing a nursery ground for many species of juvenile fish, shrimp, and crabs. Many juvenile animals feed off the grasses or off of epiphytes (plants and animals growing on the grasses) and use the grasses to hide from predators. Wetlands also act like a sponge, retaining water during times of rain. Houston was once covered in wetlands, but now because of the vast amount of concrete present, floods very easily. In addition, the roots and rhizomes (underground horizontal stems) of the salt marsh grasses help to prevent erosion by holding the soil in place. Finally, salt marsh grasses are highly effective at removing toxins from the water and holding sediments down, therefore helping to filter the water in Galveston Bay and keep the water less turbid from suspended solids.

Threats to Galveston Bay

There are many threats to Galveston Bay, including pollution, habitat loss, and subsidence. Pollution is a major threat to the bay due to the large size of the Galveston Bay watershed. A watershed is any surface area from which runoff resulting from rainfall is collected and drained through a common point. The Galveston Bay watershed covers 33,000 square miles, stretching from Dallas to Houston. The watershed for Galveston Bay is so large partly due to the Trinity River that originates in the Dallas/Fort Worth area. All of the potentially polluted runoff from the Trinity and San Jacinto rivers eventually drain into the Galveston Bay.

There are two types of pollution entering Galveston Bay: point source pollution and non-point source pollution. Point source pollution comes from definite sources, such as wastewater treatment plants, industry, or large chemical or oil spills. Non-point source pollution comes from many different sources, including storm water runoff and agricultural runoff. Non-point source pollution is a much bigger threat to water quality than point-source pollution because its origins cannot easily be identified or regulated.



MISCONCEPTIONS:

Some think that the Galveston water is dirty. While there are pollutants present in every body of water, the Galveston water appears dirty due to the turbidity, or lack of clarity. Turbidity is a result of suspended solids in the water. These solids are comprised of both organic and inorganic materials such as plankton and microscopic organisms, or clay and silt. Several different factors affect the turbidity of Galveston's water.

The sediment on the ocean floor off of Galveston Island is very fine silt that is easily suspended by wind and waves. The ocean floor also has a shallow gradient as you move away from Galveston, so the waves churn up the sediment as they head toward shore.

Sediment is also added into our coastal ecosystem. The Trinity River and other rivers and bayous in our watershed deposit sediment as they flow into Galveston Bay. Currents in the Gulf of Mexico also carry some of the sediment discharge from the Mississippi River to Galveston. Sediment loads can be greater in the spring when larger rain events and snowmelts increase river flow. Also, land-use changes have added to the sediment present in rivers as sediment becomes destabilized and more susceptible to erosion.

The presence of microscopic organisms in the water also adds to the water turbidity. These organisms in turn respond to nutrient loads in the water. Zooplankton eat phytoplankton and are food for fish and other marine life.

PREPARATIONS:

1. Acquire three cups
    a. Fill one cup with water and add one drop of red food coloring and one teaspoon of table salt
    b. Fill the second cup with water and add one drop of blue food coloring
    c. Leave the third cup empty
2. Set-up the non-point source (NPS) kit
    a. Put figurines on the model (i.e. barn, factory, home, animals, people)
    b. Fill spray bottle with water
    c. Acquire 4 small bottles and fill each with water
        i. Add one drop of red food coloring and mix
        ii. Add one drop of blue food coloring and mix
        iii. Add one drop of yellow food coloring and mix
        iv. Add one drop of green food coloring and mix

INTRODUCTION:

Show a picture of Galveston Island and ask leading questions to find out what students know and want to learn about the area. Show artifacts such as shells, skulls or feathers and ask leading questions to find out what students know and want to learn. Also take note of misconceptions that are voiced and be sure to address those later in the presentation.

GUIDED PRACTICE:

Introduction to Galveston Bay

Using a map, show the location of Galveston Bay. Explain that because Houston touches the shores of Galveston Bay, it is considered a coastal city. Ask for four volunteers. Give each volunteer a card with either the Gulf of Mexico, Galveston Bay, Trinity River, or estuary on it. Give sticky tack to the students that have the Galveston Bay, Trinity River, or the Gulf of Mexico cards and ask them to locate these areas on the map. Ask the volunteer with the estuary card to define an estuary. Students may also point out different parts of Galveston Bay such as the ship channel, West Bay, East Bay, or Trinity Bay. You should put a flag on the map near your school.

Demonstrating Brackish Water

Ask for three volunteers. Give the cup with blue water (no table salt) to the first volunteer. Give the cup with red water and table salt to the second volunteer, while the third volunteer gets the empty cup. Ask the person with the blue water to taste the water and describe what it tastes like. Next, ask them where they think this water could have come from (Trinity or San Jacinto River). Ask the second volunteer to do the same and describe where the water could have come from (Gulf of Mexico). Next, have the students each pour half of their cup of water into the empty cup. The student does not have to taste the water this time, but ask them to tell you what kind of water this is (brackish). Reiterate that this experiment is similar to the mixing of fresh and salt water in Galveston Bay.

Write the three different ranges of salinity with their corresponding area on the board for the students to see. Explain that different areas of the bay have different salinities based on their proximity to the Gulf of Mexico or fresh water sources, such as the Trinity River. Using the map, show them that Trinity Bay, for example, would have a lower salinity than west Galveston Bay. Ask them if they think the salinity would be greater in the winter or the summer (summer would be higher because the water gets hot, evaporates, and leaves salt behind. Furthermore, because of the reduced amount of rainfall in the summertime, the rivers are not contributing as much fresh water to the estuary).

Importance of the Estuary

Show the Spartina grass and root system. Explain that the roots of estuary plants are about 3x as long as the part of the plant that is above the soil and water. If you can see a 1 foot tall plant, the roots would be about 3 feet long. Demonstrate that the roots do not grow vertically down, but rather horizontally, creating a net-like affect that holds the soil in place. Pass "roots" out to multiple students that are spread out throughout the classroom. Stand in the middle of the roots holding the plant and ask students to gently pull on the "roots". Have certain students pull harder to demonstrate what it would be like when wind or water pressure increases. One-by-one, have students begin letting go of their "root" to demonstrate that even as plants are being uprooted, the plant is kept in place by these roots that go in all different directions.

Threats to Galveston Bay

To demonstrate non-point source pollution, use the non-point source pollution (NPS) kit. Set the kit out and explain that this farm represents one of the many farms between Houston and Dallas located near the Trinity River. Give the farmer a name and a specified crop. Hold up the bottles of "pollutants" and explain what each one is, how they benefit the farmer, and how each can harm the environment.

1. **Fertilizer** - used to make plants grow; can have a negative effect when it gets into waterways because it can lead to algal blooms. Oftentimes, algal blooms cloud the water, which can damage coral reefs or sea grass beds. Algal blooms can also cause hypoxia (low oxygen levels) because the bacteria that reproduce uncontrollably during the algal bloom use up all the oxygen during respiration.

2. **Herbicide** – a type of pesticide that kills unwanted weeds; can negatively affect animals when it enters waterways. Both farmers and homeowners use herbicides to kill unwanted plants, either for aesthetic lawn purposes or to prepare a more stable growing environment for the preferred crop.

3. **Insecticide** – a type of pesticide that kills organisms that eat desirable plants; can also be used on the exterior of homes or businesses to keep insects outside. DDT was used in the US during the 1950's that almost led to the extinction of the brown pelican, the bald eagle, and a few other bird species. DDT traveled up the food chain in a process called biomagnification. In biomagnification, the concentrations of a chemical become greater as you travel up the food chain. DDT was first sprayed on farms to repel and kill bugs that would eat the plants. This DDT then became present in bugs and microscopic animals and plants in the water called plankton. Fish that eat the plankton or bugs would then accumulate the DDT in their bodies, and larger carnivorous fish would eat those fish and accumulate even more in their bodies. Finally, an apex predator, such as a bald eagle or a brown pelican, who eat hundreds of fish per year, eat the large fish with DDT in them and become ill. Because DDT is not metabolized as quickly as other nutrients, it accumulates at every tropic level, causing the concentrations to become larger at each level. DDT caused brown pelican eggs to become very thin and brittle, so that when the bird sat on the egg to incubate them, they would break. Obviously, there were not many baby brown pelicans being born until after DDT was banned, in the 1960's. A woman named Rachel Carson helped to publicize the negative effects of DDT in a

book titled Silent Spring, named because of the possibility of having a silent spring when all the animals were extinct from heavy chemical use. It took many years after DDT was banned for both the brown pelican and the bald eagle to be placed off the endangered species list.

4. **Oil** – motor oil that runs off from roads or that is illegally dumped into waterways/storm drains poses a great threat to wildlife; since oil floats on the surface of the water, it is easy for animals to consume it or have it cover their body which can lead to them dying due to poisoning or drowning

Once the chemicals have been explained, have a volunteer come up one at a time to spray the chemicals on the farm. Ask the students to remember what each chemical does for the farmer and to the environment. Have the final volunteer spray water on the farm and explain that this represents a big rainstorm. Open the lid on the NPS kit and show the students the polluted water that has traveled down the river and entered Galveston Bay.

INDEPENDENT/GROUP PRACTICE:

Ask students to sketch their version of the Houston/Galveston area. Have students add 10 places, things, or landmarks to their map. These things could include their home, school, church, sport facility, or favorite restaurants, as well as the Gulf of Mexico, Galveston Bay, Pelican Island or Bolivar Peninsula. Allow students to share with the class their maps and what all they chose to include.

ASSESSMENT OF LEARNING:

Ask students to reflect on the pollutants that are threats to Galveston Bay. Have them determine 3 ways that pollutants could be minimized or prevented.

CLOSING:

As you teach lessons linked to our Galveston Bay watershed and the Gulf of Mexico you can use the “I Wonder” board as a closure assignment.

For example, after teaching about the Galveston Bay Watershed, you might ask what else the students want to learn about pollutants. Students may ask about additional animals that were affected by DDT, or specific microorganisms in Galveston Bay or other bodies of water and the water chemistry present. All of their questions (even the ones asked multiple times) would go to the “I Wonder” board. If a question was answered in the lesson, it still goes on the board.

Students may even have questions days later that could be added. The goal is to have a place for all questions about Galveston Bay and Gulf of Mexico to be housed.

EXTENSION:

Learning more about the Galveston Bay watershed and the Gulf of Mexico can be done through the NOAA VWET (Virtual Watershed Education & Training) online program and websites such as NOAA and Galveston Bay Foundation.

NOTES:

Island STYLE

Watercolor Painting: An Eco-Art Workshop by Artist Boat

SUBJECT:

Science

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Introduction
  - Scrap paper
  - Pencils
- Interpretive Art Activ
  - Watercolor palettes
  - Watercolor
  - Water cups
  - Small water boards (4.5
  - Masking tap
  - Paper towel
  - Bucket
  - Reference

'IVITY SUMMARY:

- Students will learn about local coastal ecosystems and the wildlife that inhabits them by applying new knowledge of watercolor painting techniques and creating a watercolor painting.

.RNING OBJECTIVES:

- Understand threats to the environment due to pollutants
- Recognize the value of protecting the environment
- Identify coastal wildlife species

ALIGNMENT:

TEKS:

Science -

6.3.(B) – Use models to represent aspects of the natural world
6.3.(C) – Identify advantages and limitations of models such as size, scale, properties, and materials
6.3.(D) – Relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content
6.7.(A) – Research and debate the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources

Art –

1(A) – Identify and illustrate concepts from direct observation, original sources, personal experiences, and communities such as family, school, cultural, local, regional, national, and international
1(B) – Understand and apply the elements of art, including line, shape, color, texture, form, space, and value, as the fundamentals of art in personal artworks using art vocabulary appropriately
2(A) – Create original artworks based on direct observations, original sources, personal experiences, and the community
2(C) Produce artworks, including drawings, paintings, prints, sculptures/modeled forms, ceramics, fiber art, photographic imagery, and digital art and media, using a variety of materials

Ocean Literacy Principals:

1 Earth has one big ocean with many features
4 The ocean makes Earth habitable
5 The ocean supports a great diversity of life and ecosystems
6 The ocean and humans are inextricably interconnected

VOCABULARY:

- **Brackish** – A mixture of salt and fresh water
- **Contour Line** – A line on a map joining points of equal height above or below sea level
- **Erosion** – The wearing away of the Earth's surface by wind, water, or energy
- **Estuary** – A partially enclosed, coastal body of water where freshwater from rivers and streams mixes with salt water from the ocean
- **Non-Point Source Pollution** – Pollution that comes from many different sources, including storm water runoff and agricultural runoff; origins cannot easily be identified or regulated
- **Pelagic** – Relating to the open sea
- **Point Source Pollution** – Pollution that comes from definite sources, such as wastewater treatment plants, industry, or large chemical or oil spills
- **Transparency** – Being able to see through (or partially see through) one or more layers in an artwork
- **Salinity** – Dissolved salt content of a body of water; measured in ppt (parts per thousand)
- **Watercolor Painting –** A work of art executed with watercolor paint
- **Wetland** – The place where water meets land and the land is saturated with water at some point during the year

BACKGROUND INFORMATION:

What are the 5 functions of the wetlands?

1. Flood prevention
2. Water filtration
3. Erosion prevention
4. Nursery habitat
5. Blue carbon sink

The Galveston Bay Watershed

Galveston Bay is an estuary located in between Houston and Galveston along the upper Texas coast. The Galveston Bay connects the Trinity River and the San Jacinto River to the Gulf of Mexico. Due to the combining of these two major rivers and the Gulf of Mexico, the Galveston Bay consists of brackish water.

Watercolor Painting Techniques

1. **Wash** - In a wash, colors are added on top of each other while still wet to create interesting blending effects. Remember to work from light to dark. Use this technique for the larger areas, such as the sky, water, or ground. To do this, wet the brush without paint, spread it over the paper as if there were paint on it, add some color to the paintbrush, and paint over the area with water. This technique allows paints to be spread evenly and lightly for background colors.

2. **Wet brush, dry paper** - this is the most common technique used while watercolor painting; can be used to outline large land masses and outline animals or plants

3. **Dry brush**- A dry brush technique involves not using as much water with the brush in an attempt to create details. Create a small pool of water in the color well that you are wanting to use, then pinch out the excess water left in the paint brush. Gently hold the bristles of the paint brush over the small pool of paint and allow the paint to be absorbed up into the brush.

PREPARATIONS:

1. Tape a 4.5 x 6 in. piece of watercolor paper to a wooden board (enough for the first class period at minimum)
2. Half-way fill a cup with water for each student
3. Gather reference images of local coastal wildlife

INTRODUCTION:

Provide students with reference images of local coastal wildlife (i.e. marine mammals, fish, coastal prairie mammals, birds, invertebrates). Have each student choose 3 unique images that they would consider for their watercolor painting. Allow students to quickly sketch each of these images and discuss the importance of contour lines in a painting. Ask students to partner up and discuss why they chose the images they did and determine what could be pros and cons of painting each of the images.

GUIDED PRACTICE:

Watercolor Painting Demonstration

1. Quickly choose a subject from provided resources.
2. Decide if it is going to be a portrait or a landscape.
3. Perform a quick contour line drawing of the subject, and other major parts to the painting. It is easier to look at the drawing while doing this instead of focusing on your hand, similar to playing a video game. A horizon line should be established, and the ground or water should meet the horizon line. Discourage the use of happy-faced suns, fake fluffy clouds, m-shaped birds, and other elementary symbols.
4. Sketch white areas to avoid painting over them. There is no white paint.
5. Show class that there are only 12 colors in watercolor set; encourage them to mix colors in wells.
6. Show examples of how to paint using the 3 main watercolor painting techniques: wash, wet paint – dry paper, and dry brush.
7. Allow students to ask any questions that they have regarding the painting techniques or upcoming independent practice.

INDEPENDENT/GROUP PRACTICE:

Equipment Rules

1. Do not touch supplies until asked to do so.
2. Pour out dirty water and get fresh water for the next group.
3. Paint wells should be cleaned with paper towel after each use.
4. Paint brush must be washed out and placed in paint palette with pencil.
5. Replace reference images.
6. Remove painting and stack board.
7. Throw used paper towels and tape in the trash.

Watercolor Tips

1. Portrait vs. Landscape- first decide which fits your drawing.
2. Subject must take up 2/3 of page.
3. Background must be present behind animal- gives depth
4. Foreground must be present in front of animal- gives depth.
5. Light to dark- work light to dark with watercolors.
6. Contour line drawing- the outer edge of any shape. Make a simple contour line drawing of subject. Leave detail for painting. Students should only spend 5 minutes on contour line drawing.

Watercolor Painting

1. Have students choose which of the 3 sketched images (completed during the introduction activity) they would like to use as reference for their watercolor painting.
2. Transfer the sketch to their 4.5 x 6 in. watercolor paper or create a new sketch that reflects information learned throughout this watercolor painting Eco-Art Workshop.
3. Allow students to begin watercolor painting.
4. Walk around the room while students are water coloring to assist.
5. Provide frequent updates on time remaining.
6. Have students clean up their work area, leaving it as clean as when they started. Pour out dirty water and refill with clean water for the next class. Clean dirty paint wells with paper towels. Wash out paint brushes and place back in paint palette alongside pencil. Return reference materials. Remove painting from boards when fairly dry. Throw paper towels and tape into trash.
7. Ask students to write their first and last name, as well as the date on their art piece.

ASSESSMENT OF LEARNING:

Informal viewing of artwork will show that students have gained the ability to contour line draw and watercolor paint used the three main techniques.

CLOSING:

As you teach lessons linked to Watercolor Painting: An Eco-Art Workshop by Artist Boat, you can use the “I Wonder” board as a closing assignment.

You might ask what else the students want to learn about different ecosystems within the Galveston Bay watershed, watercolor painting, or specific species in their own backyards. Students may ask about artists who are known for their watercolor paintings or coastal food chains. All of their questions (even the ones asked multiple times) would go to the “I Wonder” board. If a question was answered in the lesson, it still goes on the board.

Students may even have questions days later that could be added. The goal is to have a place for all questions about the Galveston Bay watershed, the Gulf of Mexico, and local wildlife to be housed.

NOTES:

Island STYLE

How Many Red Snapper Can I Keep?

SUBJECT:
Math

GRADE LEVEL:
6th

TIMEFRAME:
45 - 90 minutes

MATERIALS:

- 1 bag of plain popped popcorn
  - "Adult Fish"
- 1 bag of Chex Mix
  - "Bycatch"
- 1 bag of Goldfish
  - "Juvenile Fish
- Assorted seashells
- Serving spoon
  - "Large Trawl"
- Dinner spoons
  - "Small Trawl
- Chopsticks
  - "Hook and Li
- Pretend Money
  - $1 and $5 bill
- Quota tickets

lents will learn about the management of commercial and recreational fisheries using data from Gulf of Mexico and Texas state waters snapper catch.

- Students will learn about Northern red snapper, a commercially important fish species in the Gulf of Mexico
- Students will learn about the effectiveness of different fishing methods, tools, and techniques
- Students will understand biological, economical, and social impacts of regulations placed on commercial fisheries

GNMENT:
S

6.1 (A) – apply math to problems arising in everyday life, society and the workplace.
6.1 (B) -use a problem solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem solving process
6.1 (C)- select tools, including real objects, manipulatives, paper and pencil, technology as appropriate to solve problems
6.3 (D) – add, subtract, multiply and divide integers fluently
6.12 (A) – represent numeric data graphically
6.13 (A) – interpret numeric data summarized in dot plots

n Literacy Principles: 1, 5, 6

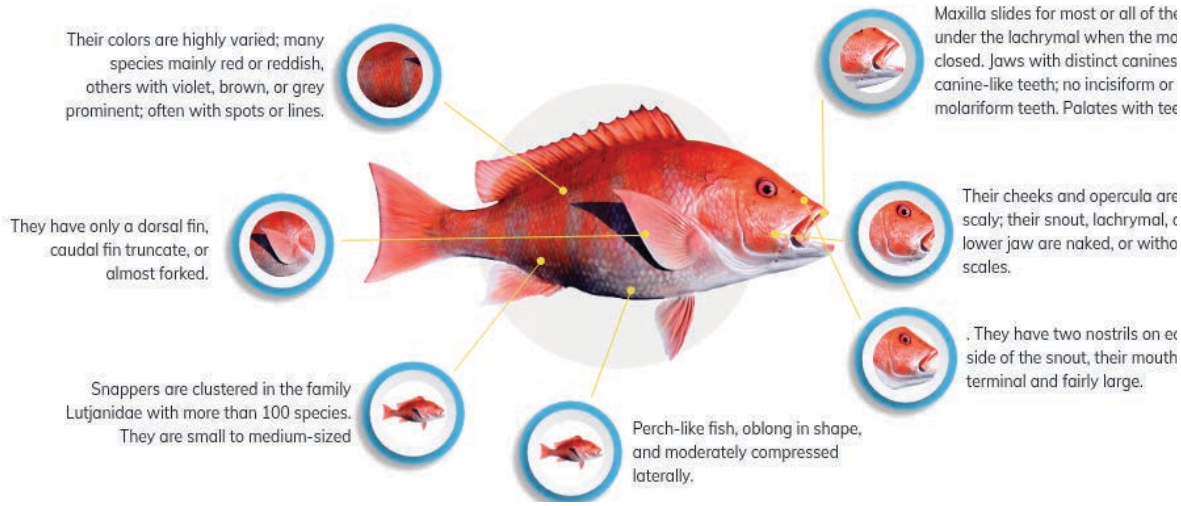
CABULARY:

- **Habitat** - The natural home or environment of an animal, plant, or other organism
- **Trawl** - An act of fishing with a trawl net

Snapper

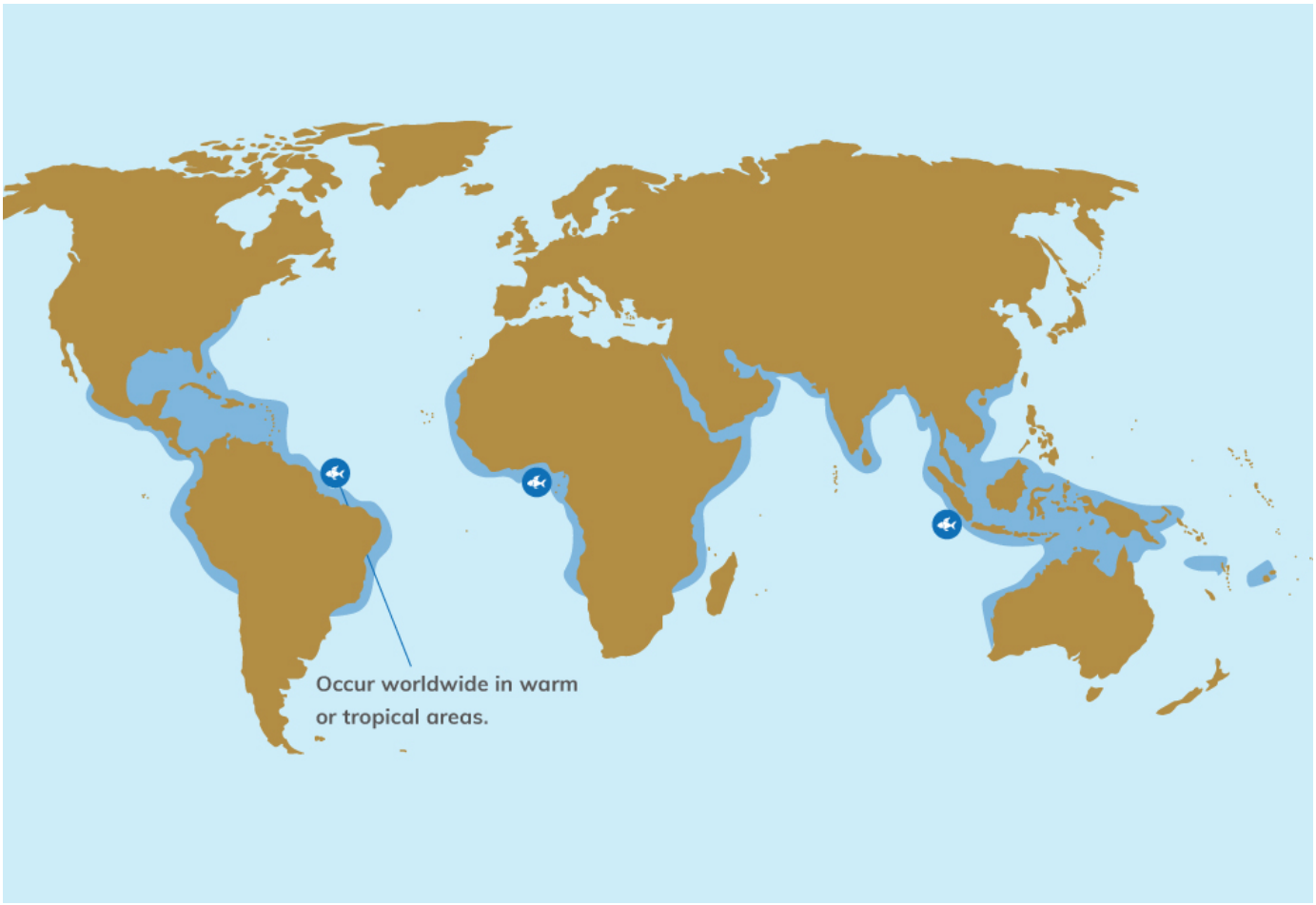
Common names: Red snapper, lane snapper, Caribbean red snapper, redfish, southern red, silk snapper

Scientific name (various species): Lutjanus purpureus, Lutjanus synagris, Lutjanus vivanus, Rhomboplites aurorubens, Ocyurus chrysurus



Habitat Depths

Location



Fishing Season

Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Fishing Methods

Bottom Trawl

Bottom Long Lines

Gill Nets / Trammel

Hand Lines

- **Species name:**
  - *Northern red snapper*
- **Native:**
  - to the Western Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico
- **Habitat:**
  - Inhabits rocky seafloors and artificial reefs such as oil rigs and shipwrecks
- **Characteristics:**
  - Ray-finned fish with a sloped profile, medium-to-large scales, a spiny dorsal fin, and a laterally compressed body. Northern red snappers have short, sharp, needle-like teeth but lack upper canine teeth. Large and red in color. Can be up to 39 inches long, weigh up to 50 lbs, and can live to be over 50 years old!
- **Commercial use:**
  - Northern red snapper (*Lutjanus campechanus*) is perhaps the most economically valuable and culturally relevant fishery in the U.S. Gulf of Mexico. The trends in fishing activity over the past 150 years have led to a depleted stock, which is now under a rebuilding plan. As the stock continues to show signs of recovery, fishermen are seeing more (and larger) red snapper in the population; however, the spawning potential of the population (the number of eggs produced by reproductively active females) is still lower than the rebuilding target. The conundrum caused by a population that is rapidly rebuilding, but has not yet met its rebuilding target (the biomass needed for long-term sustainable yield), has led to discontent among some user groups. Hearing the frustration from their constituents, lawmakers took action.
- **The Great Red Snapper Count:**
  - In 2016, Congress made funding available to independently estimate the population size of U.S. Gulf of Mexico red snapper. A total of $10 million was awarded by Mississippi-Alabama Sea Grant for a two-year project, which will run from 2017 – 2019. The project, officially titled 'Estimating the absolute abundance of red snapper in the U.S. Gulf of Mexico,' but better known as the Great Red Snapper Count, aimed to estimate the population size of red snapper in U.S. waters of the Gulf of Mexico. This evaluation was conducted separately from the assessment process employed by the Gulf of Mexico Fishery Management Council through the SEDAR process. The project was led by a well-integrated, multidisciplinary team of 21 investigators, which was comprised of leading fisheries experts from the Gulf region and beyond. A suite of methods, including habitat classification, direct visual counts, depletion surveys, and a high-reward tagging study, was used across the entire U.S. Gulf of Mexico

BACKGROUND INFORMATION:

Fishing Methods

- Some fishing methods, such as purse seining and dredging, catch a significant amount of bycatch because they use nets in the water column, which sometimes capture unintended animals. Additionally, some methods, such as trawling, cyanide fishing and explosives also wreak havoc on the seafloor, uprooting long standing corals and kelp beds.
- More environmentally friendly methods include trolling, a hook-and-line method that tows fishing lines behind or alongside a boat. Fishermen use various baits to "troll" for specific fish at different depths. This method catches fish that will follow a moving lure or bait, such as salmon, mahi mahi and albacore tuna. Trolling is an environmentally responsible fishing method. Fishermen can quickly release unwanted catch from their hooks since lines are reeled in soon after a fish takes the bait.

Conservation & Sustainability Methods

- There are many potential solutions regulating fisheries so that they are more sustainable, which means that it meets the needs of the present without compromising the ability of future generations to meet their own needs. Students will be asked to come up with their ideas for ways to be more sustainable. This will help them build critical thinking skills. However, if they struggle, you can introduce some of these ideas.
- Catch Limits: the maximum number of fish that an angler may catch from a specified waterbody or a portion of a waterbody in one day.
- Catch Share: a fishery management system that allocates a secure privilege to harvest a specific percentage of a fishery's total catch to individuals, communities and/or associations throughout the season. This often creates an increase in fish available over time.
- Marine Sanctuary: is a federally designated area within United States waters that protects areas of the marine environment with special conservation, recreational, ecological, historical, cultural, archeological, scientific, educational, or aesthetic qualities.
- Outlawing certain fishing methods: Many places are now outlawing trawling, explosives, and cyanide fishing in order to prevent bycatch, and environmental problems.
- Responsible Consumerism: If people refuse to buy certain fish because there is too much impact on the animal populations then they are practicing “responsible consumerism.” Sometimes this means buying “good alternatives,” or choosing not to consume fish at all.

PREPARATION:

Players

- 1 Fisheries manager (the teacher)
- Pairs of fishermen

Game set up

- Scatter shells across the tray playing surface
- Disperse all the adult fish, juvenile fish and bycatch across the habitat
- Distribute $10 to each pair of fishermen
- Distribute gear based on fisherman choice
- Large Trawls $10, small trawl $8, hook and line $5

Rules of the game

- All gear must be used properly!
- Trawls must have contact with the table at all times and collect everything in the path.
- Hook and line can grab just two at a time.
- New or additional gear can **only** be purchased at the beginning of a new season.
- Each target adult fish landed is worth $1
- Fisheries manager will monitor the season fishing time
- Fines for rule violation -$2 for improper gear use, -$4 for fishing outside the season
- All Fishing statistics must be reported at the end of the season.
- Fisheries manager will record the statistics and set the next season catch based on spawning rules.

Spawning rules

- Adult fish: add ½ the number of juvenile fish remaining back to the habitat.
- Juvenile fish: add 1x the number of adult fish that are left.
- Bycatch: add ½ of the number of bycatches that are left.

INTRODUCTION:

You are a local fisherman in the Galveston area targeting red snapper, the delicious fish that is on every menu at every restaurant in town. Fisherman from far and wide are meeting the demand by investing the time and money needed to bring these fish to market through many different harvest methods. A fisheries manager is responsible for ensuring a healthy and sustainable stock of all of our game fish in the state and federal water off our coastline. The Gulf of Mexico Fishery Management Council through NOAA has the authority to develop and enforce management measures and participating fisherman must comply with those rules. The rules for amount of time you can fish, how big the fish must be to keep them and how many fish you can catch change from year to year based on data from the previous fishing season.

GUIDED PRACTICE:

Season 1 - **No regulations**
- No catch limits, play for 15 seconds.

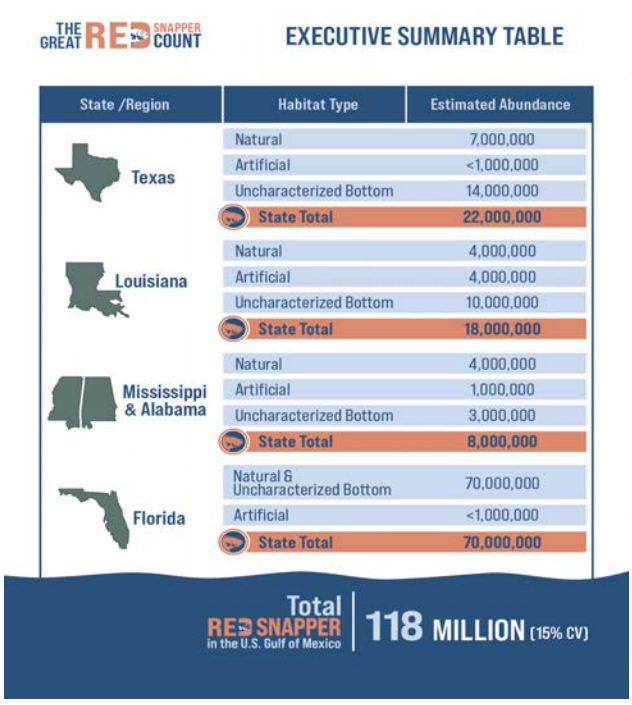
Season 2 - **Catch limits**
- Due to impacts from overfishing last season, there is now a limit of half the adult fish biomass. Fishing stops when statistics reach the catch limit.

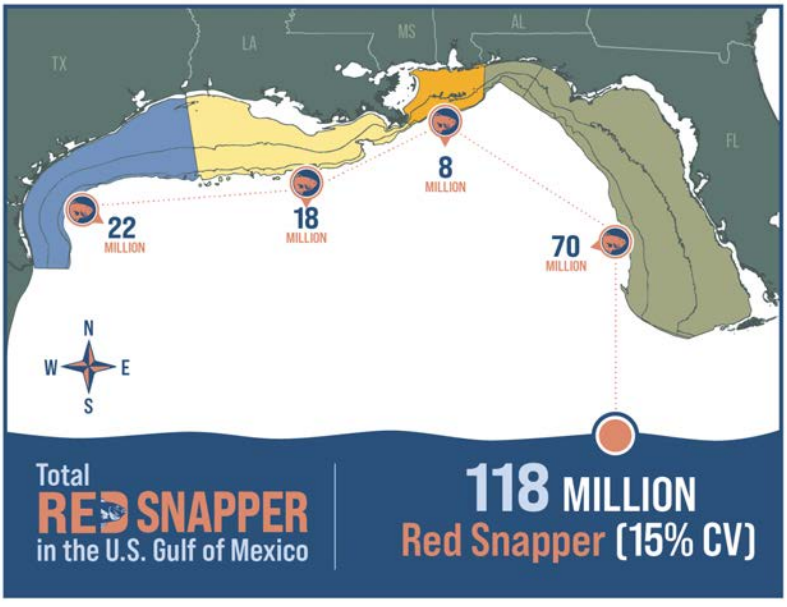
Season 3 - **Early season closure**
- The catch limit from last year is still in place, but due to declining adult populations, there will also be a shortened fishing season of five seconds. If the catch limit is reached before the five seconds, fishing will stop.

Season 4 - **Catch share or quotas**
- Catch limit of half the adult fish biomass still in place. Each fisherman also now receives a quota which guarantees each fisherman a share of the catch limit.
- Allocating quota shares - divide the catch limit by the number of fisherman teams.
- Teams can buy or sell their quota shares.
- If a fisherman team goes over their quota, they must purchase a quota share from another fisherman or borrow against next year's quota.
- There is no time limit. Each fisherman has as much time as needed to land their allotted quota.

INDEPENDENT / GROUP PRACTICE:

Have the students work in small groups to graph their data from the activity. See graphing worksheet attached below.





ASSESSMENT OF LEARNING:

Discussion -

Hold a discussion to help students process what they have learned during each season. Give real world statistics and stories about our snapper fishery that might illustrate the situation they were simulating.

- What happened **BIOLOGICALLY** after each season? Look at the graphs they created to see how the numbers of fish fluctuated.
  - Were there some areas of habitat that had more fish than others?
  - When you have been fishing, do you throw the small fish back?
  - Do they always live when you throw them back in?

- What happened **ECONOMICALLY** after each season?
  - Were there seasons when it was easier to make money?
  - Harder?
  - More stability for the long term?

- What happened **SOCIALLY** among the fisherman teams?
  - Why did they make the decisions they did about gear choice or quota selling?
  - Did they work together?
  - Fight over good fishing habitat?

Season 1 - Expect to see habitat destruction, aggression among fisherman, and high catch numbers.

Season 2 - Expect to see a shorter fishing season, landings exceeding the catch limit, fines, and a shift in gear type from trawl to hook and line.

Season 3 - Expect to see landings exceeding catch limits, fines, and a shift from trawl to hook and line.

Season 4 - Expect to see the pace of the game slow significantly. Fisherman may plan more efficiently to stay within their quota and avoid juvenile fish, bycatch and habitat destruction. Some fishermen may choose not to fish at all, but to sell their quota instead.

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 ask what else the students want to learn about fisheries management. Students may ask about other species, the difference between commercial fishing rules and recreational fishing rules, game wardens, or even how turtle excluder devices work on a shrimp boat. 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:

Play Season 1 several times in a row to show the effects of no regulation on the habitat and fishery numbers.

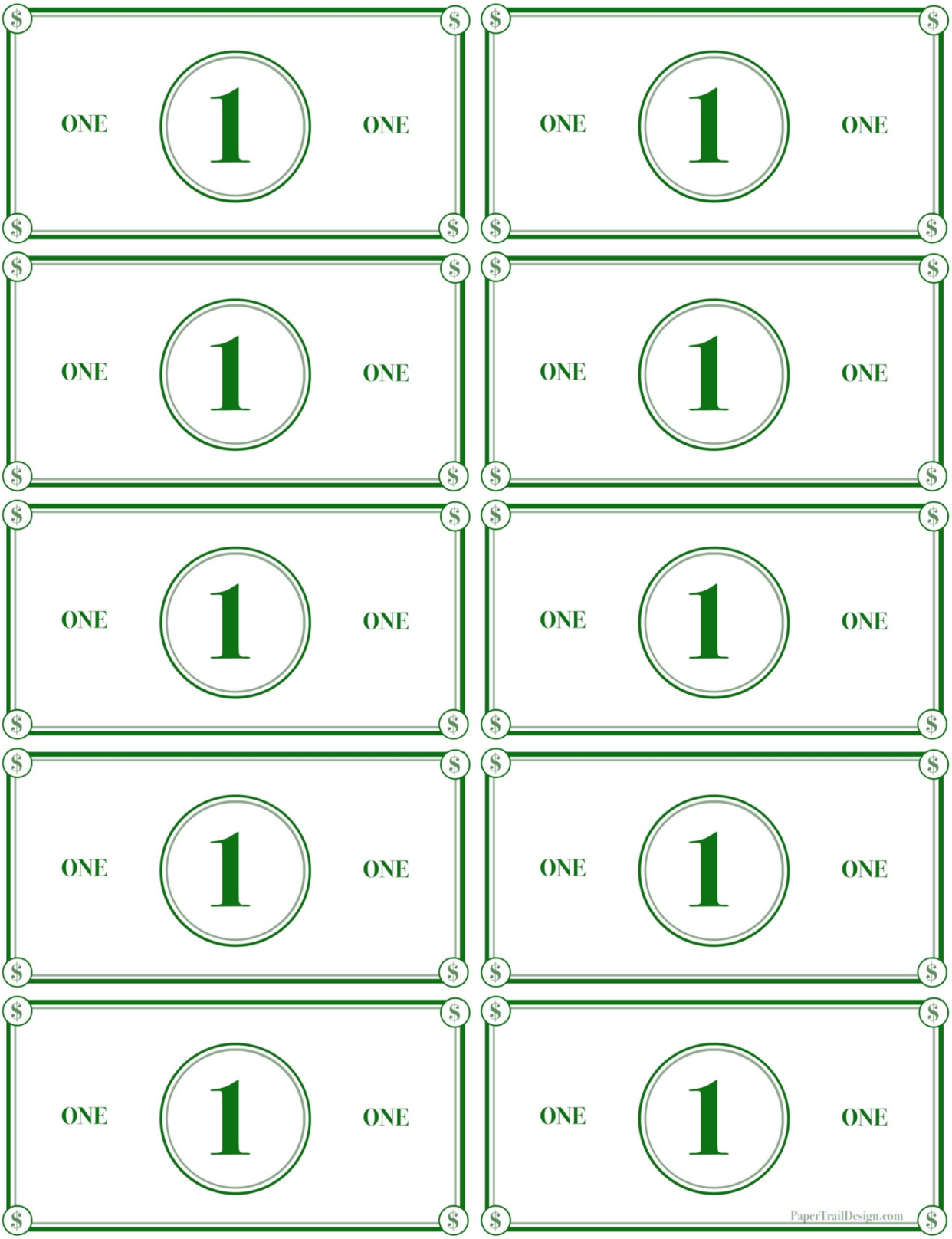
NOTES:

https://www.harteresearch.org/snappercount

https://storymaps.arcgis.com/stories/d03212c07af94ac79a98c9c3a210270e

Graphing Exercise

Create a bar graph using your fisheries statistics.
Use a separate color for each season.
Remember to include a descriptive title, x and y axis labels, and a numbering scheme that does NOT label every line!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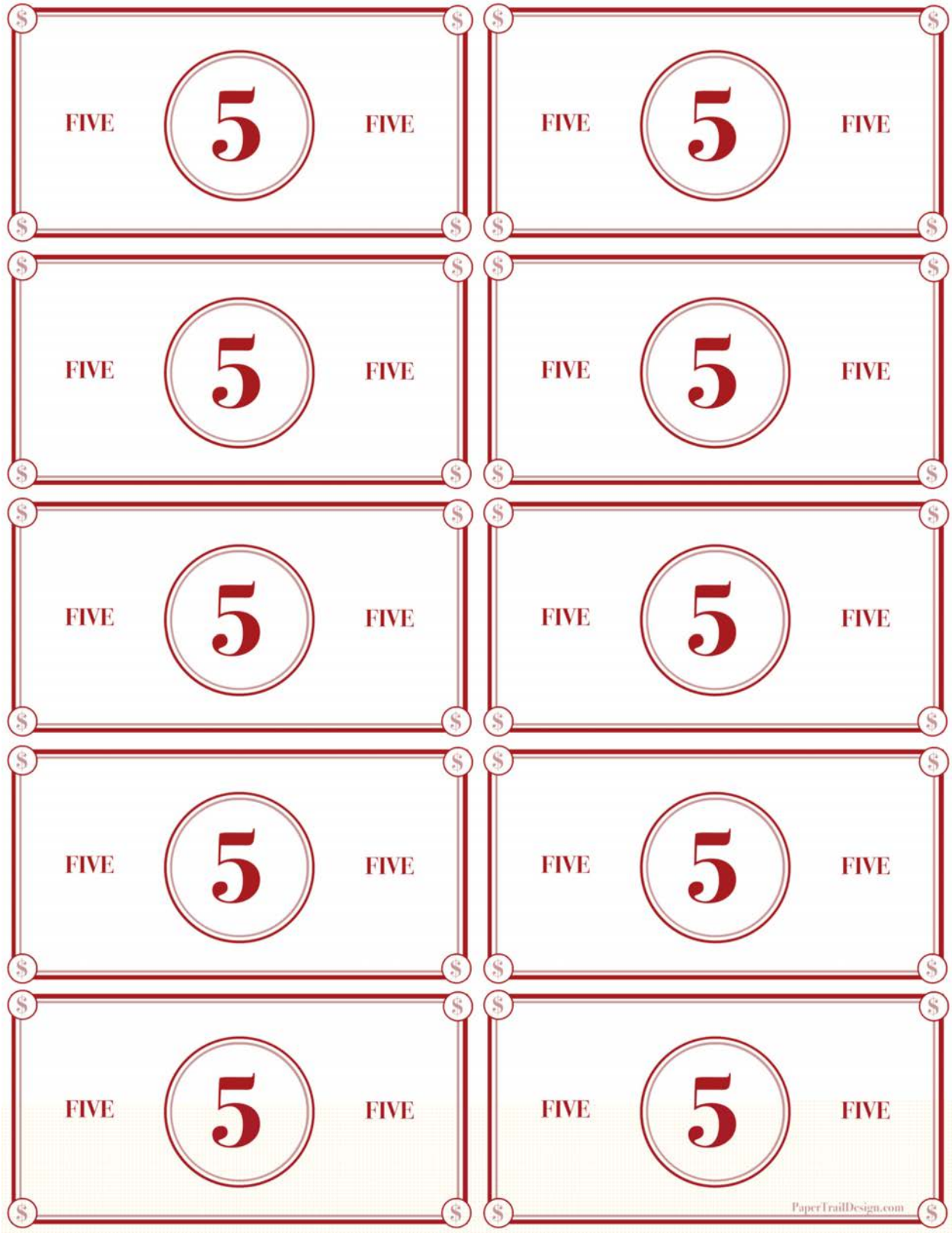
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My Fishing Statistics Log

Name of fisherman team:

Season 1

Adult fish caught	**Juvenile** fish caught	**Bycatch** caught	Revenue adult fish x $1	Gear costs	Fines costs	Profit Revenue - gear - fines

Season 2

Adult fish caught	**Juvenile** fish caught	**Bycatch** caught	Revenue adult fish x $1	Gear costs	Fines costs	Profit Season 1 profit + revenue - gear - fines

Season 3

Adult fish caught	**Juvenile** fish caught	**Bycatch** caught	Revenue adult fish x $1	Gear costs	Fines costs	Profit Season 2 profit + revenue - gear - fines

Season 4

Adult fish caught	**Juvenile** fish caught	**Bycatch** caught	Revenue adult fish x $1	Gear costs	Fines costs	Profit Season 3 profit + revenue - gear - fines

Island STYLE

Water Quality of Galveston Bay

SUBJECT:

Science

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Fully-Stocked Water Q Testing Kit
  - Waterproof st case
  - Disposable gl
  - Small trash ba
  - Pipettes
  - Sample jars
  - Nitrate suppli
  - Dissolved Oxy supplies
- Thermometer
- Turbidity tube
- White bucket for large sample
- Refractometer

'IVITY SUMMARY:

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

RNING 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

ABULARY:

- **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

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

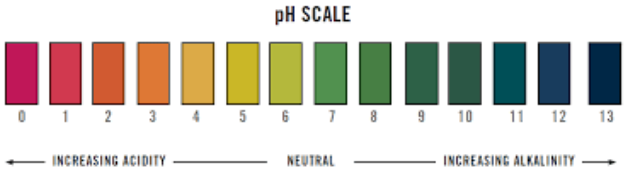
- To acquire a water sample, take the white bucket toss the bucket into the middle part of the channel, making sure to hold on to the rope attached to the bucket. Allow the water to fill the bucket from the surface and quickly pull the bucket back to the surface, being careful not to allow the bucket 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.

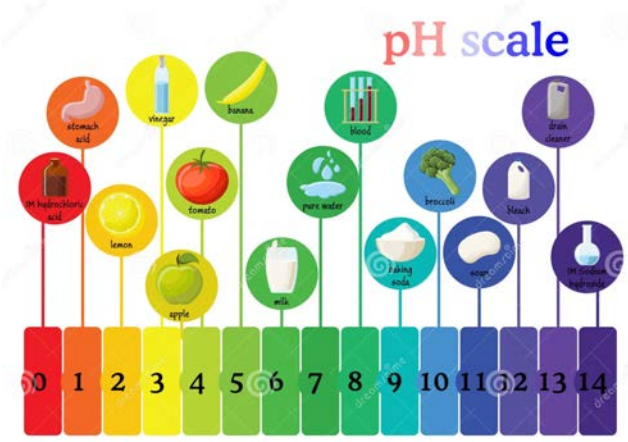
- When testing for temperature you want to take it as soon as you pull your sample because the temperature of the water in the bucket will be affected by the temperature of the air.

- 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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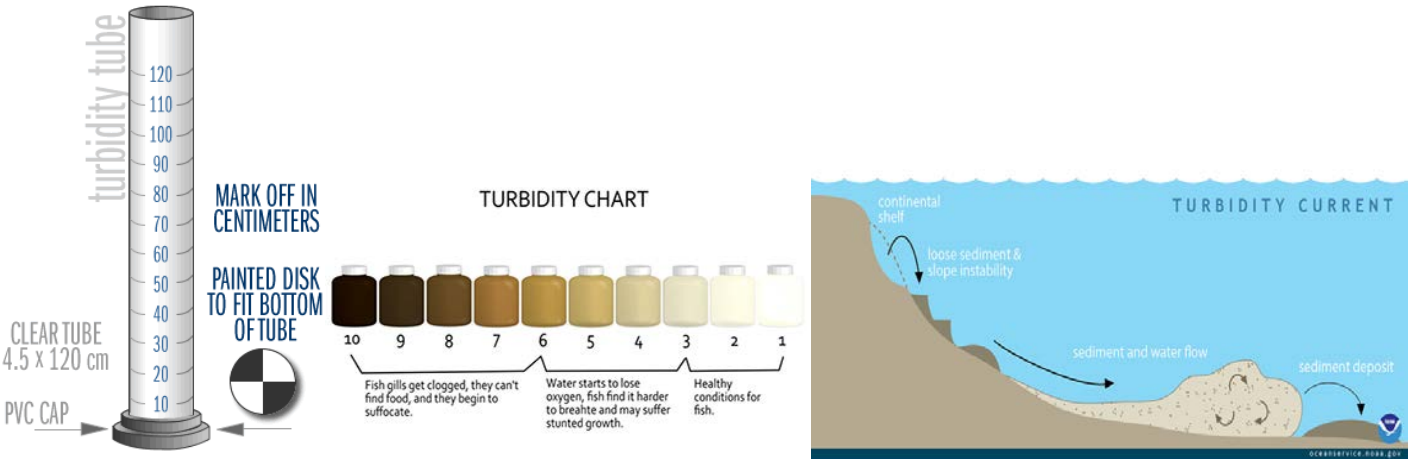
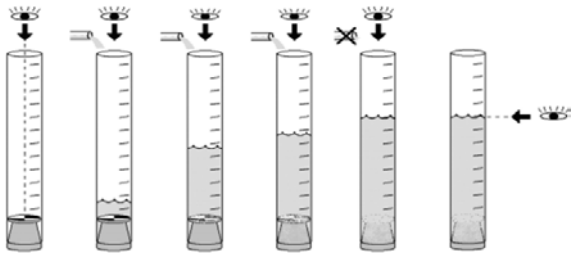


Turbidity

- 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.



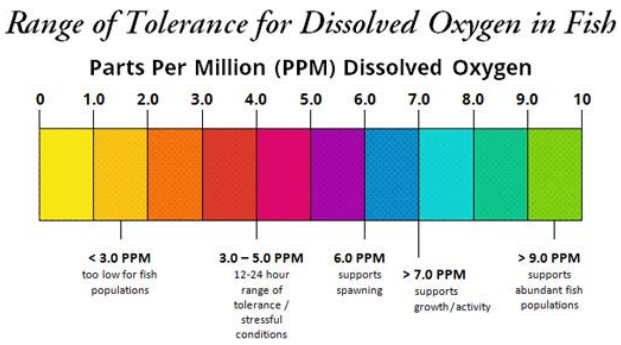
Salinity

- 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).

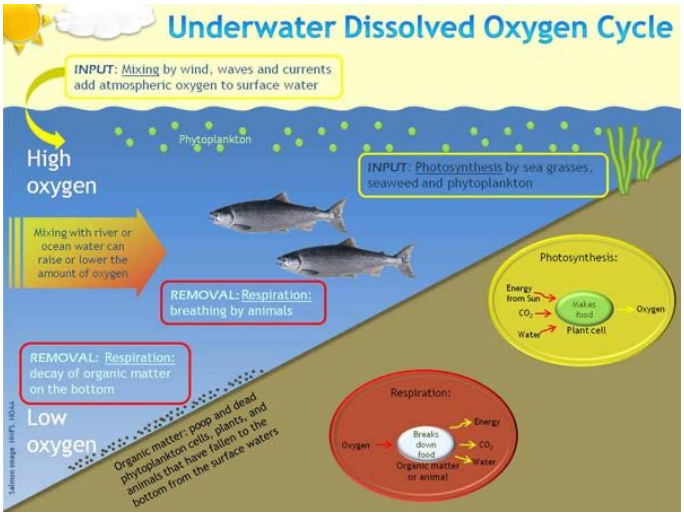
$$CO_2 + H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + O_2$$

- 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.

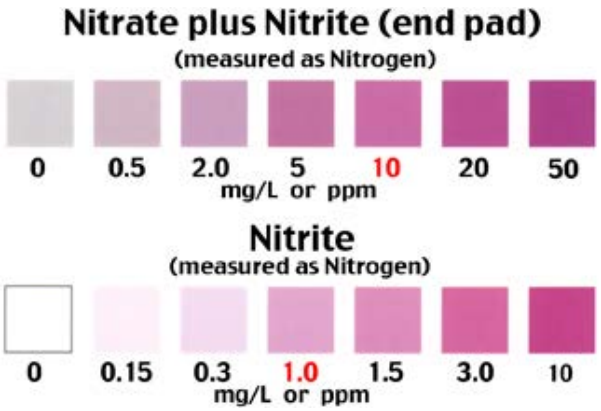
Follow the directions for your specific DO test kit making sure to use a new water sample for each test and using it right away as the DO level will go up as the oxygen from the air will diffuse into the sample bucket water surface.

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**

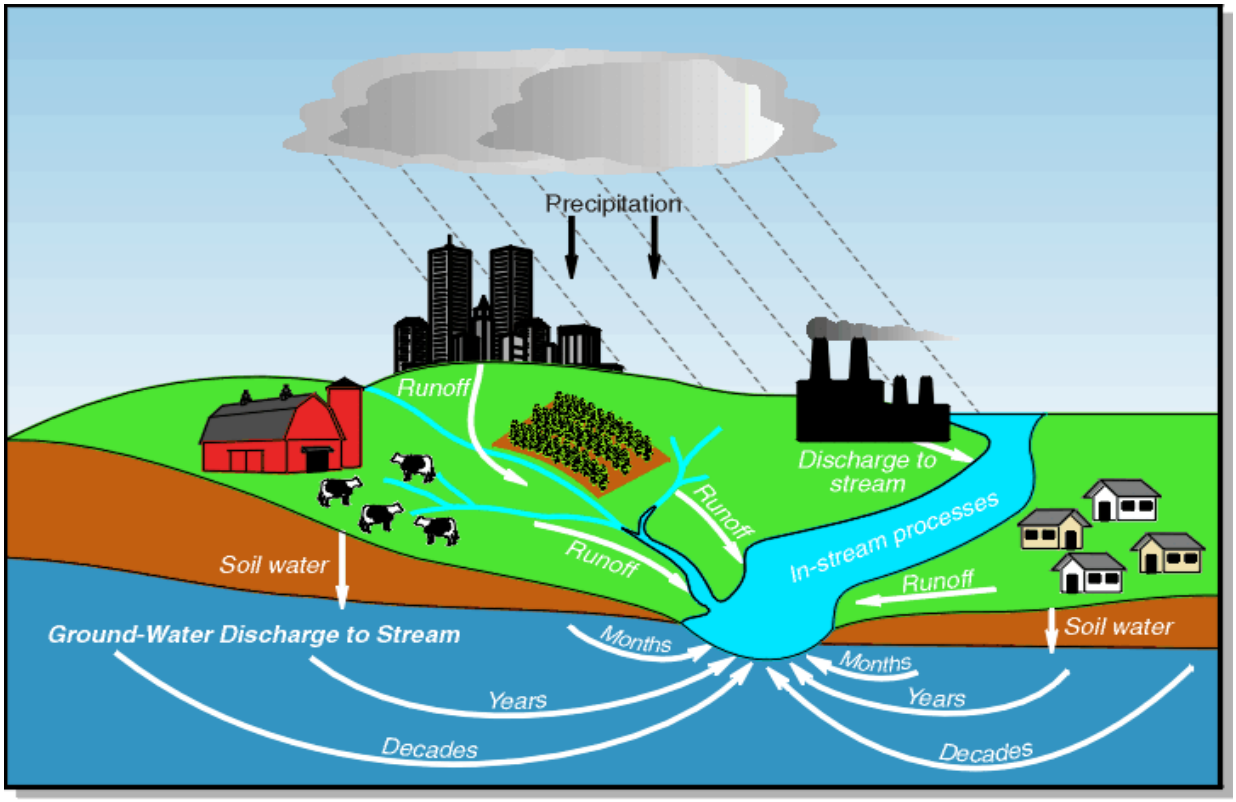


GUIDED PRACTICE:



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			

Island STYLE

Who is Restoring the Marsh?

SUBJECT:
Math
GRADE LEVEL:
6th
TIMEFRAME:
45 minutes
MATERIALS:

- Reference images of
  marsh restoration pr
  (before/after)
- Students will need pa
  and pencils for activi

'IVITY SUMMARY:

lesson serves as an introduction to the importance of conserving and restoring Galveston
d's coastal prairie and wetland ecosystems. The Galveston Bay system has lost over 8,000+
of saltwater wetlands and 80,000+ acres of freshwater wetlands in the past 20 years through
at degradation (Galveston Bay Foundation). Students will construct a restoration area using
ıetry and algebra principles, as well as follow a budget to complete a marsh restoration project.

- Students will build off of existing knowledge of coastal prairies and wetland ecosystems
- Students will learn about the organizations actively doing restoration in Galveston
- Students will utilize geometry and algebra to think like a restoration scientist and play a role in

GNMENT:
:

6.3.(D) add, subtract, multiply and divide integers fluently
6.3.(E) multiply and divide positive rational numbers fluently
6.8.(D) determine solutions for problems involving the area of rectangles, parallelograms, trapezoids, and triangles and volume of right rectangular prisms where dimensions are positive rational numbers.

n Literacy Principles:
1 Ocean 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

VOCABULARY:

- **Breakwater** - A barrier built out into a body of water to protect a coast or harbor from the force of waves
- **Berm** - A flat strip of land, raised bank, or terrace bordering a river or canal
- **Food Web** - A system of interlocking and interdependent food chains
- **Geotube Textile** - A large, tube-shaped bag made of porous, weather-resistant geotextile and filled with a sand slurry, to form an artificial coastal structure such as a breakwater, dune, or levee
- **Intertidal Zone** - The area where the ocean meets the land between high and low tides
- **Mangrove** - A tree or shrub that grows in tropical coastal swamps that are flooded at high tide
- **Marsh** - An area of low-lying land which is flooded in wet seasons or at high tide, and typically remains waterlogged at all times
- **Restoration** - The act of returning something to a former owner, place, or condition
- **Seagrass** - A grass-like plant that lives in or close to the sea
- **Turbidity** - The quality of being cloudy, opaque, or thick with suspended matter; the measure of relative clarity of a liquid
- **Ecosystem Services** - Any positive benefit that wildlife or ecosystems provide to people

BACKGROUND INFORMATION:

Salt marshes, sea grass beds, and mangrove marshes are extremely important areas. The ecosystem services these areas provide are the following:

1. Provide nursery habitat for fish, shrimp, and crab
2. Temporarily store water during a flood event and release it slowly like a sponge
3. Act as a filter to clean the water, trap pollutants, and break down pollutants over time
4. Reduce erosion to upland areas by slowing down wave energy
5. Stores carbon through plant photosynthesis and by acting as sediment traps for runoff
6. Provide nutrients which are the basis of the food web

Natural coastal habitat can be altered by both natural events and human factors. Waves such as the ones produced by tropical storms and hurricanes can erode coastlines increase turbidity and permanently or temporarily change the shape of the coastline. Waves are the result of wind on earth's surface caused by the sun unevenly heating the earth's surface.

The strength of the wind, combined with the length of time that it blows, the water depth and the size of area over which the wind can blow unimpeded in one direction will determine how large the three waves become. While most of the waves along the Texas Gulf Coast are small, waves produced by tropical storms and hurricanes can be quite large.

Human factor, such as draining, filling and construction of channels, or subsidence (sinking of land) caused by the removal of groundwater and oil also changes these habitats. Mangroves cannot tolerate extremely cold weather or low salinities. Seagrass beds become choked out when draining filling and construction deplete the water clarity. Once a marsh has been altered consequences can include increased flood damage, loss of nutrients in the ecosystem, loss of natural water filters and increased erosion. Restoration projects are undertaken with the goal of regaining the "ecosystem services" of these habitats provide.

Restoration projects vary from large scale operations requiring the cooperation of federal, state, and local entities and costing billions of dollars (such as projects in the Florida Everglades and the Mississippi River Delta regions) to smaller community-based projects led by local organizations like the wetlands plantings at the Coastal Heritage Preserve with Artist Boat.

Many restoration projects seek to raise the elevation of a site that has subsided or eroded to allow for growth of vegetation that only survives in the intertidal zone. Terraces, or marsh mounds, are long linear mounds of soil that are planted with native grasses such as *Spartina alterniflora* (smooth cordgrass). Terraces help to control the shoreline by reducing wave energy, trapping sediments, providing habitat for organisms, and increasing water clarity.

PREPARATION:

Begin class with photos (either printed or projected) of marsh restoration examples. Break students into small groups and provide each student group with a copy of the restoration information sheet and a restoration site map.

Who is doing the restoration?

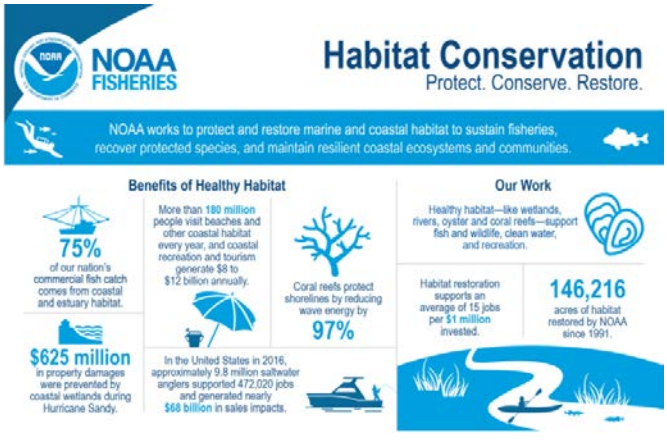
- **Artist Boat**
  - Coastal Heritage Preserve - Artist Boat is striving to preserve and restore 1,400 contiguous acres from beach to bay
  - Elementary students from GISD have restored over 24 acres of coastal prairie at Galveston Island State Park since Hurricane Ike in 2008 through Artist Boat's Habitat Restoration Adventures
- **Galveston Bay Foundation**
  - Galveston Bay Foundation has restored over 950 acres of vital coastal habitat through various restoration programs
- **NOAA Fisheries - Office of Habitat Conservation**
  - Focus on protecting and restoring habitat to sustain fisheries, recover protected species, and maintain resilient coastal ecosystems and communities.

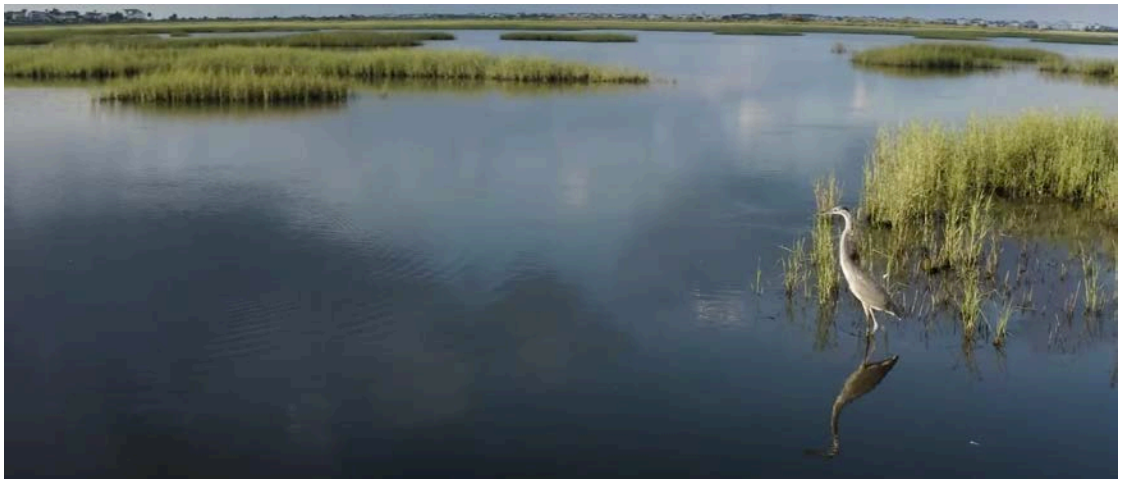
INTRODUCTION:

artist BOAT

GALVESTON BAY FOUNDATION

NOAA





GUIDED PRACTICE:

PROMPT:

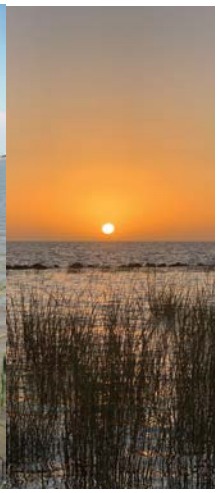
You are part of the Spanish Cove Homeowner's Association. You and your neighbors are concerned that there is increasing habitat loss of marsh and seagrass beds near your subdivision and will result in the loss of your property and yard space. Your Homeowner's association has decided to spend your dues on a marsh restoration project.

ACTIVITY:

1. Introduce concept of marsh restoration - explain functions of wetlands
2. Review / provide more depth to the examples of restoration and the organizations who are actively doing restoration work in Galveston
3. Read through the habitat restoration information packet with your students
4. Go over the synopsis and parameters
5. Each student group will then decide how to do the restoration within budget.

INDEPENDENT PRACTICE:

Student groups create their restoration plan using the attached worksheets.



ASSESSMENT OF LEARNING:

Monitor groups by asking about their budgets and decision-making process. Each group can read their paragraph and show the restoration project they created.

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 ask what else the students want to learn about marsh restoration. Students may ask about types of plants, the laws regarding marshes, planting depth or locations of projects in our community. 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.

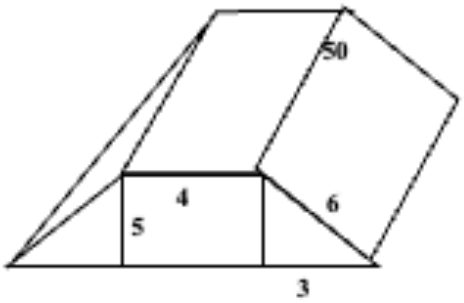
Students may even have follow-up questions after these lessons that could be added to the board The goal is to have a place for all questions about the Galveston Bay and the Gulf of Mexico in one place.

EXTENSION:

Students might research the true costs of plants and soil in our community to determine how much it would cost to actually complete their planned restoration. For more information on marsh restoration go to the Tides and Currents article by NOAA https://tidesandcurrents.noaa.gov/marsh.html

NOTES:

Restoration Information Guide
(TEACHERS)



Terrace size

- To calculate the number of plants needed for planting, the area of the top needs to be added to the area of the sides of the slopes. Area is measured in square feet.
    - Area = length x width
    - Area = 200 + 300 + 300 = 800 feet^2
    - **800 square feet of the terrace needs to be planted.**

Soil

- Soil is needed to create the terraces. Soil costs $20 per cubic foot.
    - Volume = center + side 1 + side 2
    - Volume = lwh + 2(1/2 base area * height)
    - Volume = 100 + 750
    - For this scenario above: 1750 ft^3 x $20 per cubic foot = **$35,000 for the soil**

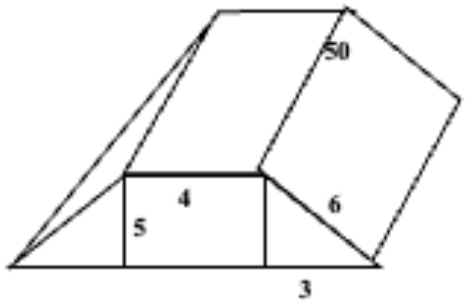
Vegetation

- Vegetation like *Spartina alterniflora* should be planted 3 feet apart on the exposed sides of the terrace. To find how many plants are needed, divide the area to be planted by 3 square feet.
    - 800 square feet need to be planted / 3^2 = 88.89
    - So, **89 plants are needed.**
    - Each plant costs $2 per stem. If 89 plants are needed, then 89 x 2 = **$178 for the plants**

Breakwaters

- Geotextile tubes will cost $200 per linear foot. The distance planned will change the cost for the group.
- Rock barriers will cost $350 per linear foot. The distance planned will change the cost for the group.

Restoration Information Guide
(Students)



Terrace size

- Most terraces will be built to a uniform size, but then molded and bent to fit the shape of the land.
- To calculate the number of plants needed for planting you need the surface area of the terrace. Area is measured in square feet.

Soil

- Soil is needed to create elevation of the terraces.
- You will need to know the volume of the terrace.
- Soil costs $20 per ft^3

Vegetation

- In order to prevent erosion of your newly created terrace and provide habitat for native wildlife, the terrace must be planted with native vegetation, like *Spartina alterniflora* (smooth cordgrass)
- The cordgrass should be planted 3 feet apart on the top and sides of the terrace.
- Number of plants needed= surface area/3^2
- Plants cost $2 per stem.

Breakwaters

- Breakwaters are constructed to reduce wave energy so that terraces or mounds of material can be placed and planted behind for protection. If terraces are built without a breakwater of some sort to protect them from waves, the constant impact of the waves will cause the terraces to erode.
- Geotextile tubes are synthetic fabric tubes that are filled with soil and are used to break waves in areas of medium to high intensity. They are stable and require little maintenance. Bird feces can strip away the uv protectant on the tube and the material can become vulnerable to tears. These will cost $200 per linear foot.
- Rock barriers are used to break waves in areas of high intensity like you would find near boat traffic areas. They are very stable and require very little maintenance. They can also provide reef type structure and habitat for animals and plants living in the area. These will cost $350 per linear foot.

Restoration Parameters

- You are restoring three acres.
- The area is in an area of high and medium intensity wave action due to the intercoastal waterway and will require a breakwater.
- The restoration will require the construction of terraces.
- Neighbors want the restored marsh to be attractive and provide habitat to native wildlife right away.
- You have $500,000 to work with and not a penny more.

Below is your restoration area site map with the wave energy areas marked.

Restoration Budget Breakdown

You will want to use a pencil so you can erase and change your budget as you modify your plan.

Total budget **$500,000**

Length of geotube breakwater installed_____ at a total cost of _____

Length of rock breakwater installed_____ at a total cost of _____

Total amount spent on breakwaters _____

Budget amount left for terraces _____

Number of terraces installed _____ at a total cost of _____

Money left over from the budget _____

Left over money spent on _____

Restoration Conclusion

How did your project go? Was it a straight forward process, or did you have to negotiate and change your plan? Write five sentences to talk about your thought process on what you designed.

Restoration Project Worksheet

You must design the restoration location to meet the parameters set out by the Homeowner's Association and stay within budget.

Part 1:

Determine the size of the site.

1 acre = 43,560 ft ^{2}

3 acres = _____

Part 2:

Determine type and length of breakwater needed.

Your breakwater needs to be between 100 and 150 ft from the shoreline. Draw a line on your restoration map for where the breakwater should be located and then measure how much is in each of the wave zones.

Length of breakwater needed in the low energy zone _____

Length of breakwater needed in the medium energy zone _____

Length of breakwater needed in the high energy zone _____

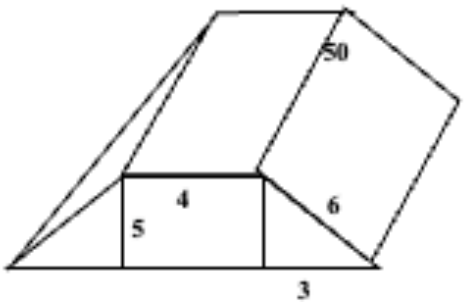
Now, you need to make some decisions. Use your guide sheet to determine the cost of installing geotube or rock or a combination of both. Many projects spend 1/3 of the budget for breakwaters and 2/3 of the budget on terraces, but it is your project, and you can decide how to spend the budget.

Cost to put in geotube: _____

Cost to put in rock barriers: _____

Total cost for your breakwater: _____

(transfer these numbers to your overall budget)



Part 3:

Determine the cost of each terrace.

Surface area of your restoration area

- To calculate the number of plants needed for planting, you start by finding the surface area of the terrace.
- Remember that the area of top needs to be added to the area of the side slopes.
- But surface area alone won't get you there. Remember that the plants need to be 3 feet apart.

Total Surface Area for planting = top area + side slope 1 area + side slope 2 area

Number of plants you need to purchase for each terrace = Surface area of terrace / 3^2

Now you know how many plants you need, but you need to include the **cost of plants** in your budget, not the number of plants needed.

Number of plants needed x cost of plants = **cost per terrace for plants**

Volume of your restoration area

- To calculate the volume of one terrace you can assume that the two side slope sections are the same size.
- Total volume of the terrace = center + side 1 + side 2

How much soil will you need to build one terrace?

Volume of terrace x cost of soil = **cost per terrace for soil**

Total cost per terrace is the cost of soil + cost of plants

_____

Part 4:

How many terraces will you build?

Now that you know how much money is left after putting in breakwaters and the cost of each terrace, you can figure out how many terraces to build.

Money left after cost of breakwaters/ total cost per terrace = number of terraces you can put in.

Did it work out perfectly or did you have a decimal? _____

Round down to the nearest whole number and figure out the total cost of your terraces.

Total cost of terraces = cost per terrace x number of terraces
(transfer these numbers to your overall budget)

Part 5:

Leftover money

If you have money left, you can plant a partial terrace (you will need to figure out the cost per linear foot to build it), you can add some length to your breakwater. Or you could do something else with the money that would benefit your neighborhood. Signage? Save the fees for other projects? Record your thoughts and math here and then transfer your final plans to your overall budget sheet.

Part 6:

Draw your terracing map

Return to the terrace map and draw in your terraces and breakwaters based on what you purchased. Create a key so your installation team knows what should go where. Remember that terraces are 50 feet in length, but do not have to be built straight. They should look naturally occurring.

Island STYLE

Making a Point!

SUBJECT:
Social Studies
GRADE LEVEL:
6th
TIMEFRAME:
45 minutes
MATERIALS:
- Background informa sheet
- Point-of-View sheet

ents will role play as community stakeholders to debate issues associated with the Gulf of co.

- Students will learn about an assigned point of view and debate a current event.
- Students will identify key information and express those points orally.
- Students will look at how roles in society are linked.

GNMENT:

6.3 (C) - Compare various world regions and countries using data from geographic tools, including maps, graphs, charts, databases, and models
6.13 (A) - Describes roles and responsibilities of citizens in various contemporary societies, including the United States
6.21 (D) - Identify different points of view about an issue or current topic
6.21 (E) - Identify elements of frame of reference that influence participants in an event
6.22 (C) - Express ideas orally

n Literacy Principles

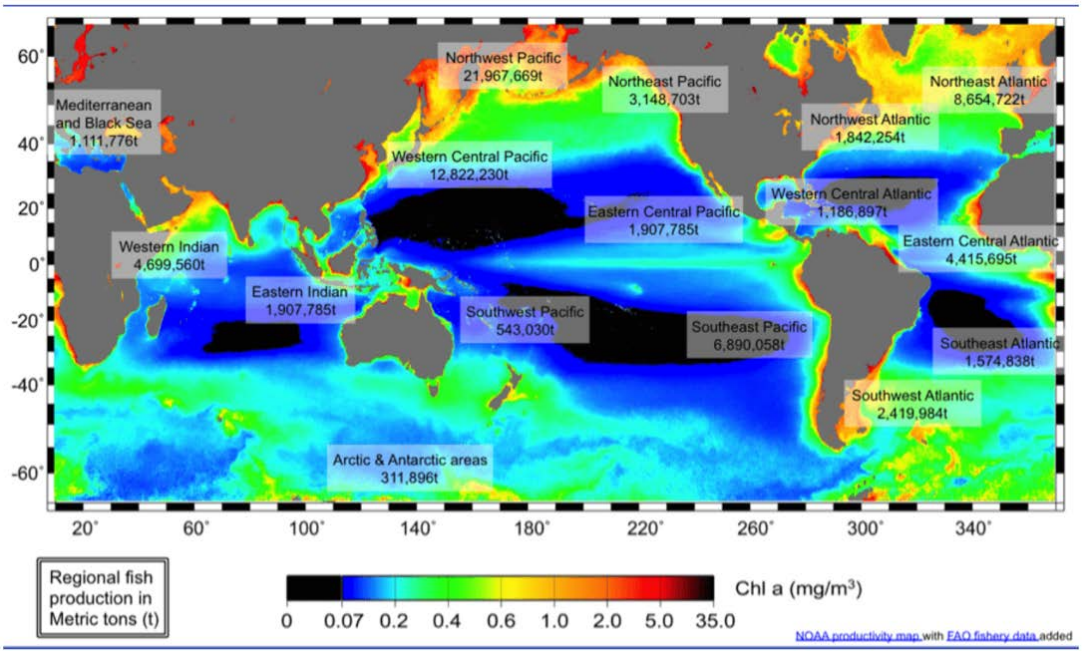
1 Earth has one big ocean with many features
2 The ocean and life in the ocean shape the features of Earth
3 The ocean is a major influence on weather and climate
4 The ocean makes Earth habitable
5 The ocean supports a great diversity of life and ecosystems

BACKGROUND INFORMATION:

Fish provide nutrition, jobs, and well-being to people. We eat them for health and tradition; we snorkel with them for spirituality and fun; we hunt them for sport and recreation; we go to aquariums to watch them with family; we rely on them for community and employment. The United Nations estimates that fish support the livelihoods of 10-12% of the world. Ensuring their sustainability is important!

Fish concentrate in areas of high **primary productivity**. Primary productivity in the ocean is the same as on land: photosynthetic organisms like plants, algae, and phytoplankton turn sunlight into organic matter. Photosynthesizing organisms are then eaten by larger organisms, which are then eaten by larger organisms, et cetera.

To find out where fish live, we can look at where photosynthesizing organisms live. Modern satellites make this easy: this map shows productivity in the ocean as measured by chlorophyll concentrations in the water.



As you can see, the most productive region in the world is near Alaska—sure enough, the North Pacific Ocean provides more wild-caught fish than any other region. The world's most-eaten fish, pollock, comes from this area.

THREE TYPES OF FISHING:

There are **three** different kinds of fishing defined by the scale and purpose of the fishing being done: **recreational fishing, subsistence & small-scale fishing, and commercial fishing.**

1. **Recreational Fishing** - people *enjoy* fishing in many ways: fly fishing creeks, lakes, and rivers can be peaceful meditation; an afternoon spent fishing from a local pier can be important family time; diving and spearing fast-moving fish is an exhilarating challenge for many, and there is no better feeling than cooking and eating your catch with loved ones. In Texas over 3000 people are employed as recreational fishing guides.
2. **Subsistence / Small-Scale Fishing** - In many parts of world, especially in coastal and island communities, where industry, trade, and wealth are not yet developed, fishing can be one of the only sources of food and money and therefore plays an important part in food security, nutrition, and development. 90% of all people who fish for livelihood do so in small-scale fisheries. In Texas, many families catch all the fish they eat instead of purchasing fish at a market or store.
3. **Commercial Fishing -** Modern society evolved from the most basic human need: to eat. Early humans stopped migratory hunting & gathering when they realized they could stay in one place if they grew their own food. Agriculture allowed permanent communities, and civilization was born. Population growth, technology, and taste have brought us to a modern system of large, industrial farming and processing that makes food more accessible than ever in human history. Commercial fishing contributes to food and protein accessibility—and typically without the environmental costs of land-based food production! In Texas, over 15,000 people are employed in the commercial fishing industry. These people work on boat, at docks and at processing facilities.

VOCABULARY

- **Aquaculture** - The breeding, rearing, and harvesting of fish, shellfish, algae, and other organisms in all types of water environments
- **Fishing** - The activity of catching fish, either for food or as a sport
- **Primary Production** - The creation of new organic matter by plants and other autotrophs
- **Sustainable** - Able to be maintained at a certain rate or level
- **Unsustainable** - Not able to be maintained at the current level or rate

PREPARATION:

Print and cut apart the stakeholder position cards for each group. Print the information sheet for each "expert" group.

INTRODUCTION:

Introduce to students the concept of "fishing"

- By a show of hands, how many of you…
  - Like to eat fish, crab, or shrimp?
  - Have ever watched a friend or family member catch a fish?
  - Have ever caught a fish on your own?
  - Did you use a net? a rod and reel?
  - For those of you that have caught your own fish, what did you do with the fish that you caught? (throw it back, eat it, use it as bait…)
  - Why?

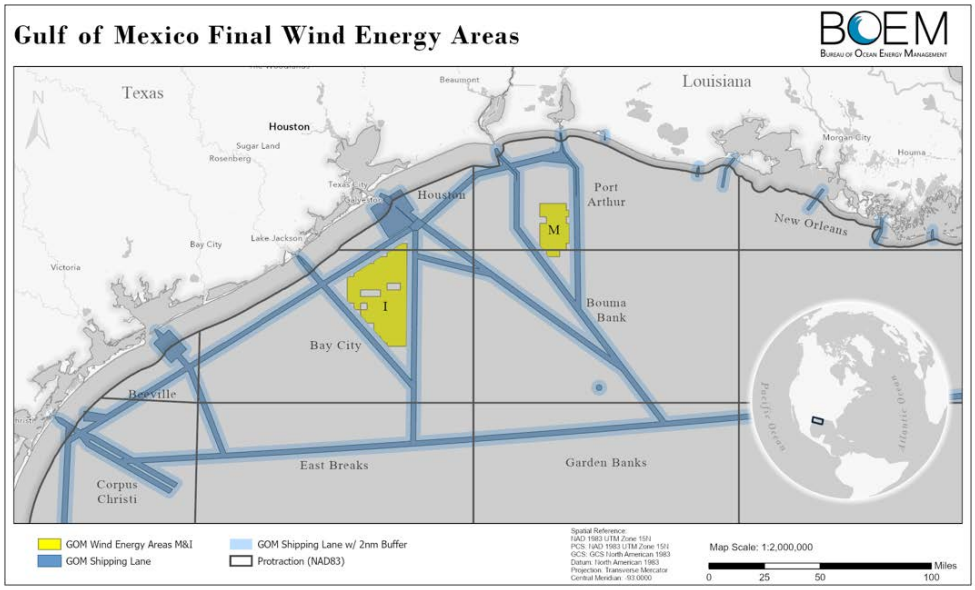
Wild fisheries are a complex and fascinating natural resource—they are extractive yet renewable, vulnerable yet resilient. About half of the world's seafood is wild-caught and about half is raised in farms called aquaculture.

GUIDED PRACTICE:

Debate Topic 1:

Building wind turbines offshore

US Department of Interior has proposed the first-ever offshore wind lease sale in the Gulf of Mexico.

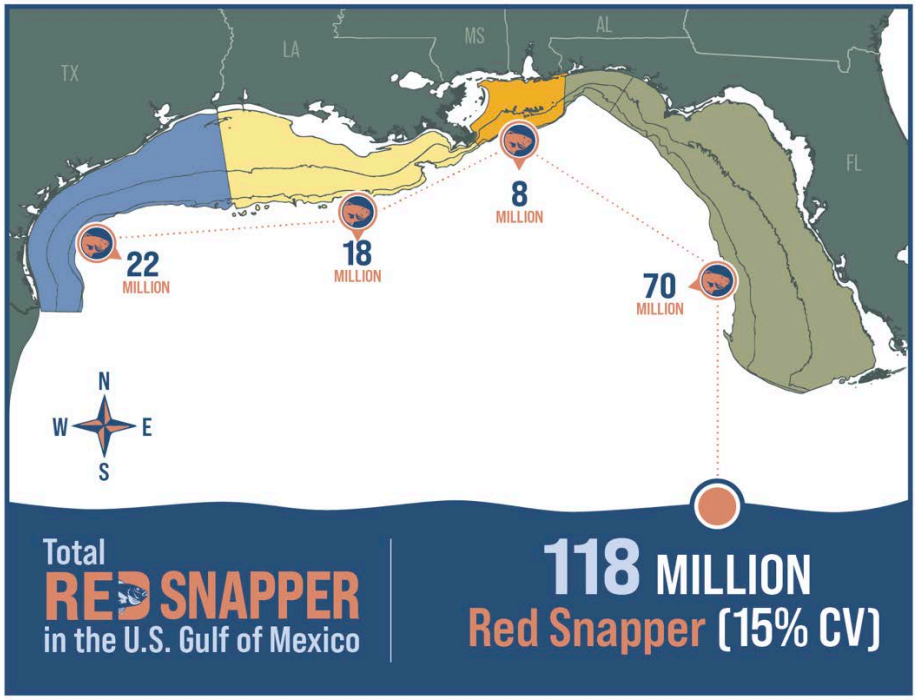


The Proposed Sale Notice announced includes a 102,480-acre area offshore Lake Charles, Louisiana, and two areas offshore Galveston, Texas, one comprising 102,480 acres and the other comprising 96,786 acres. These areas have the potential to power almost 1.3 million homes with clean energy.

In 2022, BOEM reduced the size of the two areas from their draft versions to address concerns expressed by the Department of Defense and the US Coast Guard regarding shipping, marine navigation, and military operations.

The Biden administration announced in July 2022 that it would pursue the development of offshore wind energy in the Gulf, which is already a hub for oil and gas production.

Debate Topic 2: The Great Red Snapper Count



The HARTE Research Center together with 80 scientists completed a study in 2021 that estimated that there were 118 million Red Snapper in the Gulf of Mexico. This estimate is up from the previous 2016 federal estimate of 36 million that the catch limits have been based on for the last several years. However, the newly counted fish aren't where you typically fish. Many of the fish included in the new estimate were located offshore on low relief habitats. While the majority of current red snapper fishing takes place on artificial structures close to shore.

In January of 2023, NOAA Fisheries formally revised the overfishing limit and acceptable Biological Catch based on this data.

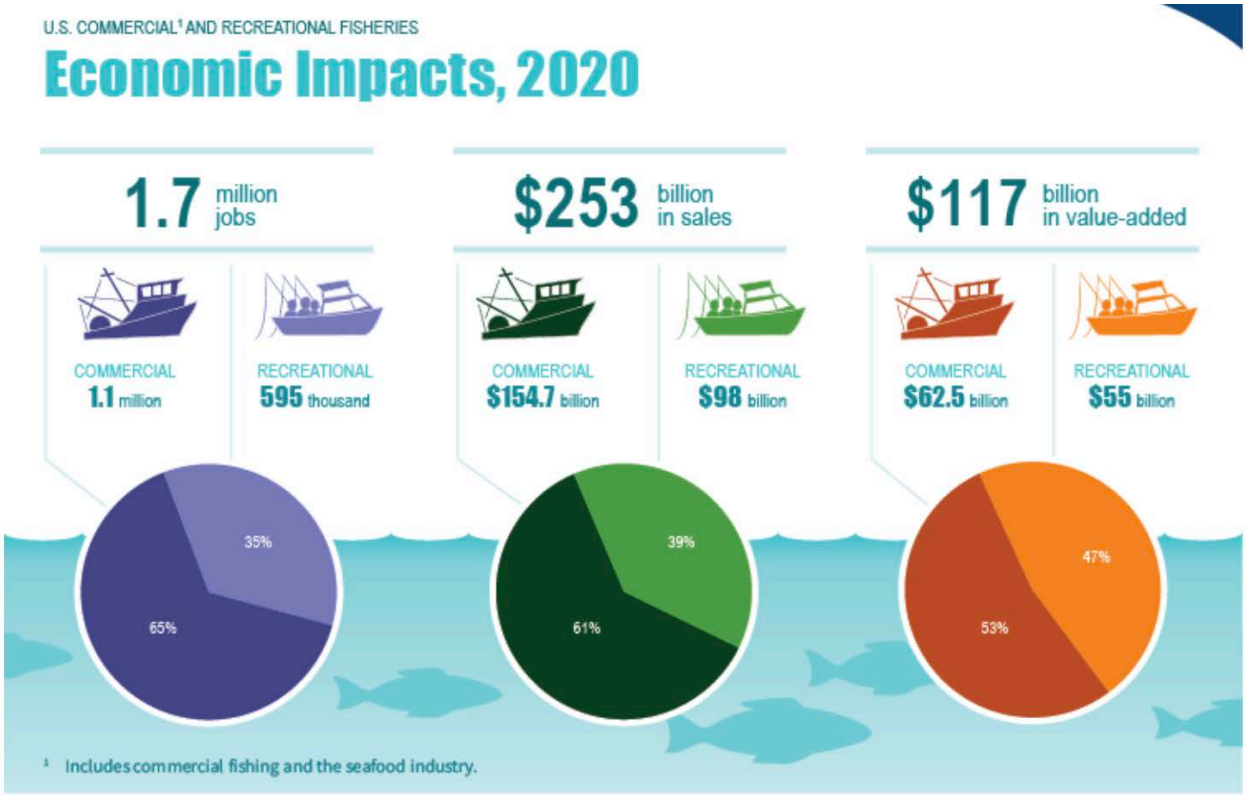
INDEPENDENT / GROUP PRACTICE:

DEBATE ACTIVITY:

- Split class into "home groups" - about 4 teams of 6 participants
- For each home group, assign each of the 6 participants to a different stakeholder position
- Allow time for the same stakeholders of each group to meet together, brainstorm ideas, share perspectives, and become "experts" in their position
- Allow for each viewpoint representative to rejoin original group
- Provide prompts from the topics to consider list to each stakeholder group and allow students to discuss.

LIST OF STAKEHOLDERS:

- **Fishermen/women** - people who catch the fish
- **Seafood companies** - people who sell seafood products
- **Seafood consumers** - people who eat the fish
- **Animal rights activists** - people who believe harvesting fish for food is morally wrong / animals should not be eaten
- **Fishery managers** - people who are decision-makers that make/enforce regulations for commercial fisheries
- **Conservationists** - people who want what is best for the planet and strive for good management



Economic impact trends of 2020 from Fisheries Economics of the United States 2020. 1.7 million jobs, $253 billion in sales, $117 billion in value added impacts. 1.1 million commercial jobs, 595 thousand recreational jobs. $154.7 billion commercial sales, $98 billion recreational sales. $62.5 billion commercial value added impacts, $55 billion recreational value added impacts.

ASSESSMENT OF LEARNING:

Student Reflection Activity:

- Do you support the position you were assigned to?
  - Why or why not?
- After this debate, would you choose to represent a different group?
  - Why or why not?

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 debates and in many more island topics. 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:

For more information on the Seafood Watch program or to print out watch cards for your students, you can go to www.seafoodwatch.org. For the Harte snapper report, please go to www.harteresearch.org.

NOTES:

Fishermen/women

- What do these people do and value?
- How might they be impacted by the wind turbines (think about positive impacts and negative impacts)?
- How might they be impacted by the change in red snapper limits (think about positive impacts and negative impacts)?

Seafood companies

- What do these people do and value?
- How might they be impacted by the wind turbines (think about positive impacts and negative impacts)?
- How might they be impacted by the change in red snapper limits (think about positive impacts and negative impacts)?

STAKEHOLDER POSITION CARDS

Fishery managers

- What do these people do and value?
- How might they be impacted by the wind turbines (think about positive impacts and negative impacts)?
- How might they be impacted by the change in red snapper limits (think about positive impacts and negative impacts)?

Conservationists

- What do these people do and value?
- How might they be impacted by the wind turbines (think about positive impacts and negative impacts)?
- How might they be impacted by the change in red snapper limits (think about positive impacts and negative impacts)?

STAKEHOLDER POSITION CARDS

Seafood consumers

- What do these people do and value?
- How might they be impacted by the wind turbines (think about positive impacts and negative impacts)?
- How might they be impacted by the change in red snapper limits (think about positive impacts and negative impacts)?

Animal rights activists

- What do these people do and value?
- How might they be impacted by the wind turbines (think about positive impacts and negative impacts)?
- How might they be impacted by the change in red snapper limits (think about positive impacts and negative impacts)?

Fisheries:

- Wild-caught seafood can be **sustainable**, where populations are taken at a rate and quantity that allows them to naturally replenish and renew; or **unsustainable** when humans take more than can naturally be replaced. A fishery is sustainable when the amount harvested does not compromise future harvests. Eating sustainable seafood ensures that you and others can enjoy that same meal in the future.
- Fish provide hundreds of millions of people with livelihoods and their primary source of protein, and they are one of the least environmentally impactful foods people can eat.
- Not all fisheries are great. Poor fisheries management that leads to overexploitation continues to be a problem in parts of the Gulf of Mexico.
- In 2021 commercial fisherman caught 7.7 million pounds of red snapper that went into restaurants and grocery stores, while recreational fisherman caught 10.3 million pounds for home consumption.
- According to the Texas Marine Mammal Stranding Network, dolphins and whales are protected federally under the Marine Mammal Protection Act. The MMPA provides for both civil and criminal penalties for illegal "takes," a term that includes harassing, feeding, or disturbing marine mammals in the wild. Potential penalties include fines of up to $100,000 and imprisonment for up to one year per violation.

Wind Turbines

- Offshore wind turbines are more efficient than those on land.
- These two areas could produce 10% of the country's wind energy.
- Habitat destruction will occur at each site but will be minimized.
- Wind turbines will be built in less than 200 feet of water. This will create underwater structure and habitat at each location. They will also stick out of the water 100's of feet creating shade.
- Visual impact from the beach will be managed by the Bureau of Land Management Office of Visual Resources
- NOAA is developing publicly available tools for assessment, planning, and mitigation of noise-making activities underwater. These Guidelines are not mandatory and are intended to provide general advice about reduction of underwater noise to designers, shipbuilders and ship operators. All ocean noise does not have the same impact. Sources of ocean noise vary in many ways including how loud they are (intensity, measured in decibels), how long they last (fractions of a second to continuous), and their pitch or tone (frequency, measured in hertz).

Topics you might want to consider

- **Overfishing** - catching fish faster than they can reproduce puts pressure on ocean ecosystems. Strong science-based management is key to protecting wild fish populations.
- **Climate** - it takes a lot of fuel to grow, package, and transport food around the world, which generates carbon dioxide and other greenhouse gases that contribute to climate change.
- **Preserve habitats** - some fishing and farming practices leave their mark on the nearby habitat. How and where seafood is fished and farmed can make all the difference in protecting ocean habitats.
- **Protect human rights** - seafood sustainability also ensures fair, safe working conditions for the people who produce the seafood.
- **Stop illegal fishing** - without strong management and enforcement policies, illegal fishing can occur - putting wild species and habitats at risk.
- **Strong management** - a key to sustainable fisheries and aquaculture is science-based management and strong enforcement of regulations.

Island STYLE

Coral Structure and Function

SUBJECT:

Science

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Demonstration coral
  - Brain
  - Staghorn
  - Elkhorn
- Demonstration elements
  - Graphite
  - Glass of milk
  - Sea shells
  - Egg shells
  - Pearls
  - Limestone
- Reference images of stony coral species
- Clay coral sculpting ma
  - Air dry clay
  - Cardboard circles
  - Clay tools
  - Wire
  - Scissors
  - Acrylic paints
  - Brushes
  - Cups for water
  - Pallets
  - Bucket

'IVITY SUMMARY:

ents will learn about the physical makeup of corals, what type of environment stony corals need ive, understand some of the challenges coral colonies face for survival. Students will create own coral clay structure modeled after different species of coral. Coral sculptures will be used ure activity

.RNING OBJECTIVES:

- Coral species structure, identification, and function
- Ecosystem requirements for healthy corals

GNMENT:

s

6.5 (A) - Know that an element is a pure substance represented by chemical symbols
6.5 (C) - Differentiate between elements and compounds on the most basic level
6.6 (C) - Test the properties of minerals including hardness, color, luster, and streak
6.12 (C) - Recognize the broadest taxonomic classification of living organisms is divided into recognizable domains
6.12 (D) - Identify the basic characteristics of organisms, including prokaryotic or eukaryotic, unicellular or multicellular, autotrophic or heterotrophic, and mode of reproduction that further classify them in the currently recognized kingdoms

n Literacy Principles

4. The ocean makes Earth habitable

VOCABULARY:

- **Adaptation:** A change or the process by which an organism or species becomes better suited for its environment.
- **Calcium Carbonate:** A material that forms coral skeletons. Occurs in nature as limestone.
- **Coral Colony:** Many coral polyps that are clustered together and are connected to one another.
- **Coral Polyp:** One individual coral animal with a soft, tube-shaped body, and a mouth surrounded by tentacles; grows in colonies to form large reef structures.
- **Nematocyst:** Thread-like stinging cells that contain toxic substances used to capture prey.
- **Photosynthesis:** The process of using energy from the sun to make starches and sugars from carbon dioxide and water.
- **Plankton:** Organisms that are suspended in the water column and transported by tides and currents.
- **Predator:** An animal that hunts and kills other animals for its food.
- **Stony Coral:** An animal with a unique polyp structure that builds a hard, rock-like skeletal base, and hosts symbiotic algae called zooxanthellae.
- **Symbiosis:** A relationship between different species where one, or both, of the organisms benefit from the presence of the other.
- **Tentacle:** A long, slender, and flexible appendage an animal uses for feeling, grasping, or moving.
- **Zooplankton:** Free-floating, microscopic aquatic animals.
- **Zooxanthellae:** Microscopic, single-celled algae that live inside the tissues of corals and produce food for coral through photosynthesis.

BACKGROUND INFORMATION:

- **Classification -**
  - Corals are generally classified as either "hard coral" **(stony)** or "soft coral". There are around 800 known species of hard coral, also known as the "reef building" corals. They live only in the photic zone (above 50 m), the depth to which sufficient sunlight penetrates the water.
- **Feeding -**
  - Corals are animals because they do not make their own food, as plants do. Corals have tiny, tentacle-like arms that they use to capture their food from the water and sweep into their inscrutable mouths.
  - Corals themselves are heterotrophs. However, some species (not all) form a symbiotic relationship with dinoflagellate algae. These algae colonize the corals' bodies and carry out photosynthesis, providing the corals with food in exchange for protection. In some sense the coral/algae partnership can be thought of as an autotrophic compound organism, somewhat similar to lichen. However, this partnership is not necessarily a permanent one. When the corals come under environmental stress, they tend to expel the algae. This is known as "coral bleaching" because the corals are much lighter in color after this occurs. If conditions do not improve to the point where the corals are able to accept the algae again, they eventually die.

- **Habitat -**
  - Coral reefs are among the most important biodiversity hotspots on earth. A quarter of all animals and plants that live in the ocean rely on them for food, nursery areas, and places to hide from predators. Reefs are where many fish species and sea creatures choose to spawn. They also provide a space for feeding and raising babies for some sea mammals. Seagrass meadows next to the reefs act as nurseries for manatees and dugongs.
- **Water Filtration -**
  - Most corals and sponges are filter feeders, which means that they consume particulate matter suspended in the water column. This contributes to the enhanced quality and clarity of our nearshore waters.
- **Polyps -**
  - Each individual coral animal is called a polyp, and most live in groups of hundreds or even thousands of genetically identical polyps that form a "colony". The colony is formed by a reproduction process called budding, which is where the original polyp literally grows copies of itself.
- **Zooxanthellae -**
  - Coral polyps do not photosynthesize but have a symbiotic relationship with microscopic algae, commonly referred to as zooxanthellae.
  - The zooxanthellae also provide much of the color that corals have. When the zooxanthellae are expelled, the colony takes on a stark white appearance, which is commonly described as "coral bleaching."
  - These organisms live within the polyps' tissues and supply the coral with organic products of photosynthesis, including glucose, glycerol, and amino acids. These compounds are utilized by the coral as building blocks in the manufacture of proteins, fats, and carbohydrates, as well as the synthesis of calcium carbonate, used to build a hard, cup-shaped skeleton that protects the soft, delicate body of the polyp. In return, the corals shelter the zooxanthellae and provide a constant supply of the carbon dioxide they need for photosynthesis. Because of this relationship, coral reefs grow much faster in clear water, which admits more sunlight. Without their symbionts, coral growth would be too slow to form significant reef structures.

PREPARATION:

- Gather materials listed above
- Prepare lesson-introduction demonstration materials:
  - Pencils / diamonds, inflated balloon, glass of milk
  - Sea shells, egg shells, pearls, limestone
  - Coral specimens and photo examples
- Prepare clay sculpting activity - ensure enough supplies for each participant + a demonstration model
  - Each participant needs: 1 grapefruit sized ball of clay, 3-5 assortment of clay sculpting tools, 1 cardboard base, 1 paint pallet 1 paint brush, 1 small cup of water

INTRODUCTION:

QUESTION 1: What are stony corals made of?

Note: allow students to feel see and feel element examples

- **Carbon** [pencil/diamond] - easily forms with other elements, is found in all living tissues
- **Calcium** [milk] - gives structure, hardness, and strength to bones and teeth
- **Oxygen** [inflated balloon] - the life supporting element in the air we breathe
- **Calcium carbonate** [sea shells, egg shells, pearls, limestone] - see definition below

Hard corals tend to secrete **calcium carbonate ($CaCO_3$)** underneath their bodies. This turns into a hard, rock-like structure upon which other coral larvae can settle. Over time, as the calcium carbonate builds up and corals reproduce, the size of a coral reef grows. The skeleton not only gives corals their structure, but also provides the architecture for the coral reef overall!

QUESTION 2: What are the different types of stony corals?

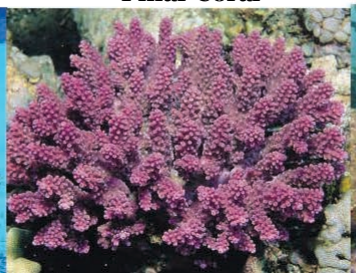
- **Brain coral**
  - Brain-like appearance - grows in shallow, warm water and forms colonies. Can live to be 900 years old. Storm-hardy!
- **Pillar coral**
  - Pillar-like appearance - can grow as tall as 8' high. Pillar corals do not have secondary branches.
- **Staghorn coral**
  - Resembles male deer antlers - branching limbs, can reattach broken pieces to new surface and continue to grow. Fragile!
- **Table coral**
  - Grows in massive flat plates to maximize sun exposure.
- **Cauliflower coral**
  - Resembles cauliflower - often can be found in hues of pink and purple.
- **Elkhorn coral**
  - Similar to staghorn coral - has branching limbs resembling antlers

Brain Coral

Pillar Coral

Staghorn Coral

Table Coral



Cauliflower Coral

Elkhorn Coral

GUIDED PRACTICE:

QUESTION 3: What type of environment do they need to survive?

- **Food**
  - Corals get their food from algae living in their tissues or by capturing and digesting prey. Most reef-building corals have a unique partnership with tiny algae called **zooxanthellae**. The algae live within the coral polyps, using sunlight to make sugar for energy.
- **Water:**
  - Stony corals need **clear, warm (75 degrees F or 24 degrees C), shallow waters** where lots of sunlight filters through their symbiotic algae.
- **Shelter:**
  - Stony corals armor up! Tiny animals called polyps build the coral reefs stonelike structure. They create **hard exoskeletons** around themselves to protect their soft bodies. Coral polyps live in tight colonies, building their exoskeletons — made from the calcium carbonate found in seawater — on top of one another.
- **Oxygen:**
  - The corals and these special cells have a mutualistic relationship. The coral provides the zooxanthellae with a protected environment and compounds they need for photosynthesis. In return, the zooxanthellae produce oxygen and help the coral to remove wastes.

QUESTION 4: What are threats to the survival of corals?

- Global climate change (increased water temperatures)
- Unsustainable over-overfishing
- Land-based pollution

Climate change affects coral reef ecosystems by increasing sea surface temperatures and leads to coral bleaching, disease, sea level rise and storm activity. Additionally, increased carbon dioxide in the atmosphere changes ocean chemistry and harms reef-building corals.

Unsustainable fishing practices in coral reef areas can lead to the loss of ecologically and economically important fish species. Such losses often have a ripple effect not just on the coral reef ecosystems themselves, but also on the local economies that depend on them.

The effects of land-based sources of pollution, such as coastal development and agricultural runoff, can impede coral growth and reproduction, disturb ecological function and cause disease.

Although some of the biggest threats facing coral reefs are global in nature and require action on a similar scale, addressing local stressors like reducing runoff and promoting sustainable fishing is equally important.

INDEPENDENT / GROUP PRACTICE:

CLAY CORAL SCULPTING ACTIVITY - INSTRUCTIONS

- **Look at Reference Images**
  - Look at varied images of coral reefs. Talk about color, texture, pattern and shape within the context of the corals presented. Look specifically at corals found in the Flower Garden Banks, about 100 nautical miles (190 km) offshore of Galveston. Ask the students to describe the corals, and the kinds of marine life that they see in the images presented.
- **Prep the Cardboard Base**
  - Let each student choose a cardboard base that they want to work off of. They do not all have to be the same shape, but an organic shape will help in the overall look of the final piece. Once bases are chosen, give each of the students a small clump of clay, to start covering their base with. Have them cover the base with clay using their fingers, until the whole base is covered.
- **Create the Clay Corals**
  - Gather students and show them a few examples of what clay corals can look like. Use tools to create similar textures, patterns, and shapes of corals that were seen in reference images. Show students how to use slip and cross-hatching to attach the clay pieces to their base. Send students back to seats with new clumps of clay to begin working on their coral pieces. Have students come up one at a time to use the garlic press, to press through a clump of clay to create long strands of clay that can be used however they like in their reef. (Could be used for an anemone, seagrass, etc.)
- **Make sure Corals are Well-attached and add additional details.**
  - Give students clay tools to poke holes and add in additional texture to the piece. Make sure that all pieces are attached securely.
- **Set pieces to dry**
  - Overnight is best - but if time does not allow, wet clay can be painted (remind students to be gentle). Brief lesson on coral coloration and bioluminescence can be given while clay is drying.
- **Paint Coral Pieces with Acrylic Paint**
  - Once pieces are fairly dry, bring back out to students. Give students tutorial on acrylic painting, showing them several different techniques. Provide students with three different sized paint brushes, and small amounts of paint in paint pallets. Have students completely paint the coral piece, using different colors.
- **Add Glow in the Dark Paint**
  - Have students add glow in the dark paint once they have finished painting the rest of the piece. If time allows, find dark space to see the glow in the dark paint work!

ASSESSMENT OF LEARNING:

- Ask students to describe which species of coral their clay sculptures are modeled after
- Ask students which physical elements are inside of coral
- Ask students what are some of the threats that coral species are currently facing

CLOSING:

As you teach lessons linked to our Galveston Bay watershed and the Gulf of Mexico you can use the "I Wonder" board as a closure assignment. You might ask what else the students want to learn about corals. Students may ask about photosynthesis, or depth of water or who eats them or how boats anchor in areas with coral. All of their questions (even the ones asked multiple times) would go on the I Wonder board. If a question was answered in the lesson, it still goes on the board.

Students may even have questions days later that could be added. The goal is to have a place for all questions about Galveston Bay and Gulf of Mexico to be housed.

EXTENSION:

- Ask and discuss with students the ways that humans can do to keep coral reef ecosystems healthy
  - Use a reef-friendly sunscreen - Chemicals in sunscreen like oxybenzone and octinoxate harm marine life and can kill corals
  - Reduce carbon emissions - Climate change is one of the leading threats to coral reef survival
  - Look but don't touch the reef - Trampling the reef with your feet or fins will damage the corals
  - Conserve water - The less water that you use, the less wastewater will eventually find its way back into the ocean
  - Don't pollute - Choose biodegradable cleaning and gardening products at home to prevent chemical runoff into the water system
  - Don't buy wild coral - Corals grow very slowly, harvesting wild corals is unsustainable
  - Volunteer in a beach or reef cleanup - Help keep plastics and other debris out of the water
  - Choose sustainable seafood - Overfishing is a major threat to reef ecosystems and the ocean as a whole

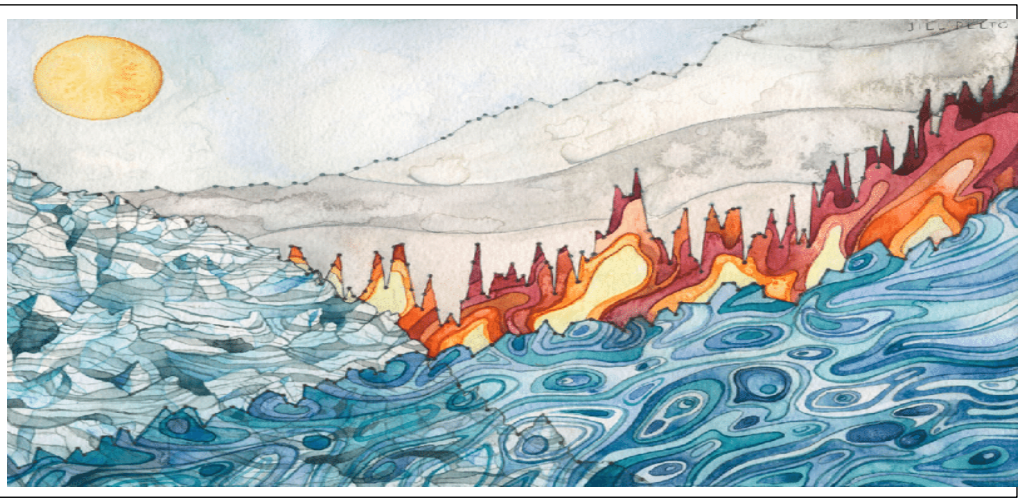
NOTES:

Island STYLE

Blue Carbon Interpretive Art Workshop

SUBJECT:
Science
GRADE LEVEL:
6th
TIMEFRAME:
45 minutes
MATERIALS:

- Introduction to Interpretive Art
  - Scrap paper
  - Interpretive themes
- Interpretive Art Activ
  - Watercolor palettes
  - Watercolor
  - Water cups
  - Large water boards (9x1
  - Masking tap
  - Paper towel
  - Bucket
  - Reference Images



'IVITY SUMMARY:

- Students will learn about coastal ecosystems, oceans, and climate by analyzing graphs and interpreting data in an artistic way.

.RNING OBJECTIVES:

- Understand threats to the environment due to carbon emissions
- Recognize the value of carbon sequestering
- Identify advantages of models to communicate a message

ALIGNMENT:

TEKS:

Science -

6.3.(B) – Use models to represent aspects of the natural world
6.3.(C) – Identify advantages and limitations of models such as size, scale, properties, and materials
6.3.(D) – Relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content
6.7.(A) – Research and debate the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources

Art –

1(A) – Identify and illustrate concepts from direct observation, original sources, personal experiences, and communities such as family, school, cultural, local, regional, national, and international
1(B) – Understand and apply the elements of art, including line, shape, color, texture, form, space, and value, as the fundamentals of art in personal artworks using art vocabulary appropriately
2(A) – Create original artworks based on direct observations, original sources, personal experiences, and the community
2(C) Produce artworks, including drawings, paintings, prints, sculptures/modeled forms, ceramics, fiber art, photographic imagery, and digital art and media, using a variety of materials

Ocean Literacy Principals:

3 The ocean is a major influence on weather and climate
4 The ocean makes Earth habitable
5 The ocean supports a great diversity of life and ecosystems
6 The ocean and humans are inextricably interconnected

VOCABULARY:

- **Anthropogenic** – Originating in human activity
- **Blue Carbon** – Carbon that is stored in the soils of wetlands
- **Carbon Dioxide** – A gas produced by burning fossil fuels; absorbed by plants during photosynthesis
- **Carbon Sink** – Description of wetlands as they sequester carbon and store it in their soil
- **Calcium Carbonate** – Ions are extracted from seawater and used as the building blocks that create the outer shell of some marine species
- **Climate Change** – Significant change in the Earth's climate over a long period of time; includes major changes in temperature, precipitation, or wind patterns that will last for extended periods of time
- **Ocean Acidification** – The changing chemistry of the ocean that is causing it to become more acidic
- **Sea Level Rise** – Change in the level of the sea that occurs because of thermal expansion, melting of land ice, and subsidence
- **Thermal Expansion** – Rise in level of water due to movement and expansion of water molecules
- **Interpretive Art** – Trying to communicate a message through art

BACKGROUND INFORMATION:

What are the 5 functions of the wetlands?

1. Flood prevention
2. Water filtration
3. Erosion prevention
4. Nursery habitat
5. Blue carbon sink

The Galveston Bay Watershed

Galveston Bay is an estuary located in between Houston and Galveston along the upper Texas coast. The Galveston Bay connects the Trinity River and the San Jacinto River to the Gulf of Mexico. Due to the combining of these two major rivers and the Gulf of Mexico, the Galveston Bay consists of brackish water.

Climate Change

Climate change is significant change in the Earth's climate over a long period of time that can include major changes in temperature, precipitation, or wind patterns that lasts for decades or longer. Climate change is partially attributed to anthropogenic causes, meaning that humans are causing climate change. The burning of oil, coal, and natural gas puts excess carbon dioxide into our atmosphere, acting like a heat trapping blanket around the globe. Climate change leads to changes such as sea level rise and ocean acidification.

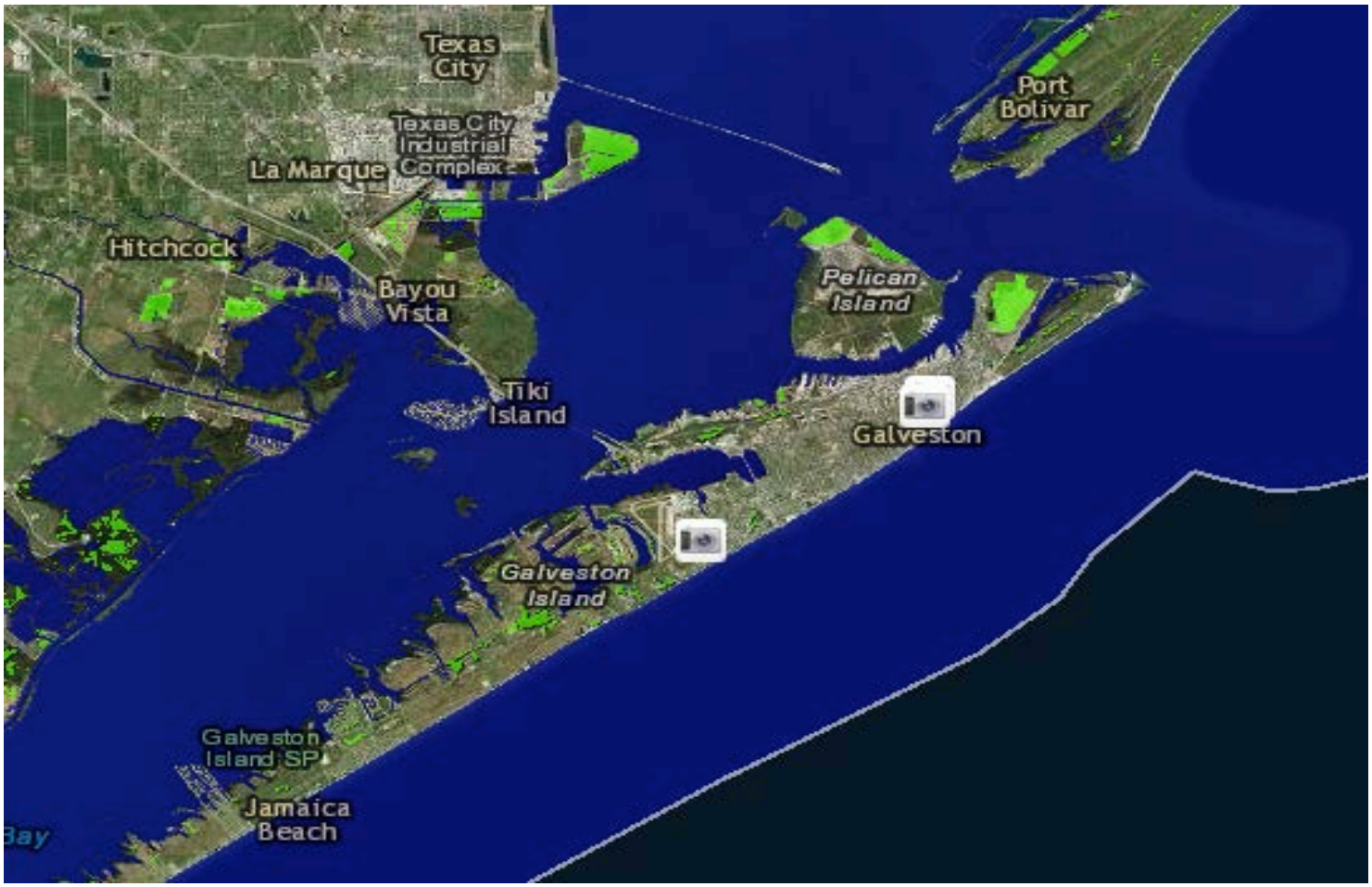
Sea Level Rise

Sea level is rising on a global scale, but the Galveston area is experiencing sea level rise 3x the national average. These changes due to sea level rise do not happen overnight, therefore there isn't a physical danger to humans. The map below depicts the current sea level in the Galveston region.

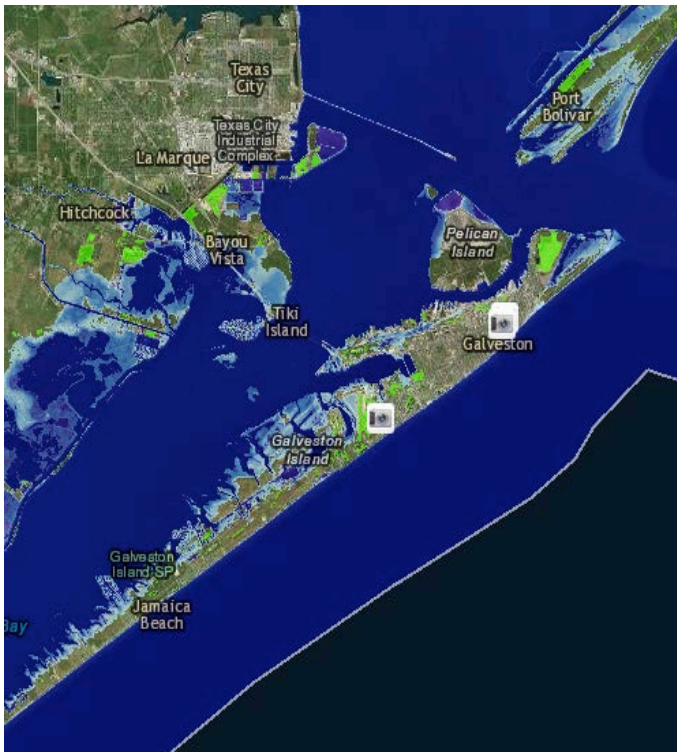
Sea level rise can occur due to thermal expansion, land-based ice melting, or land water storage. Thermal expansion is the tendency of matter to change in shape, volume, and area in response to a change in temperature. This occurs as water warms and it expands. Thermal expansion can be represented by visualizing a pot of boiling water. As water boils, bubbles form and at times, the water may begin to overflow out of the pot. The same occurs in the Earth's bodies of water. Land water storage alterations occur when changes in runoff and storage of surface and groundwater affect sea levels. This is when the land begins sinking due to oversaturation of the soil, but it appears as though the water level is increasing. Venice, Italy is one example of a "sinking city". The groundwater was pumped out from beneath the city for years, causing the slow shift of increasing sea levels. Land-based ice melting occurs as giant blocks of ice melt and rapidly adds thousands of gallons of water to the volume of the ocean. Both Greenland and Antarctica are great examples of this.

Currently, the city of Galveston is only about 7 feet above sea level on average. Scientists have predicted that in the next 50 years the sea level in this region will increase by 3 feet. If this occurs, low-lying areas of the island and areas surrounding Galveston Bay will slowly become submerged. Identifiable landmarks affected by this increase may include East Beach, the Artist Boat headquarters, and Tiki Island. Predictions have also been made that in the next 100 years, sea level will increase by 6 feet. The majority of regional landmarks, including the Bolivar Peninsula, west Galveston Island, and the Strand would no longer be livable or accessible. Pelican Island and Galveston's "mid-town" are the only land areas that may remain above the increased sea level.

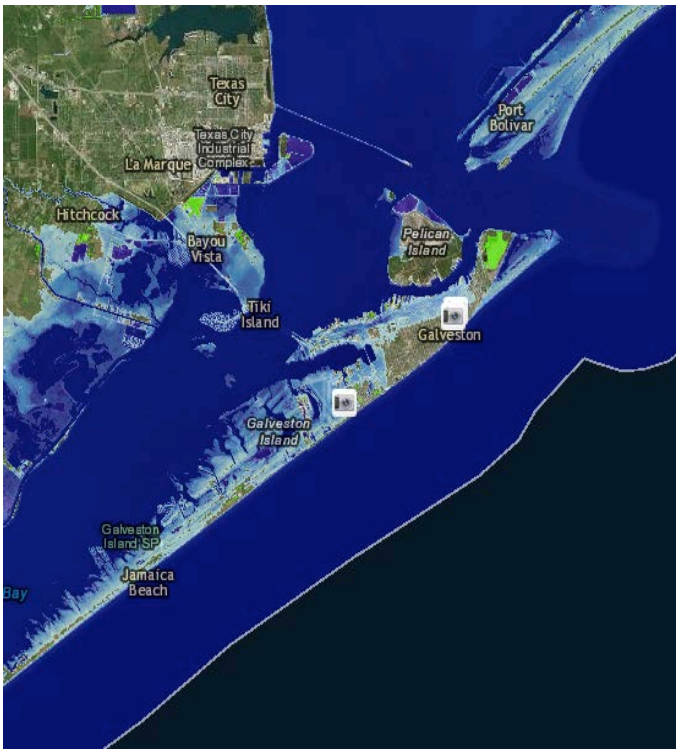
Current Sea Level



3 foot increase

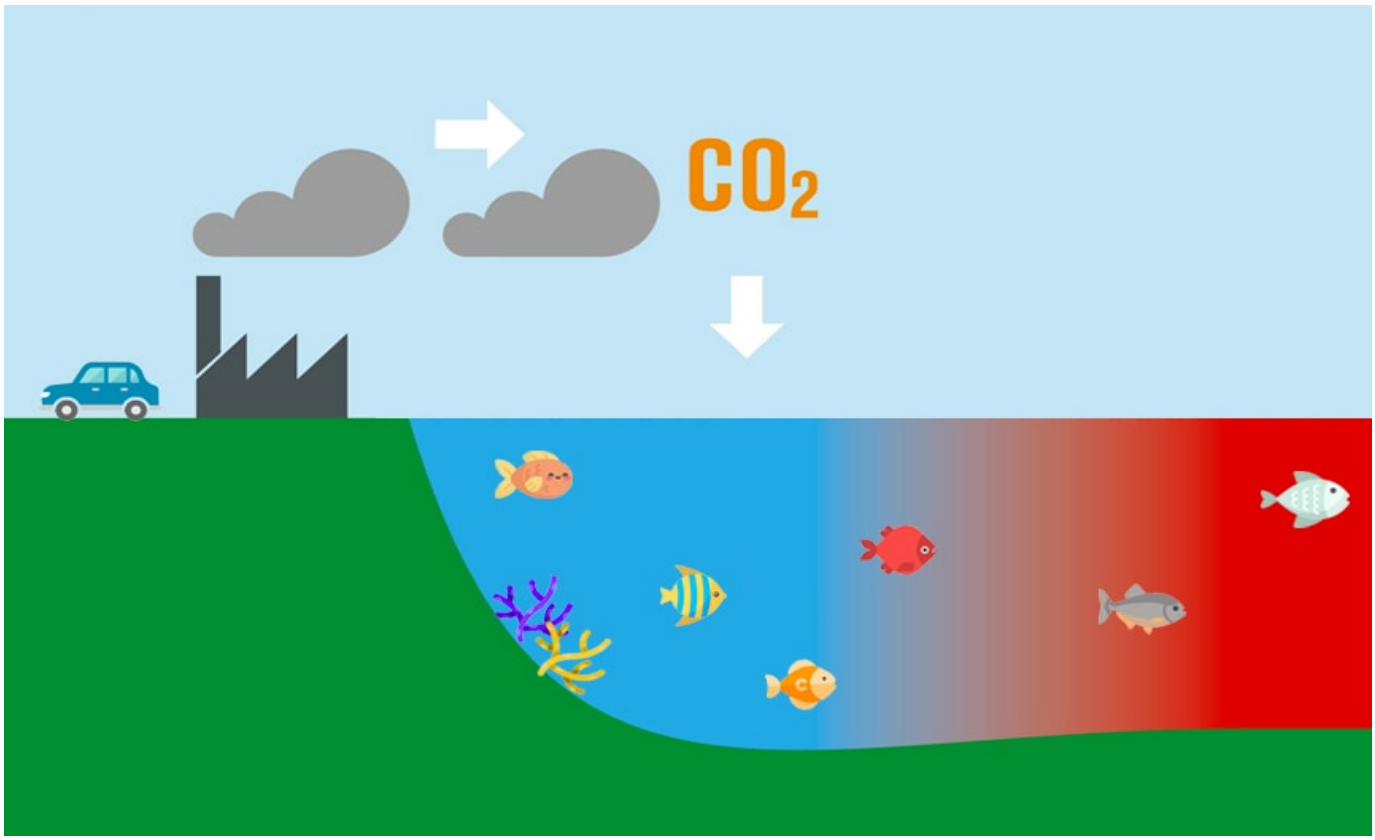


6 foot increase



Ocean Acidification

The carbon that does not get trapped in the atmosphere is absorbed by the ocean. Approximately 48% of carbon emitted by fossil fuel burning is sequestered in the ocean. The chemistry of the ocean is being changed by human activity, which affects all sea life. pH stands for "potential of hydrogen" and measures the acidity or basicity of liquids. Sea life has adapted over many years to a specific pH and temperature in the ocean, so even small fluctuations can cause drastic changes in their ecosystem. Water has a pH of 7, while seawater is slightly basic at 8.1. Many marine organisms such as coral, oysters, clams, and mussels have calcium carbonate shells or skeletons. When the pH of the ocean lowers, the calcium carbonate begins dissolving and the animals that use it to form their shells and exoskeletons cannot survive.



Carbon Storage

As the world population grows, our carbon footprint increases. We use more electricity, drive more cars, and require more industry. The biggest sources of CO_2 emissions consist of 87% use of fossil fuels, 9% land use changes (i.e. deforestation), and 4% come from industrial processes. Tropical forests store carbon in their biomass, while salt marshes and mangroves take in CO_2 through photosynthesis and store large amounts of carbon in the soil. This makes ecosystems that store carbon in their soil capable of storing 10x more carbon than traditional forests. Oceanic mangroves store the most atmospheric carbon overall.

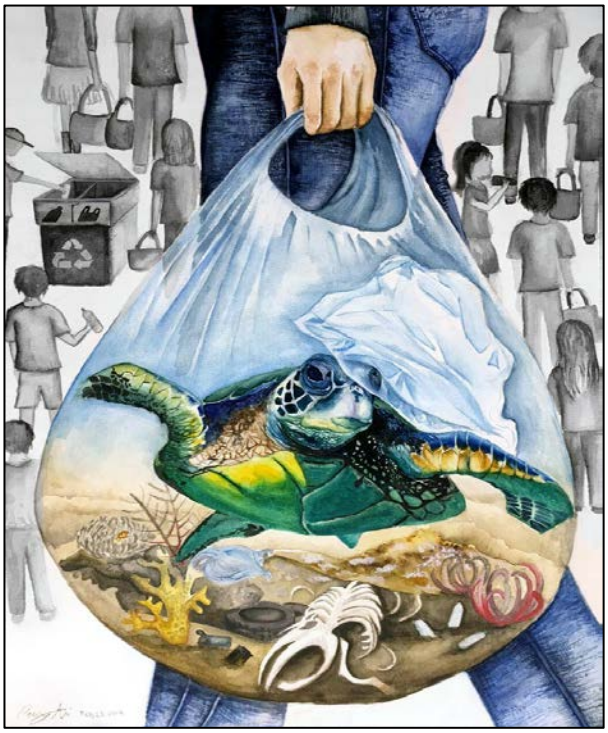
Interpretive Art

An interpretive art piece should be created by using knowledge of a topic to create art about key points that stuck out, while aiming to encourage an audience to take action.

Interpretive art can be categorized in <u>three</u> different ways:

1. An interpretation of data visualized by creating a graph in an art piece to help emphasize a point
2. Transforming an ordinary item into something extraordinary
3. Spreading a message of hope

The above image was created by Jill Pelto and is named “Gulf of Maine Temperature Variability”. This piece tells the story of increasing temperature fluctuations in Maine’s coastal marine environment. The watercolor uses ocean temperature data from the past 15 years to highlight how greater variability affects various species including humans.



The above image named “Anyone Can Save the Ocean” was created by Becky Ni. While conducting research, Ni discovered that only 1 plastic bag is recycled in every 200 that are used. A large portion of plastic bags end up in the ocean, therefore injuring or killing thousands of marine creatures each year.

The above image was created by Jane Zhang for a junior art contest in 2019. Titled “Our Future”, this piece depicts the past, present, and future of arctic marine life. As global temperatures rise due to increased carbon emissions, glacial ice is slowly melting, therefore many marine species are losing their ecosystems.

PREPARATIONS:

1. Tape a 9 x 12 in. piece of watercolor paper to a wooden board (enough for the first class period at minimum)
2. Half-way fill a cup with water for each student
3. Gather reference images and example interpretive artwork

INTRODUCTION:

Pass out an Interpretive Art theme and a piece of scratch paper to each student. Ask the students to quickly sketch a picture that illustrates what they read. Have the students share what they have drawn. Encourage students to begin thinking about different ways to tell a story through art or share knowledge through an art piece.

GUIDED PRACTICE:

As a group, examine artwork by individuals such as Jill Pelto, Erin Zheng, Madison Miller, and Inang Kalikasan. Discuss what category of interpretive art each piece could fall into. Have students point out what parts of the image represent graph points. Additionally, have students share what changes they would make to improve spreading the intended message of the artwork.

INDEPENDENT/GROUP PRACTICE:

Interpretive Art

Equipment Rules

1. Do not touch supplies until asked to do so.
2. Pour out dirty water and get fresh water for the next group.
3. Paint wells should be cleaned with paper towel after each use.
4. Paint brush must be washed out and placed in paint palette with pencil.
5. Replace reference images.
6. Remove painting and stack board.
7. Throw used paper towels and tape in the trash.

Watercolor Tips

1. Portrait vs. Landscape- first decide which fits your drawing.
2. Subject must take up 2/3 of page.
3. Background must be present behind animal- gives depth
4. Foreground must be present in front of animal- gives depth.
5. Light to dark- work light to dark with watercolors.
6. Contour line drawing- the outer edge of any shape. Make a simple contour line drawing of subject. Leave detail for painting. Students should only spend 5 minutes on contour line drawing.

Watercolor Demonstration

1. Quickly choose a subject from provided resources.
2. Decide if it is going to be a portrait or a landscape.
3. Perform a quick contour line drawing of the subject, and other major parts to the painting. It is easier to look at the drawing while doing this instead of focusing on your hand, similar to playing a video game. A horizon line should be established, and the ground or water should meet the horizon line. Discourage the use of happy-faced suns, fake fluffy clouds, m-shaped birds, and other elementary symbols.
4. Sketch white areas to avoid painting over them. There is no white paint.
5. Show class that there are only 12 colors in watercolor set; encourage them to mix colors in wells.
6. **Watercolor Painting Techniques**:
    - **Wash**- In a wash, colors are added on top of each other while still wet to create interesting blending effects. Remember to work from light to dark. Use this technique for the larger areas, such as the sky, water, or ground. To do this, wet the brush without paint, spread it over the paper as if there were paint on it, add some color to the paintbrush, and paint over the area with water. This technique allows paints to be spread evenly and lightly for background colors.
    - **Wet brush, dry paper**- this is the most common technique used while watercolor painting
    - **Dry brush**- A dry brush technique involves not using as much water with the brush in an attempt to create details. Create a small pool of water in the color well that you are wanting to use, then pinch out the excess water left in the paint brush. Gently hold the bristles of the paint brush over the small pool of paint and allow the paint to be absorbed up into the brush.

Interpretive Art Act

1. Have students either transfer their sketches that were made during the introduction to their 9 x 12 watercolor paper or create a new sketch that reflects information learned throughout this Blue Carbon Interpretive Art Workshop.
2. Allow students to begin watercolor painting.
3. Walk around the room while students are water coloring to assist.
4. Provide frequent updates on time remaining.
5. Have students clean up their work area, leaving it as clean as when they started. Pour out dirty water and refill with clean water for the next class. Clean dirty paint wells with paper towels. Wash out paint brushes and place back in paint palette alongside pencil. Return reference materials. Remove painting from boards when fairly dry. Throw paper towels and tape into trash.
6. Ask students to write their first and last name, as well as the date on their art piece.

ASSESSMENT OF LEARNING:

Informal viewing of work will show that students have gained the ability to paint a picture that tells a story, evokes emotion, and encourages taking action.

CLOSING:

As you teach lessons linked to Blue Carbon Interpretive Art, you can use the “I Wonder” board as a closing assignment.

You might ask what else the students want to learn about interpretive art or reducing their carbon emissions. Students may ask about additional artists who create interpretive art pieces, ocean acidification harming marine life, or sea level rise causing physical harm to the human population. All of their questions (even the ones asked multiple times) would go to the “I Wonder” board. If a question was answered in the lesson, it still goes on the board.

Students may even have questions days later that could be added. The goal is to have a place for all questions about Galveston Bay and the Gulf of Mexico to be housed.

NOTES:

Island STYLE

Blue Carbon Science Workshop

SUBJECT:

Science

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Sea Level Rise Activit
  - Expo marke
  - 2 plastic tub
  - Ice
- Ocean Acidification Activity
  - Clear cup
  - Eggs
  - Vinegar
- Carbon Storage Visua
  - 4 plastic bin
  - 50 green pi pong balls
  - 50 black pi pong balls

'IVITY SUMMARY:

- Students will learn about coastal ecosystems, oceans, and climate by analyzing graphs and interpreting data.

.RNING OBJECTIVES:

- Differentiate sea/land ice characteristics
- Understand threats to Galveston Island due to carbon emissions
- Identification of Galveston watershed contributing bodies of water

ALIGNMENT:

TEKS:

Science -

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
6.3.(B) – Use models to represent aspects of the natural world
6.3.(C) – Identify advantages and limitations of models such as size, scale, properties, and materials
6.3.(D) – Relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content
6.5.(C) – Differentiate between elements and compounds on the most basic level
6.7.(A) – Research and debate the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources

Ocean Literacy Principals:

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

VOCABULARY:

- **Anthropogenic** – Originating in human activity
- **Estuary** – A partially enclosed, coastal body of water where freshwater from rivers and streams mixes with salt water from the ocean
- **Brackish Water** – A mixture of salt and fresh water
- **Blue Carbon** – Carbon that is stored in the soils of wetlands
- **Carbon Dioxide** – A gas produced by burning fossil fuels; absorbed by plants during photosynthesis
- **Carbon Sink** – Description of wetlands as they sequester carbon and store it in their soil
- **Calcium Carbonate** – Ions are extracted from seawater and used as the building blocks that create the outer shell of some marine species
- **Climate Change** – Significant change in the Earth's climate over a long period of time; includes major changes in temperature, precipitation, or wind patterns that will last for extended periods of time
- **Ocean Acidification** – The changing chemistry of the ocean that is causing it to become more acidic
- **Subsidence** – Sinking of land due to changes in use of surface and ground water
- **Sea Level Rise** – Change in the level of the sea that occurs because of thermal expansion, melting of land ice, and subsidence
- **Thermal Expansion** – Rise in level of water due to movement and expansion of water molecules

BACKGROUND INFORMATION:

What are the 5 functions of the wetlands?

1. Flood prevention
2. Water filtration
3. Erosion prevention
4. Nursery habitat
5. Blue carbon sink

The Galveston Bay Watershed

Galveston Bay is an estuary located in between Houston and Galveston along the upper Texas coast. The Galveston Bay connects the Trinity River and the San Jacinto River to the Gulf of Mexico. Due to the combining of these two major rivers and the Gulf of Mexico, the Galveston Bay consists of brackish water.

Climate Change

Climate change is significant change in the Earth's climate over a long period of time that can include major changes in temperature, precipitation, or wind patterns that lasts for decades or longer. Climate change is partially attributed to anthropogenic causes, meaning that humans are causing climate change. The burning of oil, coal, and natural gas puts excess carbon dioxide into our atmosphere, acting like a heat trapping blanket around the globe. Climate change leads to changes such as sea level rise and ocean acidification.

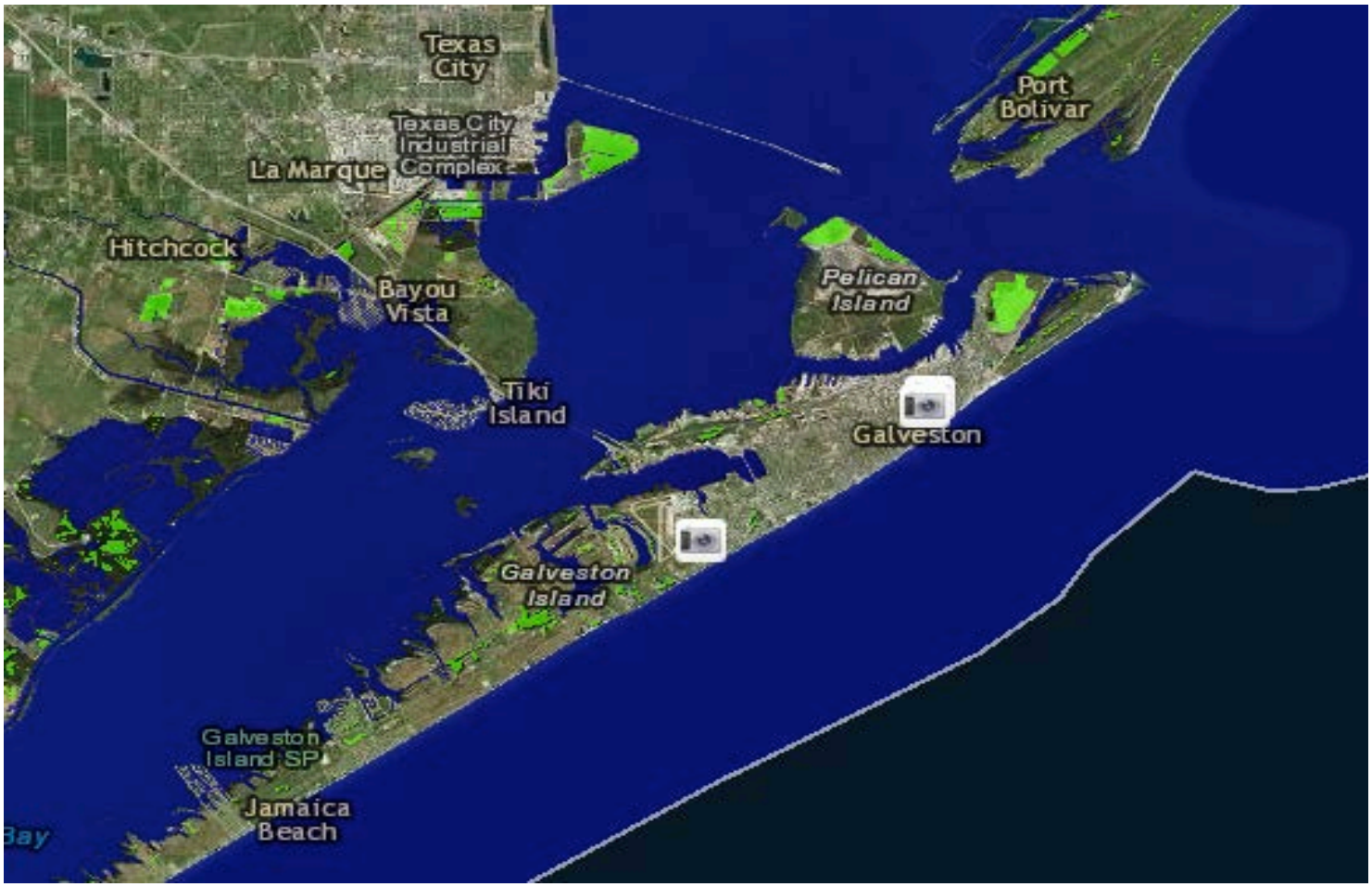
Sea Level Rise

Sea level is rising on a global scale, but the Galveston area is experiencing sea level rise 3x the national average. These changes due to sea level rise do not happen overnight, therefore there isn't a physical danger to humans. The map below depicts the current sea level in the Galveston region.

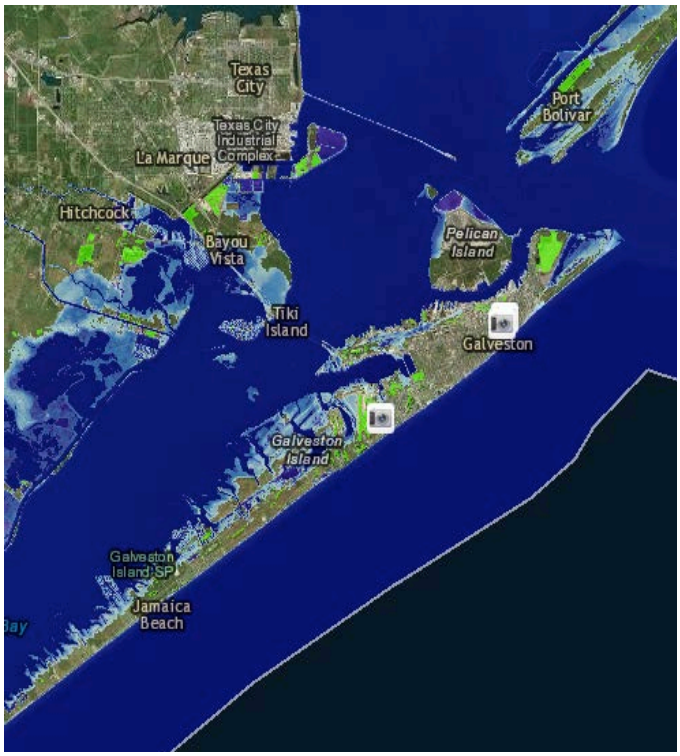
Sea level rise can occur due to thermal expansion, land-based ice melting, or land water storage. Thermal expansion is the tendency of matter to change in shape, volume, and area in response to a change in temperature. This occurs as water warms and it expands. Thermal expansion can be represented by visualizing a pot of boiling water. As water boils, bubbles form and at times, the water may begin to overflow out of the pot. The same occurs in the Earth's bodies of water. Land water storage alterations occur when changes in runoff and storage of surface and groundwater affect sea levels. This is when the land begins sinking due to oversaturation of the soil, but it appears as though the water level is increasing. Venice, Italy is one example of a "sinking city". The groundwater was pumped out from beneath the city for years, causing the slow shift of increasing sea levels. Land-based ice melting occurs as giant blocks of ice melt and rapidly adds thousands of gallons of water to the volume of the ocean. Both Greenland and Antarctica are great examples of this.

Currently, the city of Galveston is only about 7 feet above sea level on average. Scientists have predicted that in the next 50 years the sea level in this region will increase by 3 feet. If this occurs, low-lying areas of the island and areas surrounding Galveston Bay will slowly become submerged. Identifiable landmarks affected by this increase may include East Beach, the Artist Boat headquarters, and Tiki Island. Predictions have also been made that in the next 100 years, sea level will increase by 6 feet. The majority of regional landmarks, including the Bolivar Peninsula, west Galveston Island, and the Strand would no longer be livable or accessible. Pelican Island and Galveston's "mid-town" are the only land areas that may remain above the increased sea level.

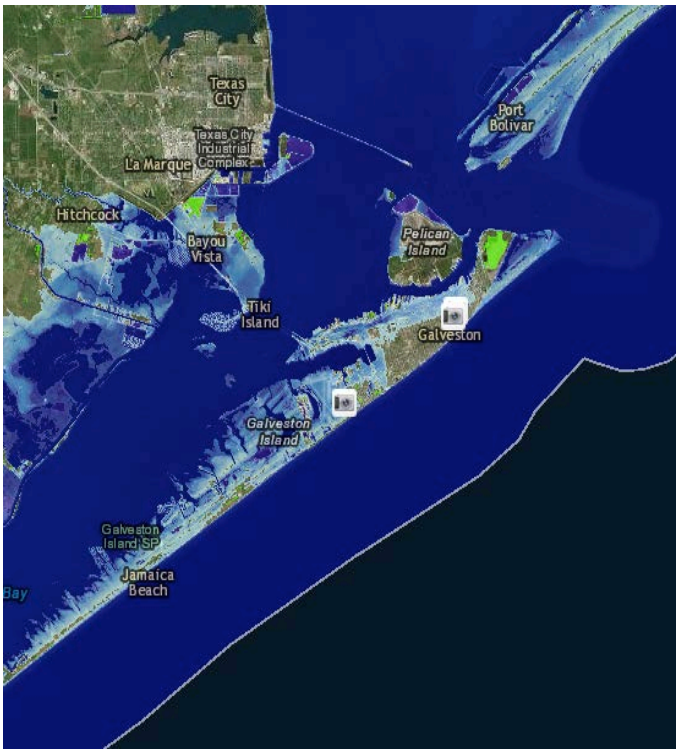
Current Sea Level



3 foot increase

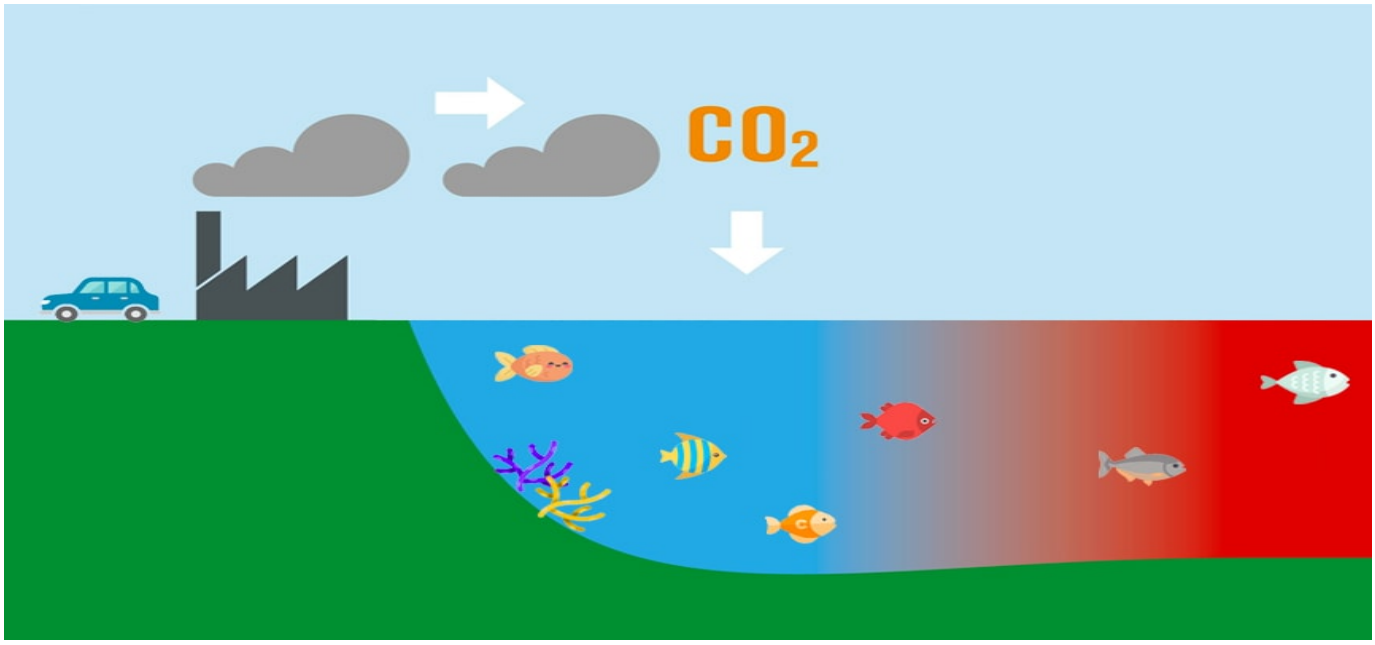


6 foot increase



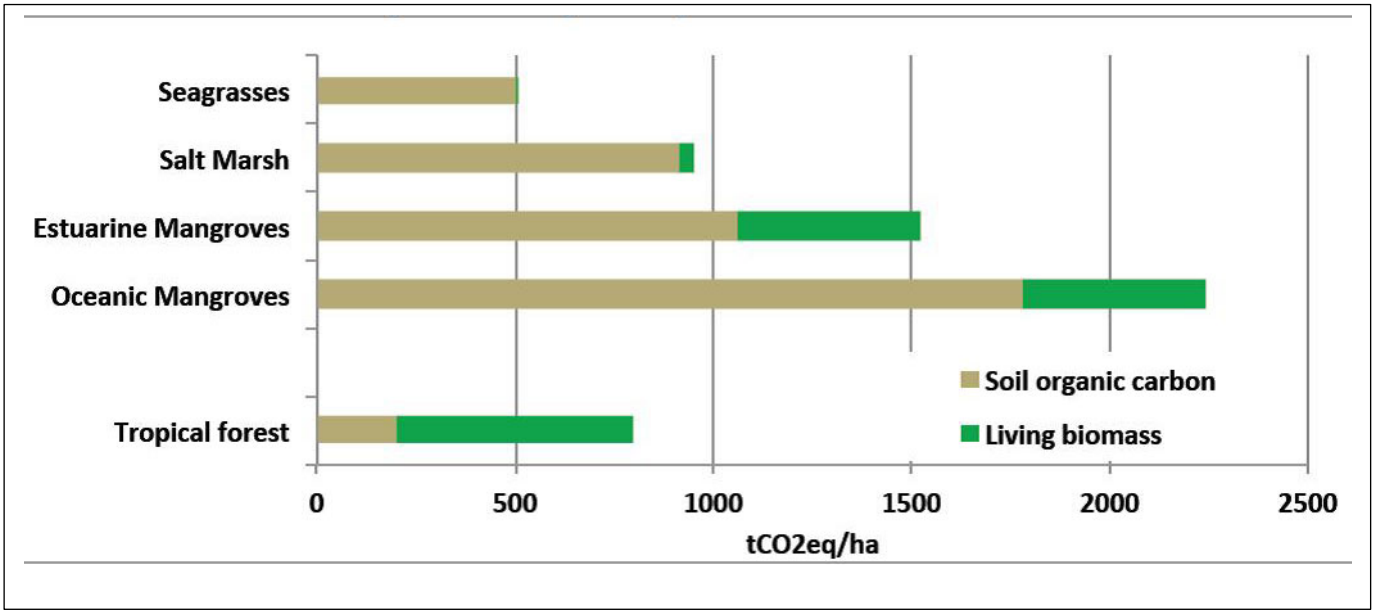
Ocean Acidification

The carbon that does not get trapped in the atmosphere is absorbed by the ocean. Approximately 48% of carbon emitted by fossil fuel burning is sequestered in the ocean. The chemistry of the ocean is being changed by human activity, which affects all sea life. pH stands for "potential of hydrogen" and measures the acidity or basicity of liquids. Sea life has adapted over many years to a specific pH and temperature in the ocean, so even small fluctuations can cause drastic changes in their ecosystem. Water has a pH of 7, while seawater is slightly basic at 8.1. Many marine organisms such as coral, oysters, clams, and mussels have calcium carbonate shells or skeletons. When the pH of the ocean lowers, the calcium carbonate begins dissolving and the animals that use it to form their shells and exoskeletons cannot survive.



Carbon Storage

As the world population grows, our carbon footprint increases. We use more electricity, drive more cars, and require more industry. The biggest sources of CO_2 emissions consist of 87% use of fossil fuels, 9% land use changes (i.e. deforestation), and 4% come from industrial processes. Tropical forests store carbon in their biomass, while salt marshes and mangroves take in CO_2 through photosynthesis and store large amounts of carbon in the soil. This makes ecosystems that store carbon in their soil capable of storing 10x more carbon than traditional forests. Oceanic mangroves store the most atmospheric carbon overall.



MISCONCEPTIONS:

Some think that carbon is only used in the form of fuel (i.e. coal, oil, natural gas), but in reality, carbon is essential to life. Carbon is the primary component of almost everything in your body, including proteins, fats, DNA, sugars, and muscle tissues. Carbon dioxide gas is used when plants photosynthesize. Carbon in the form of graphite is used in pencils, while carbon as activated charcoal is used for filtration and purification. Carbon as diamonds are used for cutting large pieces of rock and stone.

PREPARATIONS:

1. Label one plastic tub "Sea Ice" and a second plastic tub labeled "Land Ice".
2. Have ice and eggs ready for use in a cooler.
3. Label one plastic bin " Salt Marshes", one "Mangroves", one "Tropical Forests", and one "Seagrasses".

INTRODUCTION:

What are the 5 functions of wetlands?

- Flood prevention, water filtration, erosion prevention, nursery habitat, and Blue Carbon sink

What bodies of water contribute to the Galveston watershed?

- Trinity River, San Jacinto River, Galveston Bay, and Gulf of Mexico

Identify different kinds of animals in the Galveston watershed.

- Oysters, clams, dolphins, sharks, shrimp, crabs, fish

GUIDED PRACTICE:

Sea Level Rise

Have 1 tub labeled "Sea Ice" with water and a handful of ice inside. Use an expo marker to mark the initial sea level. During each class period, mark the sea level again. Note how it does not change. Label a second tub "Land Ice". Fill the tub with the same amount of water as the first. Add 3 cups of ice each class period and mark the sea level. Note how the sea level is rising. Revisit the experiment on Day 2 to discuss the final results.

Carbon Storage Visual

Have one plastic bin labeled " Salt Marshes", one "Mangroves", one "Tropical Forests", and one "Seagrasses". Ask students to hypothesize how many black ping pong balls (representing soil organic carbon) and how many dark green ping pong balls (representing living biomass) will be in each ecosystem. Have students take turns tossing ping pong balls into correct bins to visualize their hypothesis. Sort ping pong balls correctly following this activity. Seagrass bin will have 1 dark green and 5 black ping pong balls. Salt Marsh bin will have 1 dark green and 10 black ping pong balls. Mangroves bin will have 27 dark green and 33 black ping pong balls. Tropical Forest bin will have 21 dark green and 2 black ping pong balls.

INDEPENDENT/GROUP PRACTICE:

Ocean Acidification

Split students into groups. Have students formulate a hypothesis about how an egg would be affected by vinegar. Assign each group a different amount of vinegar that is to be added to a plastic cup, being sure that at least one egg is fully submerged. Explain to the students that vinegar is slightly acidic. Allow the egg to remain in the vinegar overnight. Revisit the experiment on Day 2 to discuss the final results.

Reflection

Have students discuss how they can reduce carbon emissions in their day-to-day life. Some examples include drinking from reusable water bottles, walking short distances instead of driving, turning off lights when not in a room, unplugging devices when not in use, and recycling.

ASSESSMENT OF LEARNING:

Monitor students by asking student to document and share their individual practice results from the ocean acidification activity.

CLOSING:

As you teach lessons linked to Blue Carbon, you can use the "I Wonder" board as a closing assignment.

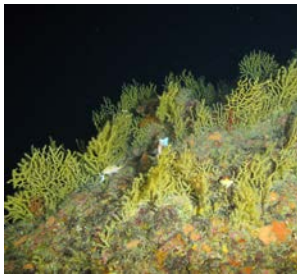
You might ask what else the students want to learn about reducing their carbon emissions or our impact on the environment. Students may ask about ocean acidification harming marine life, sea level rise causing physical harm to the human population, or differences in salt marshes and mangroves. All of their questions (even the ones asked multiple times) would go to the "I Wonder" board. If a question was answered in the lesson, it still goes on the board.

Students may even have questions days later that could be added. The goal is to have a place for all questions about Galveston Bay and the Gulf of Mexico to be housed.

NOTES:

Island STYLE

Deepwater Soft Corals and Oil Spills



SUBJECT:

Science

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Demonstration soft c
  - Sea Fan
  - Sea Pen
  - Black coral
- Demonstration stony
  - Brain
  - Elkhorn
  - Staghorn
- Reference images of stony coral species
- Oil Spill Simulation
  - Pipe cleaner (coral sculpt
  - 3D Printed c
  - Coral refere images
  - Glass beake
  - Glass pan
  - Saran wrap
  - Water
  - Vegetable oi
  - Food colorir
  - Cajun Inject
  - Spoon
  - Paper towels

'IVITY SUMMARY:

ents will learn about the physical makeup of soft corals, what type of environment soft corals to thrive, learn about the historic *Deepwater Horizon* Oil Spill, the devastating impact it had e mesophotic and deep benthic coral communities, and how scientists are helping these

.RNING OBJECTIVES:

- Soft coral species structure, identification, and function
- Ecosystem requirements for soft corals
- Differentiate stony/soft coral characteristics
- Understand threats to soft coral ecosystems
- Recognize impact of Deepwater Horizon Oil Spill

GNMENT:

s:

6.6(A) - Compare metals, nonmetals, and metalloids using physical properties such as luster, conductivity, or malleability
6.11(B) - Understand that gravity is the force that governs the motion of our solar system
6.12 (E) - Describe biotic and abiotic parts of an ecosystem in which organisms interact

n Literacy Principles:

5 The ocean makes Earth habitable
7 The ocean and humans are inextricably interconnected

VOCABULARY:

- **Buoyancy** - the ability or tendency to float in water or air or some other fluid
- **Deep benthic** - Areas on the seafloor where sunlight is not present; for Gulf restoration, this deeper than 980 feet
- **Density** - the degree of compactness of a substance
- **Mesophotic benthic** - Areas on the seafloor where sunlight levels are low; for Gulf restoration, this is ~160 feet to ~980 feet
- **Oil** - a viscous liquid derived from petroleum, especially for use as a fuel or lubricant
- **Oil Rig** - a structure with equipment for drilling and servicing an oil well
- **Oil Well** - a well or shaft drilled through rock, from which petroleum is drawn
- **Pollution** - the presence in or introduction into the environment of a substance or thing that has harmful or poisonous effects
- **Restoration** – Repairing and supporting recovery of injured or degrading habitats, populations, or ecosystems
- **Soft Corals** - Soft corals are soft and bendable and often resemble plants or trees. These corals do not have stony skeletons and are non-reef-building corals—instead, they grow wood-like cores and fleshy rinds for protection

BACKGROUND INFORMATION:

CORALS:

In the previous science lesson, students have learned about the physical makeup of stony corals, what type of environment stony corals need to thrive, and aimed to understand some of the challenges coral colonies face for survival. This lesson will introduce soft corals.

OIL SPILLS:

***Deepwater Horizon* oil spill**, also called **Gulf of Mexico oil spill**, the largest marine oil spill in history, caused by an April 20, 2010, explosion on the Deepwater Horizon oil rig—located in the Gulf of Mexico, approximately 41 miles off the coast of Louisiana—and its subsequent sinking on April 22:

The April 20, 2010, the explosion, subsequent fire, and sinking of the *Deepwater Horizon* mobile drilling unit triggered a massive release of oil and other substances from BP's Macondo well. Initial efforts to cap the well following the explosion were unsuccessful and, for 87 days after the explosion, the well blasted oil and natural gas continuously and uncontrollably into the northern Gulf of Mexico. Oil under pressure gushed into the deep ocean from the BP's Macondo well, located about 1 mile below the ocean surface and about 50 miles offshore. Subsea videos captured dramatic images of oil spewing unchecked from the well's broken riser pipe into the deep ocean. Oil moved with deep-sea currents, creating a plume of oil within the deep sea; oil and associated "marine oil snow" also settled on the sea floor. More buoyant oil traveled up through about a mile of water column and formed large surface slicks; at its maximum extent on June 19, 2010, oil covered over 15,300 square miles of the ocean, an area about 10 times the size of Rhode Island. Cumulatively over the course of the spill, oil was detected on over 43,300 square miles of the ocean, an area about the size of Virginia.

In total, the *Deepwater Horizon* oil spill released 134 million gallons of oil into the Gulf of Mexico. To clean oil from the open water, 1.8 million gallons of dispersants —substances that emulsified the oil, allowing for easier metabolism by bacteria—were pumped directly into the leak and applied to the slick from above using airplanes. Booms to corral portions of the slick were deployed, and the contained oil was then siphoned off or burned. As oil began to contaminate Louisiana beaches in May, it was manually removed; more difficult to clean were the state's marshes and estuaries, which are knit together by delicate plant life, and underwater habitats. By June, oil and tar balls had made landfall on the beaches of Mississippi, Alabama, and Florida. In all, an estimated 1,100 miles of shoreline were polluted. The oil came into contact with and injured deep-sea coral, fish and shellfish, birds, sea turtles, and marine mammals. Additionally, the oil spill prevented people from fishing, going to the beach, and enjoying recreational activities along the Gulf of Mexico.

Under the Oil Pollution Act (OPA), a council of federal and state "trustees" was created soon after the spill to assess the natural resource injuries resulting from it, develop a restoration plan to address those injuries, and acquire funding to make restoration possible. One of the 13 restoration areas in need identified during this plan are mesophotic and deep benthic communities in the Gulf, which consist of soft corals, sponges, fish, and invertebrates and are important habitats in the food web of larger Gulf species.

More than 770 square miles of deep-sea habitat and 4 square miles of mesophotic habitat were injured by the *Deepwater Horizon* oil spill. Humans have a limited understanding of mesophotic and deep benthic communities, including the species found in these ecosystems and how they interact, how long they live, how they reproduce, and how they can be effectively conserved or restored. Restoring mesophotic and deep-sea habitats is a challenging task due to the limited knowledge of these ecosystems and the fact that restoration at these depths has rarely been done so far. To ensure these habitats are restored as effectively as possible, 4 projects were created for the National Oceanic and Atmospheric Administration (NOAA) to work together with partners on this effort.

These projects will:

- Improve understanding of mesophotic and deep-sea communities to inform better management and ensure resiliency
- Restore mesophotic and deep benthic invertebrate and fish abundance for injured species, focusing on high-density mesophotic and deepwater coral sites and other priority hard-ground areas to provide healthy habitats from the coast to offshore
- Actively manage valuable mesophotic and deep-sea communities to protect against multiple threats and provide a framework for monitoring, education, and outreach.

PREPARATION:

Gather all necessary materials listed above. Set up small group stations for each group to conduct their own oil spill activity.

INTRODUCTION:

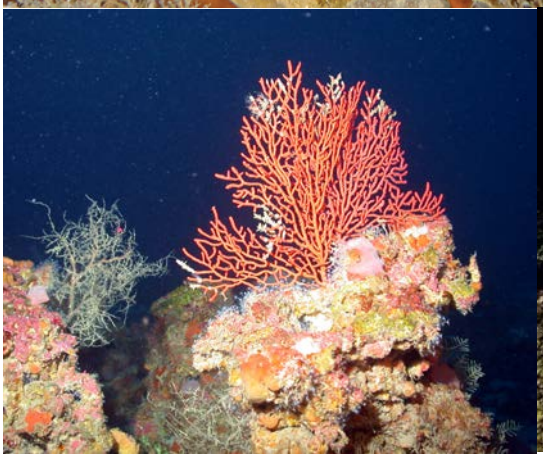
What is the difference between Coral Specimen #1 and Coral Specimen #2?

Allow for students to touch both **stony** and **soft coral** specimens. Make a list of similarities and differences.

Soft corals can survive in much deeper, colder waters than the stony corals!

Soft corals can be distinguished from hard corals by their appearance and by their movement in the water. They are also found in a huge range of forms and shapes, from doughy/fleshy shapes to delicate fans and whips.

Some species are much **more depth tolerant** than their harder cousins; **Their large, eight-tentacled polyps** feed voraciously in deep water currents. Soft corals are present in larger numbers **in temperate or even polar waters** because they are **not as dependent on algae** to produce the bulk of their food.



Sea Fan **Sea Pen** **Black Corals**

GUIDED PRACTICE:

Introduction to Oil Spills

- What is oil?
  - Crude oil, the liquid remains of ancient plants and animals, is a fossil fuel that is used to make a wide range of fuels and products. Oil is found below ground or below the ocean floor in reservoirs, where oil droplets reside in "pores" or holes in the rock. After drilling down and pumping out the crude oil, oil companies transport it by pipes, ships, trucks, or trains to processing plants called refineries. There it is refined so it can be made into different petroleum products, including gasoline and other fuels as well as products like asphalt, plastics, soaps, and paints.
- What is an oil spill?
  - An oil spill is a form of pollution generally found in a marine ecosystem. However, oil spills can happen on land too. An oil spill occurs when oil leaks or spills into the water. Oil spills can also happen in rivers or lakes!
- What causes an oil spill?
  - Oil spills are often caused by accidents, but they can also be caused by human error or carelessness. These accidents involve tankers, barges, oil drill rigs, and other places or methods of transportation that store or hold large amounts of oil.
- Why are oil spills harmful?
  - Oil spills are harmful to marine birds and mammals as well as fish and shellfish. Oil coats the feathers and fur of marine life, leaving them susceptible to hypothermia (being too cold) because their fur or feathers cannot protect them from the weather.
  - Additionally, an oil spill can contaminate the food supply or food chain. Marine mammals that eat fish or other food exposed to an oil spill may be poisoned by oil.

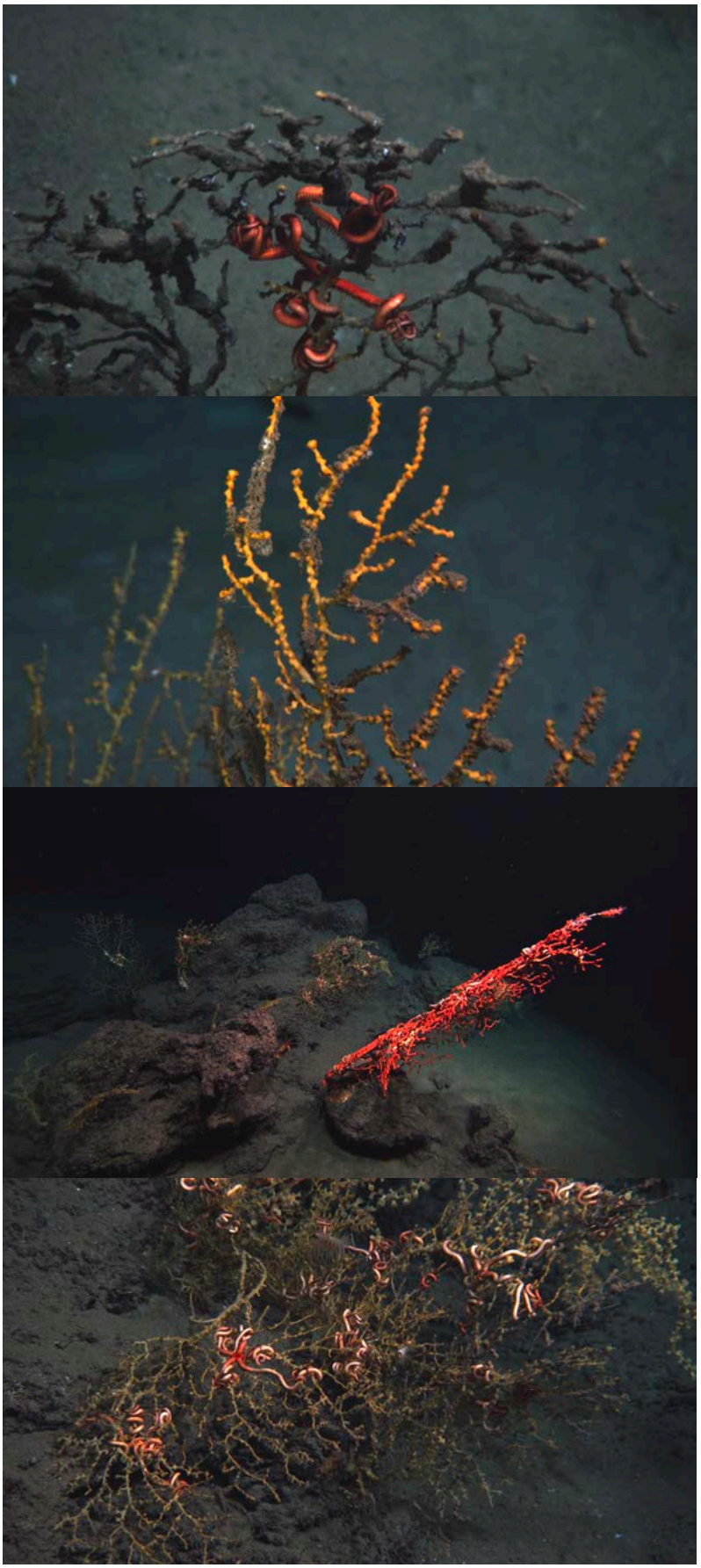
The Deepwater Horizon Oil Spill

- Largest marine oil spill in history, caused by an April 20, 2010, explosion on the Deepwater Horizon oil rig—located in the Gulf of Mexico, approximately 41 miles off the coast of Louisiana—and its subsequent sinking on April 22. The spill dumped 3.19 million barrels of oil into the Gulf of Mexico.

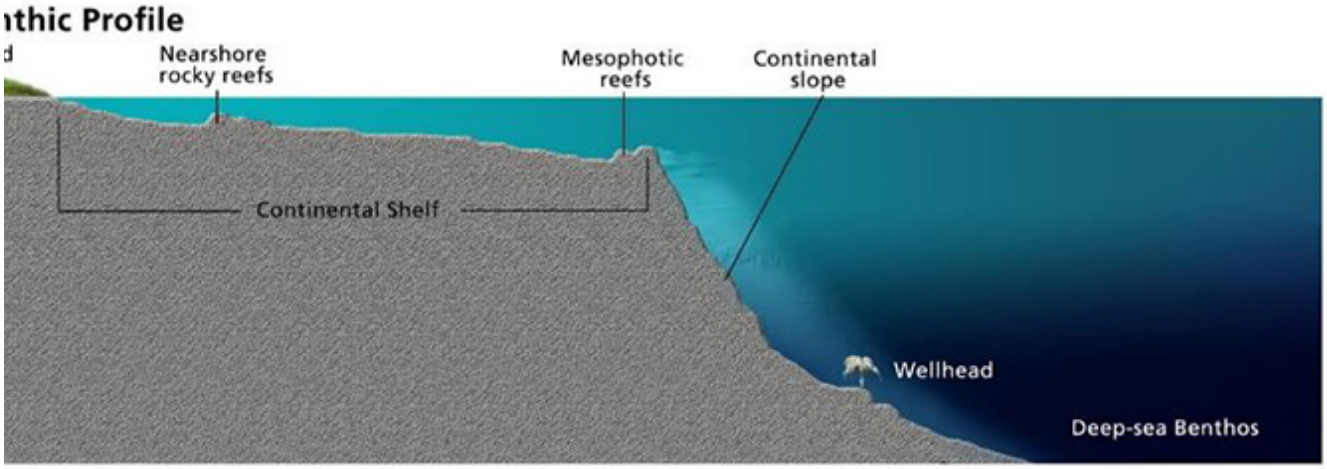
Impact on Deep Coral Communities

- Oil, gas, and dispersant spilled out from the site of the leak about 5,000 feet below the sea surface. A mixture of oil, dispersant, microbes, and mucus clumped together and rained down on the seafloor.
- More than 770 square miles of deep-sea habitat and 4 square miles of mesophotic habitat were injured by the *Deepwater Horizon* oil spill. Restoring mesophotic and deep-sea habitats is a challenging task due to the limited knowledge of these ecosystems and the fact that restoration at these depths has rarely been done so far.
- Coral colonies presented signs of stress - tissue loss, sclerite enlargement, excess mucous production, bleached commensal ophiuroids, and being covered in brown flocculent material (floc).

VIDEO - Deepwater Corals: Where Did the Gulf Oil Go?



INDEPENDENT / GROUP PRACTICE:



A profile of the Gulf of Mexico seafloor habitats extending from the shore to depths around the Macondo wellhead. The mesophotic coral reefs in this study were located at the edge of the continental shelf. (NOAA/Kate Sweeney)

OIL SPILL SIMULATION ACTIVITY:

- Create oil well:
  - Fill condiment cup with oil (weigh down if possible), place lid on top
- Create ocean scene:
  - Carefully fill clear glass pan half full with cold water, add blue food coloring
- Add biodiversity:
  - Place coral sculptures (make from pipecleaners) and marine toys in the bottom of the pan, weigh down if possible
- Simulate an oil spill:
  - Carefully take Cajun Injector and puncture hole through the plastic lid of condiment cup extract oil into syringe
  - Remove the Cajun Injector entirely
- Observe the oil spill:
  - Where does it go? Does it sink, float, attach to marine life?
- Add in marine snow:
  - Sprinkle in cup of dirt
  - Observe how it attaches to the oil. Where does it go? Does it stick to the coral?
- Attempt to clean the oil spill! Which is most effective? Which tool best helps you clean the oil off of the coral?
  - Q-tips
  - Cotton balls
  - Paper towels
  - Sponges
  - Spoon

ASSESSMENT OF LEARNING:

- What are some of the key differences between stony and soft corals?
- Describe the properties of oil and how it behaved when it was added to the water
- Describe the difficulty level of removing the oil from the water completely
- Discuss the different ways that scientists clean up oil spills
- Discuss the ripple effect impact that oil spills have on the marine environment

CLOSING:

As you teach lessons linked to our Galveston Bay watershed and the Gulf of Mexico you can use the "I Wonder" board as a closure assignment. You might ask what else the students want to learn about corals. Students may ask about photosynthesis, or depth of water or who eats them or how boats anchor in areas with coral. All their questions (even the ones asked multiple times) would go on the I Wonder board. If a question was answered in the lesson, it still goes on the board.

Students may even have questions days later that could be added. The goal is to have a place for all questions about Galveston Bay and Gulf of Mexico to be housed.

EXTENSION:

Students may have more questions about the mesophotic and deep benthic communities or drilling in general. There are many resources put out by NOAA that can assist their discovery. https://www.fisheries.noaa.gov/southeast/habitat-conservation/mesophotic-and-deep-benthic-communities-restoration

NOTES:

Island STYLE

Trash's Travels

SUBJECT:

ELA

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Pencils
- Colored pencils
- Printer paper

IVITY SUMMARY:

Students will create a concrete point of view story describing the travels of a piece of marine debris in the Galveston Bay Watershed and the Gulf of Mexico

RNING OBJECTIVES:

- Students will learn about what marine debris is and where it comes from
- Students will recognize the magnitude of trash currently in our ocean
- Students will learn about the structure of concrete poems and will create their own

GNMENT:

ng TEKS

6.5 (E) - Make connections to personal experiences, ideas in other text, and society
6.5 (I) - Monitor comprehension and make adjustments such as rereading, using background knowledge, asking questions, and annotating when understanding breaks down
6.5 (H) - Synthesize information to create new understanding
6.14 (E) - Revise final draft in response to feedback from peers and teacher and publish written work for appropriate audiences
6.15 (A) - Write imaginative stories that include: a clearly defined focus, plot, and point of view, a specific, believable setting through the use of sensory details, dialogue that develops the story
6.15 (B) - Write poems using: (i) - poetic techniques, figurative language, graphic elements

n Literacy Principles:

BACKGROUND INFORMATION:

Concrete Poems and Stories

A concrete poem is an arrangement of words on a page into shapes or patterns that reveal an image. Concrete poems are an artistic blend of the literary and the visual arts. Readers experience a concrete poem via its words, typography, and the visual representation of the subject of the poem. In this type of visual poetry, what the words mean and how they look are often equally important. Within the graphic space of their work, concrete poets also rely on color and typeface to further characterize the poem and image at hand.

According to the NOAA Marine Debris division the Gulf of Mexico has a productive, diverse, and beautiful coastline. However, marine debris is a threat to our ocean and waterways, that can affect navigation safety, the economy, and even human health. The NOAA Marine Debris Program is the federal government's lead for addressing marine debris, with a mission to investigate and prevent its adverse impacts.

Where does marine debris come from?
All marine debris comes from people. Most trash reaches the seas via rivers, and 80% originates from land through littering, poor waste management practices, storm water discharge, and extreme natural events such as tsunamis and hurricanes. Debris can also come from ocean-based sources, such as fishing vessels, stationary platforms used for offshore oil and gas, cargo ships, and other large vessels.

Marine debris in the Gulf of Mexico ranges from large concentrations of litter (i.e. cigarette butts and plastic bottles) that find their way through the storm drains to the beaches to large 190-foot derelict vessels that disturb marshes and seagrass habitats. The NOAA Marine Debris Program aims to prevent and reduce marine debris in the Gulf of Mexico through education, research, removal, and response to large debris events.

What are common types of marine debris?

- **Plastics such as single-use water bottles, grocery bags, food wrappers, and cigarette butts**
- **Microplastics (pieces <5mm) that are manufactured or come from the breakdown of larger pieces of plastic**
- **Derelict Fishing Gear**
- **Abandoned and Derelict Vessels**

The term 'garbage patch' is a misleading nickname for areas of the open ocean where man-made litter and debris accumulate. Although many believe that garbage patches are "islands of trash" that are visible from afar, these areas are actually made up of small plastic pieces, called microplastics, that are easily missed at first glance, or bundles of derelict fishing gear. This debris is always moving due to winds and currents, causing the garbage patches to constantly change size and shape. The items making up the garbage patches can be found from the surface all the way to the ocean floor.

Garbage patches are created from rotating ocean currents called gyres. These currents pull debris into a centralized location, forming 'patches' where marine debris accumulates. Although these patches exist around the world, the most well- known is the 'Great Pacific Garbage Patch,' located between California and Hawaii in the North Pacific Subtropical High. This patch is as big as Texas and it is estimated that it will double in size in the next five years.

What are the impacts of garbage patches?

Large accumulations of marine debris can threaten wildlife through entanglement, ingestion, and ghost fishing, and can be a hazard to ocean vessels by clogging engines and propellers. According to seaturtles.org, sea turtles are affected by plastic during every stage of their life. They crawl through plastic on the way to the ocean as hatchlings, swim through it while migrating, confuse it for jellyfish (one of their favorite foods), and then crawl back through it as adults. Thousands of sea turtles, whales, and other marine mammals, and more than 1 million seabirds die each year from ocean pollution and ingestion or entanglement in marine debris. Researchers have also estimated that for every 2.2 pounds (1 kilogram) of plankton in this area, there is 13.2 pounds (6 kilograms) of plastic.

Why don't we just clean up the garbage patches?

Cleaning up marine debris found in the open ocean is not as simple as it may sound. Cleaning the open ocean would be challenging for several reasons:

- **Things keep moving.** The areas where debris accumulates move and change throughout the year as wind and water currents shift.
- **They're really big.** These accumulations of debris are usually very large and debris is unevenly distributed from the surface of the water all the way to the ocean floor.
- **Most of the debris is tiny.** The garbage patches are composed mainly of microplastics, bits of plastic that are five millimeters or less in size. Because of their small size, microplastics can't be easily removed from the water column.
- **It would cost a lot.** Collecting and transporting marine debris from the open ocean to shore for disposal could be very costly. Resources can go much farther when removal is focused along the coast.

VOCABULARY:

- **Marine Debris** - Also known as marine litter, any persistent solid material that is manufactured or processed, and directly or indirectly, intentionally or unintentionally disposed of or abandoned into the marine environment or Great Lakes
- **Concrete Poems** - Poems that are written in an arrangement that forms a picture

PREPARATION:

Provide students with paper, writing materials, and colored pencils for decoration.

INTRODUCTION:

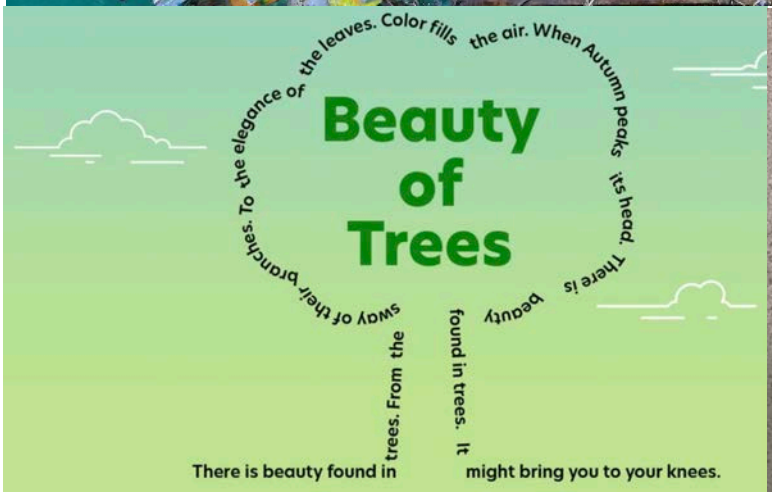
Have you ever found a message in a bottle? Have you ever thrown one out to sea? The idea is that the ocean currents will move that message along the coastline for someone else to find. Unfortunately, what you are actually doing is littering. Any trash that blows off the land near the Trinity River washes downstream and becomes marine debris in our Galveston Bay and eventually the Gulf of Mexico.

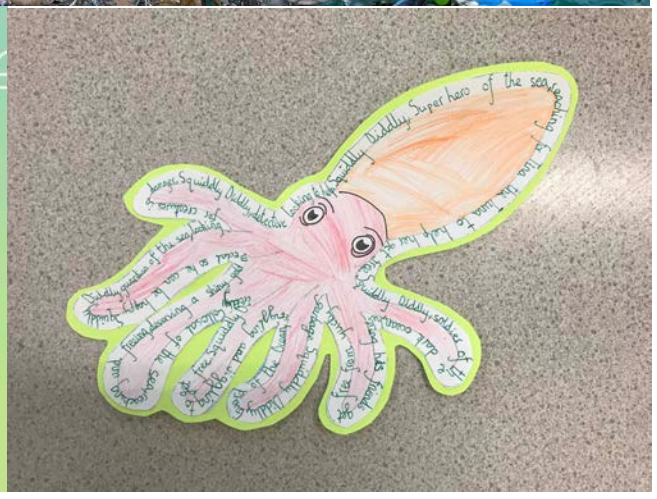
INDEPENDENT / GROUP PRACTICE:

You will be writing from the point of view of one of these pieces of marine debris. Where did it start its journey? Who bought it? What purpose did it serve? How did it get separated from its original purpose? Where did it go? Who did it encounter along the way? Did it stay in one piece, or did it break up? The conclusion of your story should be how the piece of marine debris was removed from the ocean. Be descriptive and use all the academic and lesson vocabulary you have learned throughout this semester about the Galveston Bay Watershed and the Gulf of Mexico.

Once you have your draft, trade with a peer to edit and revise your writing.

Now, draw the outline of the trash item you were writing about. You will write your completed point of view writing using this shape as your guide. This is often called concrete poetry because your words are arranged into shapes or patterns that reveal an image. Concrete poems are an artistic blend of the literary and the visual arts. In this type of visual writing, what the words mean and how they look are often equally important.





ASSESSMENT OF LEARNING:

Students will read their stories and display their artwork.

CLOSING:

As you teach lessons linked to our Galveston Bay Watershed and the Gulf of Mexico you can use the "I Wonder" board as a closure assignment. You might ask what else the students want to learn about marine debris. Students may ask about hurricane debris, or nurdles or if turtles really get straws stuck in their noses. All of their questions (even the ones asked multiple times) would go to the I Wonder board. If a question was answered in the lesson, it still goes on the board. Students may even have questions days later that could be added. The goal is to have a place for all questions about Galveston Bay and Gulf of Mexico to be housed.

EXTENSION:

3D Marine Debris Art Concrete Poem:

- Have students create an acrylic canvas painting of something marine themed (sea animal, marine bird, ocean view, etc)
- Have students write a Point of View poem to accompany the painting
- Have students collect trash (from the beach, from home, from the school yard, etc)
- Incorporate the trash items by hot gluing them to the acrylic painting
- Have students type and print out text to their poems, cut out the words/sentences, and glue them to the acrylic painting

NOTES:

https://marinedebris.noaa.gov/gulf-mexico

https://marinedebris.noaa.gov/resources/fact-sheets

https://youtu.be/7c9mSVPXYxU What is the Great Pacific Garbage Patch 2:12 by NOAA Marine Debris program

https://youtu.be/FfSFKEM5Psc What is Marine Debris 2:06 by NOAA Marine Debris Program


Photo: NOAA

Marine Debris

Marine debris is a global problem.

Marine debris is not only a pervasive threat to our ocean, Great Lakes, and waterways, but can affect navigation safety, the economy, and even human health. The NOAA Marine Debris Program (MDP) is the federal government's lead for addressing marine debris, with a mission to investigate and prevent its adverse impacts.

Where does marine debris come from?

All marine debris comes from people. It can enter the ocean and waterways from land through littering, poor waste management practices, storm water discharge, and extreme natural events such as tsunamis and hurricanes. Debris can also come from ocean-based sources, such as fishing vessels, stationary platforms used for offshore oil and gas, cargo ships, and other large vessels.

What is marine debris?

Any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or Great Lakes.


o: NOAA

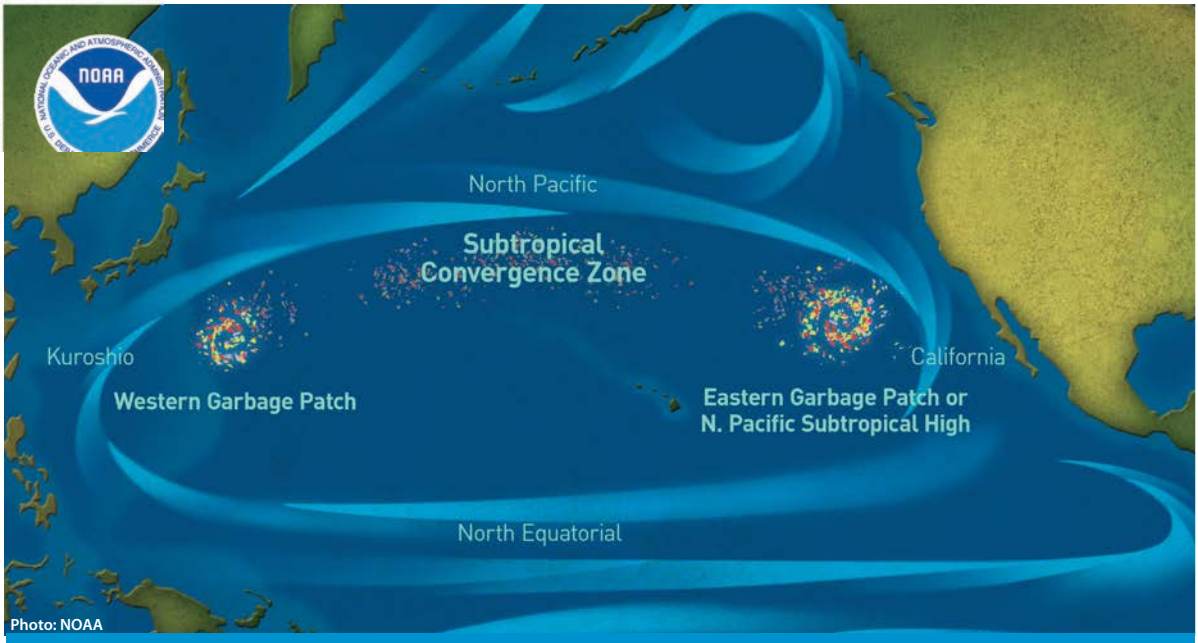


Photo: NOAA

What are Garbage Patches?

The term 'garbage patch' is a misleading nickname for areas of the open ocean where man-made litter and debris accumulate. Although many believe that garbage patches are "islands of trash" that are visible from afar, these areas are actually made up of small plastic pieces, called microplastics, that are easily missed at first glance, or bundles of derelict fishing gear. This debris is always moving due to winds and currents, causing the garbage patches to constantly change size and shape. The items making up the garbage patches can be found from the surface all the way to the ocean floor.

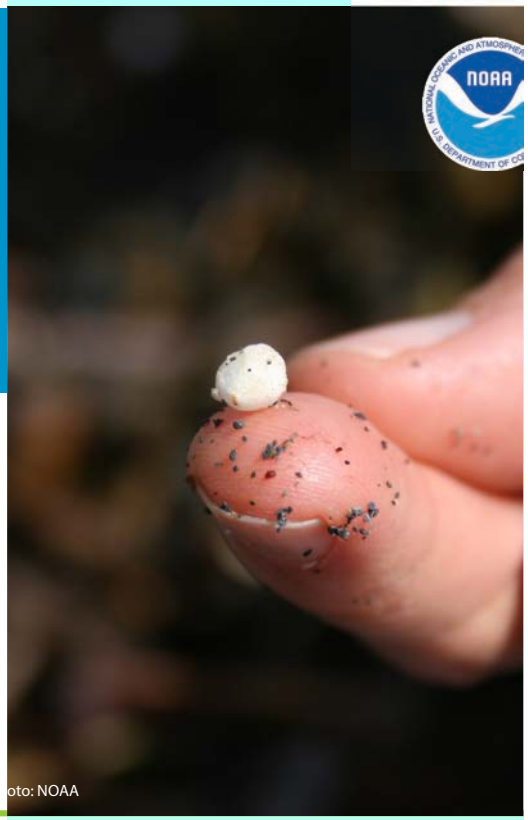
Garbage patches are created from rotating ocean currents called gyres. These currents pull debris into a centralized location, forming 'patches' where marine debris accumulates. Although these patches exist around the world, the most well-known is the 'Great Pacific Garbage Patch,' located between California and Hawaii in the North Pacific Subtropical High.

What are the impacts of garbage patches?

Large accumulations of marine debris can threaten wildlife through entanglement, ingestion, and ghost fishing, and can be a hazard to ocean vessels by clogging engines and propellers. More research is needed to fully understand the specific impacts of garbage patches on both humans and the environment.

BACKGROUND INFORMATION:

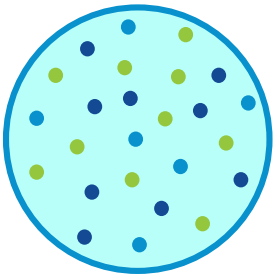
Microplastic Marine Debris



oto: NOAA

What are Microplastics?

Microplastics are small plastic pieces or fibers that are smaller than 5 mm in size. They come in many forms including beads, fragments, pellets, fibers, and more.



Primary microplastics are made to be small and can come in the form of resin pellets and beads. Products like resin pellets are melted and used to create larger plastic items, while microbeads may be found in personal care products, such as toothpaste, face washes, and cosmetics.

Secondary microplastics come from larger pieces of plastics, such as beverage bottles, bags, and toys. Sun, wind, and waves can cause these plastics to become brittle and fragment into smaller and smaller pieces in the environment, though they may never fully go away.

Plastic microfibers are synthetic fibers, such as polyester or nylon, which are used to make clothing, furnishings, and even fishing nets and lines. Through general wear or washing and drying, fibers may break apart from larger items, creating secondary microplastics.

Why are Microplastics a Proble

Our ocean and Great Lakes are polluted with a wide variety of marine debris, ranging from large fishing net and abandoned vessels, down to the smallest plastic particles that can't be seen with the naked eye. These microplastics are found throughout the ocean, from tropical waters, to polar ice, and even in fresh water an the air we breathe. Microplastics have also been found tap and bottled water, sea salt, and other products we or drink.

Because they are so small, wildlife can mistake microplastics for food. Zooplankton, fish, mussels, and even whales have been found to ingest microplastics. microplastics and chemicals in the plastics may impact the bodily functions of animals.

Microplastics can also carry harmful pollutants. They m absorb pollutants that are in the water around them, o leach chemicals that are added to plastics to make the colorful or flexible. Although wildlife may ingest or be exposed to these contaminants, more research is need to understand how they might be affected.

Photo: H al the Bay

Marine Debris and the Economy

Marine debris is an eyesore along shorelines around the world. It can be dangerous for wildlife, damage sensitive habitats, create safety and navigation haar ds, and impact the economy.

In the United States, the tourism and recreation sector is the largest employer in the ocean and Great Lakes economy. Marine debris littered on beaches degrades the beauty of the environment and may even prevent tourists from spending their time and money in coastal communities that rely on tourism. Local governments and volunteer organia tions also spend limited resources to clean up.

Lost and derelict fishing gear can impact commercial and recreational fisheries. Most modern gear is generally made of synthetic materials and metal, and can persist for a very long time in the environment. Once lost from the control of a fisher, derelict gear can degrade sensitive habitats, create haar ds to safety and navigation, continue to capture wildlife, and compete with active gear. This can lead to injur y or death for animals that become trapped or entangled in the derelict gear.

Plastics and other single-use items are a big part of our waste stream and a very visible part of the marine debris problem. In many communities, restaurants and food service businesses seek alternatives to single-use materials, but may need assistance in making the transition.

In order to reduce the economic impacts of marine debris, the NOAA Marine Debris Program (MDP) funds projects that benefit commercial and recreational fisheries, small businesses, and coasta communities by preventing marine debris from entering the marine environment in the first place and removing existing debris from shorelines and coastal areas.


Photo: NOAA

BACKGROUND INFORMATION:

Plastic Marine Debris

Plastic debris is the most abundant type of marine debris in our ocean, waterways, and Great Lakes. The word "plastic" is used to describe a collection of synthetic or manmade organic compounds (polymers), often derived from petroleum. Plastic polymers can be altered to come in many shapes, sizes, colors, and densities.

Plastic marine debris found in our ocean or waterways is often consumer items such as food wrappers, plastic beverage bottles, plastic bottle caps, plastic/foam carryout containers, drinking straws, and grocery bags. Plastic marine debris also includes items such as lost/discarded fishing gear or plastic sheeting. All of these plastic items can enter the marine environment in a variety of ways, including ineffective or improper waste management, intentional or accidental dumping or littering, or through stormwater runoff. Once in the environment, plastics will remain there indefinitely, which is why preventing these items from entering our waters in the first place is especially important.

Common Types of Plastic

Resin Code	Name	Product Examples
1	Polyethylene Terephthalate (PE TE,PE T)	Plastic bottles, food jars , ovenabl and microwavable food trays, textiles (polyester), monofilamer carpet, and films.
2	High-Density Polyethylene (HPE	Bottles (beverage, detergent, shampoo), bags, cereal box liner extruded pipe, and wire and cab covering.
3	Polyvinyl Chloride (PVC)	Packaging (clamshells, shrink wrap), pipes, siding, window frames, fencing, flooring, and medical products (blood bags, tubing).
4	Low Density Polyethylene (L DPE	Bags (produce, dry cleaning, newspaper, and garbage bags), squeeze bottles, container lids, shrink wrap, toys, coatings for mi cartons and beverage cups, and wire and cable coverings.
5	Polypropylene (PP)	Yogurt and other food container medicine bottles, straws, bottle caps, fibers, appliances, and carpeting.
6	Extruded and Expanded Polystyrene (PS)	CD cases, yogurt containers, cups, plates, bowls, cutlery, hing takeout containers (clamshells), electronic housings, building insulation, coat hangers, medica products, packing peanuts and other packaging foam, foamed coolers, and egg cartons.
7	Other is a resin different than the six listed above, or made from a combination of resins.	Three- and five-gallon reusable water bottles, glasses (lenses), some citrus juic e and ketchup bottles, oven-baking bags, and custom packaging.

Island STYLE

Development of a Driving Question

SUBJECT:

Interdisciplinary

GRADE LEVEL:

6th

TIMEFRAME:

2 x 45 minutes

MATERIALS:

- Sticky notes
- Note cards
- Bulletin board
- Voting stickers / box
- Writing utensils

'IVITY SUMMARY:

In this lesson, we will help lead the students from their individual wonderings to develop a Driving Question for their continued explorations.

'RNING OBJECTIVES:

- Students will practice the art of questioning from personal interest
- Students will learn how to focus their questions and condense them into one main "driving" question

How does the Gulf of Mexico, the Galveston Bay, and Galveston Island add value to the quality of life for people?"

ALIGNMENT:

TEKS

MATH

- 6.1 (B) – Use a problem solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution and evaluating the problem solving process and the reasonableness of the solution.

SOCIAL STUDIES

- 6.19 (B) analyze information by sequencing, categorizing, identifying cause-and-effect relationships, comparing, contrasting, finding the main idea, summarizing, making generalizations and predictions, and drawing inferences and conclusions;
- 6.19 (C) organize and interpret information from outlines, reports, databases, and visuals, including graphs, charts, timelines, and maps; and
- 6.19 (D) identify different points of view about an issue or current topic.
- 6.21 (B) incorporate main and supporting ideas in verbal and written communication based on research;
- 6.21 (C) express ideas orally based on research and experiences;
- 6.22 Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others. The student is expected to use problem-solving and decision- making processes to identify a problem, gather information, list and consider options, consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of the solution.

SCIENCE

- 6.1 (A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;
- 6.1 (B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;
- 6.1 (C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;
- 6.2 (A) identify advantages and limitations of models such as their size, scale, properties, and materials;
- 6.2 (B) analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations;
- 6.2 (D) evaluate experimental and engineering designs.

READING

- 6.10 (D) – synthesize and make logical connections between ideas within a text and across two or three texts representing similar or different genres.

WRITING

- 6.14 (A) – plan a first draft by selecting a genre appropriate for conveying the intended meaning to an audience, determining appropriate topics through a range of strategies, and developing a thesis or controlling idea.
- 6.14 (E) – revise a final draft in response to feedback from peers and teacher and publish written work for appropriate audiences.

VOCABULARY:

- **Project-Based Learning (PBL)** - The process of learning through the design, development, and completion of projects.
- **Driving Question** - A problem to be solved; A question that is open-ended, provocative, discipline-centered, challenging, and consistent with curricular standards and frameworks. Provides students with freedom to explore their ideas, invites collaboration, and it provides a “North Star” to guide students work, and it inspires students to take action. These questions invite students to explore a wide variety of solutions while placing parameters on the content or product.

BACKGROUND INFORMATION:

DEVELOPING A DRIVING QUESTION

Is your question...

Complex: Good questions can't be answered with a simple "yes" ("no," and a Google search won't turn up the solution. Complex questions set the stage for higher-order thinking.

Related to the Real World: Good questions live in the real wor not just in the classroom. For inspiration, look at the questions tha captivate journalists, historians, scientists, architects, photographe engineers, artists, doctors, technologists and others.

Open Ended: Good questions don't have one right answer. Open ended questions may challenge students to make an argument, def a position, or weigh the pros and cons of potential solutions.

Actionable: Good questions set the stage for action. They challen students to ask, "What can we do about this issue?" **Relevant:** Go questions matter to youth. They connect to their lives, their familie and their communities.

Challenging: Good questions encourage higher-order thinking sl such as making connections and inferences, evaluating, applying existing information to solve new problems, and much more.

Substantial: Good questions get at core content. They are though provoking, and inspire students to reflect on important ideas and information.

Provocative: Good questions get under your skin and provoke yo investigate, discover, figure out a response or learn more about a t

Intriguing: Good questions often involve an element of mystery. Intriguing questions cause students to wonder, to have a compelli "need to know."

LITIES OF A QUALITY DRIVING QUESTION:

PARATION:

ting the "I Wonder" Board

Throughout the year the students will be exposed to different aspects of the Galveston Bay and the Gulf of Mexico. They will have questions not covered in that particular lesson or extensio from what you covered that day or even questions about what yo did cover in that lesson. We want to teach students that it is gre to have questions and that their questions matter enough to be followed up on.

As you teach lessons linked to our Galveston Bay watershed and the Gulf of Mexico you can use your I Wonder board as a closur assignment. It could be a bulletin board that students could pin their questions to, or a parking lot that kids could write questio on or attach sticky notes to. This area will be getting questions a semester so your chosen method needs to be permanent enough and large enough that no question is lost.

ıre of Each Lesson

As you teach lessons linked to our Galveston Bay watershed and the Gulf of Mexico you can use the "I Wonder" board as a closur assignment.

For example, in science after teaching about shallow water coral you might ask what else the students want to learn about corals. Students may ask about photosynthesis, or depth of water or wh eats them or how boats anchor in areas with coral. All of their questions (even the ones asked multiple times) would go to the I Wonder board. If a question was answered in the lesson, it still goes on the board.

Students may even have questions days later that could be adde The goal is to have a place for all questions about Galveston Bay

INTRODUCTION:

How to choose your class's Driving Question for second semester

Now that you have taught all the content for the program, it is time for the class to choose a "Driving Question" that they would like to build upon about this semester.

The Sorting

- You have a semester's worth of questions on the "I Wonder" board. Take this down and type up all the questions they have asked. We want every student to feel like their question was important and readable for all the other students. If a question is asked more than once, type it up more than once.
- Cut up the questions and offer them to the students to group. Perhaps there are several questions about sharks, those would all go together. Perhaps there are questions about shrimp nets, shrimp fishing and shrimp processing, those could all go together. It is important that the class has the opportunity to create the groupings.
- If you work with small groups and part of the questions first, then put two groups together to combine their piles and keep combining until you have a class consensus on the groupings.

The Cull

- Sometimes questions make it on the list that really aren't about the topic. "Are there whales in space?"
- Empower your student groups to pull those questions out and ask the class as a whole if they should be removed from the groupings.
- Sometimes you will have a question that needs clarification to be included. "Can eat coral?" Who are they asking about? What do they really want to know?
- Sometimes the question is so complex that it needs to be broken down into parts. "If corals grow in shallow water and in deep water, can they both photosynthesize and eat the same things and reproduce the same way and do the same things eat them?" Maybe this all fits in one category and maybe it needs to be split into several categories.
- Once again, empower your students to make the decisions about including, editing or removing those questions.

GUIDED PRACTICE:

The Rewrite

- Now that you have some groupings of questions, could the grouping be rewritten as one more complex question? Assign a group of questions to each student group to read through. Have them write a new more expansive question including all the parts of the old questions.
- Assist your groups to include who they are, what they want to study, and for what purpose.

INDEPENDENT / GROUP PRACTICE:

Voting with Stickers

- Now, you have five to ten questions that were created by your students which you obviously don't have the time to research all of. But who should choose? The kids of course. This is their curiosity, their wonders.
- Hang the questions around the room and give each student a chance to go read each question and ask any questions they may have about.
- Give each student two stickers to vote for their top two choices. Knowing your students and any issues you may have with following the leader or voting their own minds, have the students vote by placing their two stickers on the question of their choice.
- I might use a "one, two, three, run!" method or a "cake walk" method where you bring your arm up to every question but only place your sticker on the question of your choice. This can be cover for voting. You may even create a voting booth and have them submit their number choices into a box for complete anonymity.

ASSESSMENT OF LEARNING:

Walk around and listen to the conversations that the students are having as they work to rewrite their questions.

CLOSING:

Collect the votes, tally them, and announce the winning question to the class.

NOTES:

https://www.noaa.gov/sites/default/files/2022-09/MWEE-Guide.pdf a pdf guide to the MWEE model

You for Youth - PBL Questions

Island STYLE

Oh, the Places We Will Go!

SUBJECT:
Interdisciplinary
GRADE LEVEL:
6th
TIMEFRAME:
45 minutes
MATERIALS:
- Whiteboard
- Dry erase markers

IVITY SUMMARY:

In this lesson, we will take the *Driving Question* that the students created and decide what kind of *Student-Selected Adventure* the class should go on in order to gain further insight into their questions.

RNING OBJECTIVES:

- Open students' eyes to the many hidden wonders of Galveston Island
- Connect students firsthand to leading experts and professional scientists in the field
- Allow for students to gain insight and collect data in order to answer their Driving Question

ABULARY:

- **Adventure** - An unusual and exciting experience or activity
- **Adventure Learning** - The promotion of learning through adventure centered experiences
- **Experiential Education** - A teaching philosophy based on challenge and experience followed by reflection leading to growth
- **Field Trip** - A trip made by students or research workers to study something at first hand
- **Place-Based Learning** - Engages students in their community, including their physical environment, local culture, or people
- **Student-Selected Adventure** - An intrinsically engaging, student chosen, elevated field trip experience that is rooted in the child's natural curiosity and interests; the adventure experience directly connects the student to an expert/professional in the field that can help address the student's *Driving Question*
- **Outdoor Education** - Experiential learning in, for, or about the outdoors

BACKGROUND INFORMATION:

Meet the Experts!

Now that your class has established a *Driving Question,* the next step is to determine *Student-Selected Adventure* location to visit and connect with an *Expert* in order to discover more about their chosen topic.

What is the class's Driving Question?
Which organizations or specific people are already doing the work related to this Driving Question?

For this Island STYLE Project, a team of *Exceptional Experts* was created in order to help connect your students to many different potential experts and places. If your students choose a Driving Question that is better addressed by an *Additional Expert* or someone else that isn't listed below, that is okay too!

Exceptional Experts:

- NOAA Marine Debris Program
- NOAA Southeast Fisheries Science Center
- NOAA Mesophotic & Deep Benthic Communities
- NOAA Flower Garden Banks National Marine Sanctuary
- NOAA Office of Habitat Conservation
- Texas Marine Mammal Stranding Network
- Moody Gardens
- Artist Boat's Coastal Heritage Preserve

Additional Experts:

- Galveston Island Nature Tourism
- City of Galveston Waste Water Treatment Plant
- Galveston Island Park Board
- Galveston County Emergency Management
- Coast Guard
- Texas Parks and Wildlife Department
- City of Galveston Recycling Center
- And more…!

BACKGROUND INFORMATION:

MWEE Meaningful Watershed Educational Experience

Field Experiences - Student Actions
Locally Relevant Connections
Classroom Work
Teacher Training



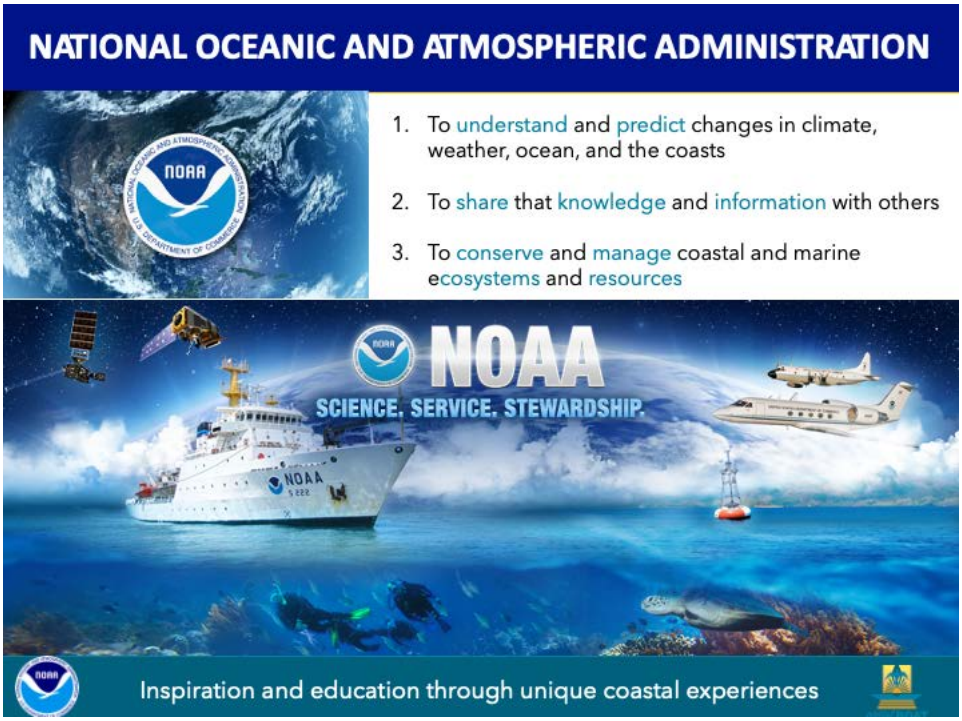
This project is to encourage the students to create their own learning experience and in such we want them to be involved as much as possible. We all know we can't just ask 25 students where they want to go. You would get 25 answers. However, we can help them narrow down some ideas by asking leading questions.

Remember - the goal of the Student-Selected Adventure is for them to gain insight into their Driving Question, as well as generate inspiration and excitement so that the students are motivated for the next step: their Environmental Action Projects!

Revisit the *Driving Question* and ask the students where they might need to go in order to learn more about this topic. It can be a "popcorn activity," give each child a marker to write on the board, or even have them write you a sentence or two and collect the answers. Narrow dow their ideas and compare it to the list above. Is there a perfect student adventure on the list already? Is there something close that we could potentially modify? Do we need to work together to find a different partner?

Advise your students about their options and allow them to vote.
Once your class has made a decision, contact Artist Boat and we will assist you with the rest!

EXCEPTIONAL EXPERTS



EXCEPTIONAL EXPERTS

NOAA SOUTHEAST FISHERIES SCIENCE CENTER

ure 1. SEFSC's laboratory locations and jurisdictions that cover areas of responsibility for three Fishery Management ocks and Atlantic Highly Migratory Species. Inshore and coastal habitats are under the jurisdiction of eight southeastern ies, Puerto Rico, and the U.S. Virgin Islands.

Provides the scientific advice and data needed to effectively manage the living marine resources of the Southeast region and Atlantic high seas.

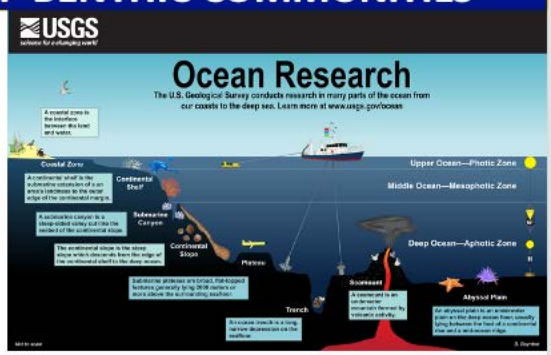
Fisheries management councils, fisheries commissions, and federal, state and local agencies depend on our science to make decisions that protect and conserve the region's living marine resources.

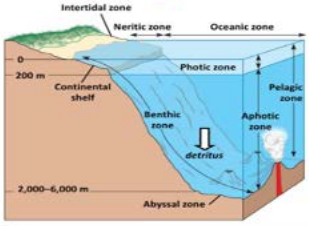
Inspiration and education through unique coastal experiences

artistBOAT

NOAA GULF OF MEXICO MESOPHOTIC & DEEP BENTHIC COMMUNITIES

The term *mesophotic* comes from the Greek words for "middle" and "light," and refers to the fact that this zone doesn't have as much light as waters near the surface of the ocean, but it's also not completely dark. This is evidenced by the presence of some light-dependent organisms such as stony (reef-building) corals and algae.





Vital seafloor habitats were damaged by the 2010 Deepwater Horizon oil spill. NOAA and partners are building a network of experts and resources to restore this underexplored area in the Gulf of Mexico.

Inspiration and education through unique coastal experiences

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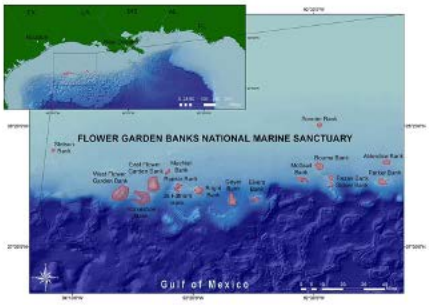
EXCEPTIONAL EXPERTS

NOAA FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY



Flower Garden Banks National Marine Sanctuary is one of 15 national marine sanctuaries and two marine national monuments protected by NOAA's Office of National Marine Sanctuaries.

It is the only sanctuary site located in the Gulf of Mexico and the sanctuary protects portions of 17 separate reefs and banks in the northwestern Gulf of Mexico.

Research Vessel – R/V MANTA

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NOAA OFFICE OF HABITAT CONSERVATION

Protecting and restoring habitat to **sustain fisheries**, recover **protected species**, and maintain **resilient coastal communities** and **ecosystems**

1. Conserve habitat for managed fisheries and protected resources
2. Restore fisheries and protected resources impacted by oil and chemical spills
3. Increase the resilience of coastal ecosystems, communities, and economies through habitat conservation

NOAA — National Oceanic and Atmospheric Administration — U.S. Department of Commerce

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EXCEPTIONAL EXPERTS

MOODY GARDENS

Public non-profit educational destination utilizing nature in the advancement of Rehabilitation, Conservation, Recreation, and Research

Aquarium Pyramid
Rainforest Pyramid
Animal Encounters
Coral Reefs Lab

MOODY GARDENS
GALVESTON ISLAND

Inspiration and education through unique coastal experiences

TEXAS MARINE MAMMAL STRANDING NETWORK

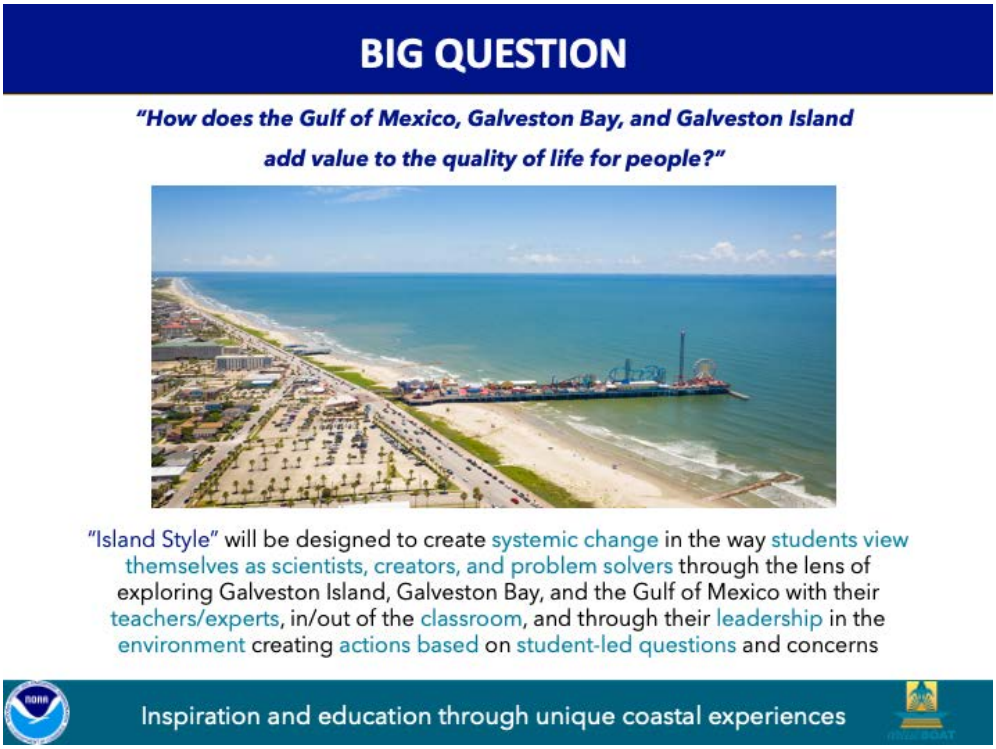
Dedicated to the Conservation of Marine Mammals through Rescue and Rehabilitation, Research and Education

TMMSN is a non-profit 501(c)(3) organization created in 1980 to further the understanding and conservation of marine mammals through rescue and rehabilitation, research and education

The TMMSN consists of six regions along the Texas coast, which provide a coordinated response to all marine mammal strandings along the Texas coastline

Inspiration and education through unique coastal experiences

INDEPENDENT / GROUP PRACTICE:



Before Adventure Day:

Continue to "wonder" about your Driving Question so your students are keeping it in the forefronts of their brains. Perhaps recreate your "I Wonder" Board with the Driving Question as a central topic and prompt the students to develop supporting questions that they would like to ask the "Expert" that they will meet on their Student-Selected Adventure.

Day of Adventure:

Prepare for your Student-Selected Adventure with all the necessary forms, buses, subs, and lunch requests based on your school's needs. Ready the students for their adventure by reminding them of the Driving Question and the questions they still want to know more about. Ready students for the space they are headed into by explaining behavior expectations that are appropriate to where they will be going. Many places might require inside voices, respectful listening, raised hands, quiet walking feet, hands to themselves, and no electronics whatsoever.

After the Adventure:

Debrief the Student-Selected Adventure experience with your class. This could be done in the afternoon directly after their adventure or sometime during the following day. What did the students learn? What did they see, hear, smell? Could they tell someone else about their Driving Question based on what they experienced? Did they answer their Driving Question? What could they do to learn more? What could they do to change behaviors or make a difference in their communities?

ASSESSMENT OF LEARNING:

Encourage the students to select an Adventure Site that will allow for them to experience something new for the first time. For instance, many students in Galveston will probably have already been to Moody Gardens with family or on another field trip, but very few students will have had the opportunity to have an exclusive, private tour of the jellyfish propagation laboratory with a trained Aquarist. Many students might feel compelled to clean up the litter found on the Galveston beaches, but very few students have ever had the opportunity to see for themselves seen the sheer magnitude of the landfill and the extensive, complete journey our trash undergoes once it is "thrown away." Open their eyes to seeing Galveston in a new light - perhaps, when they are older, they might find themselves in the career field of their selected Adventure Site!

CLOSING:

Allow time for a debrief activity at the end of the Student-Selected Adventure or during the next time that you see this class. It is important to debrief while the experience is still fresh in their minds.

The debrief can take place as a group discussion or as an individual reflection activity.

Some questions to ask could include:

- What was our Driving Question?
- What answers did we discover?
- What additional questions did we think of?
- How did we investigate our Driving Question?
- Where did we go?
- Who did we meet?
- Why did we did we choose to explore outside of the classroom to answer our Driving Question?

NOTES:

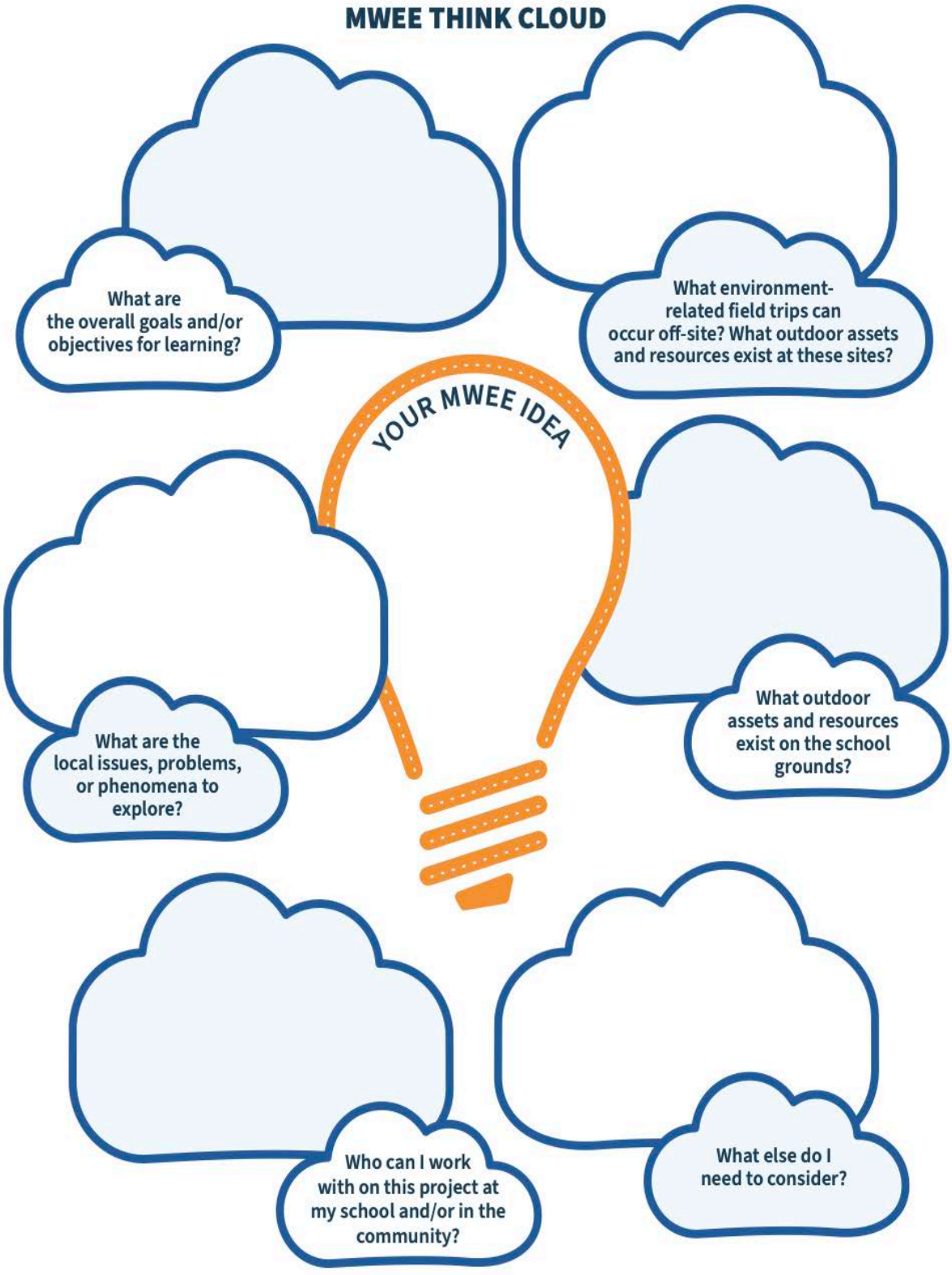
ASKING QUESTIONS AND PLANNING INVESTIGATIONS

Name: _____ **Class:** _____

Driving question:

What do we want to know?	How can we investigate it?	Where can we investigate it?

MWEE THINK CLOUD



Island STYLE

Environmental Action Projects

SUBJECT:

Interdisciplinary

GRADE LEVEL:

6th

TIMEFRAME:

45 minutes

MATERIALS:

- Paper
- Pencils
- Access to technology
- Poster Supp

The students will design, create, and implement their own Environmental Action Projects that will provide a solution to their Driving Questions by using the information, tools, resources, and data gained through the Student-Selected Adventure.

RNING OBJECTIVES:

- Students will bring their projects from the ideas stage to the implementation stage
- Students will practice project management skills
- Students will increase their knowledge of existing environmental issues and will work towards developing/implementing solutions to these issues
- Students will connect with Exceptional Experts and stakeholders, utilize real data, and create a project that intrinsically create lasting positive changes in the environment

n Literacy Principles

1 Earth has one big ocean with many features.
2 The ocean and life in the ocean shape the features of Earth.
3 The ocean is a major influence on weather and climate.
4 The ocean makes Earth habitable.
5 The ocean supports a great diversity of life and ecosystems.
6 The ocean and humans are inextricably interconnected.
7 The ocean is largely unexplored.

VOCABULARY:

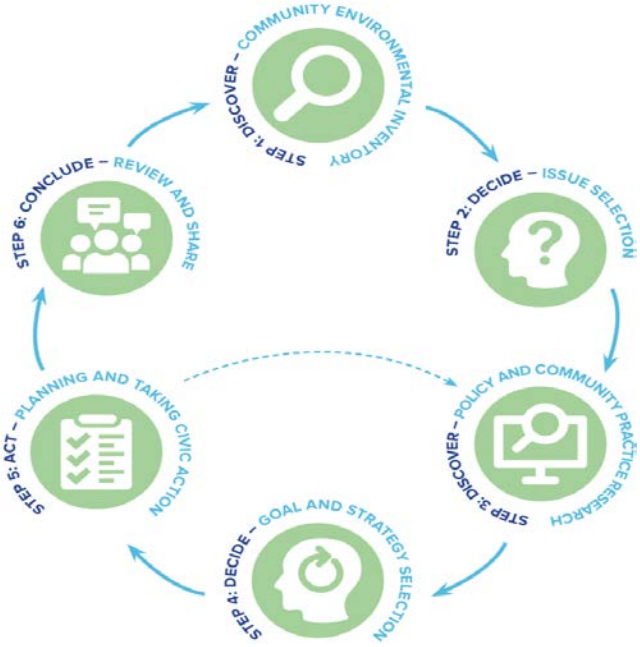
- **Environmental Action Civics** - An educational approach where youth work in partnership with adults to identify a local environmental issue and engage with community members to take action by advocating for systemic changes to policies/practices
- **Environmental Action Project** - Is a project that addresses the root cause or problem of a community issue, and has a long-term impact; example - implementing a permanent recycling process on a school campus
- **Service Project** - A project that addresses an immediate, short-term need in the community; example - volunteering time to clean up litter from the beach

BACKGROUND INFORMATION:

The culmination of the Island STYLE curriculum is for students to implement an environmental action project that will provide a solution to their driving question using information gained during the student adventure. This will look different for each class based on their driving question and their choice of student adventure. A **service project** is a project that address an immediate, short-term need in the community and can include volunteering time to clean litter off the beach. An **environmental action project** is a project that addresses the root cause or problem of a community issue, and has a long-term impact.

Environmental Action Projects can take many forms and may fall into the following types:

- **Restoration or Protection**: actions that assist in the recovery or preservation of a watershed or related ecosystem that has been degraded, damaged, or destroyed. Examples include: plant or restore protective vegetation/trees; restore a local habitat; remove invasive plants; develop a school garden, natural history area, community garden, or other sustainable green space; install rain gardens to help manage stormwater.
- **Everyday Choices:** actions that reduce human impacts on watersheds and related ecosystems and offer ways to live more sustainably. Examples include: refuse/reduce/reuse/recycle; monitor and save water in the face of potential drought or reduction in water availability; compost food or yard waste; research and implement energy efficient strategies or energy alternatives at school and/or at home.
- **Community Engagement:** actions that inform others about how to address community-level environmental issues. Examples include: give presentations to local organizations; organize community events; record or broadcast public service announcements; share information on social media; post flyers in community; share posters at community events/fairs/festivals; mentoring.
- **Civic Engagement:** actions that identify and address issues of public concern. Students acting alone or together to protect societal values or make a change or difference in a student's school, neighborhood, or community. Examples include: present to school principal or school board; attend, speak, or present at town meetings; write to local or state decision makers or elected officials.



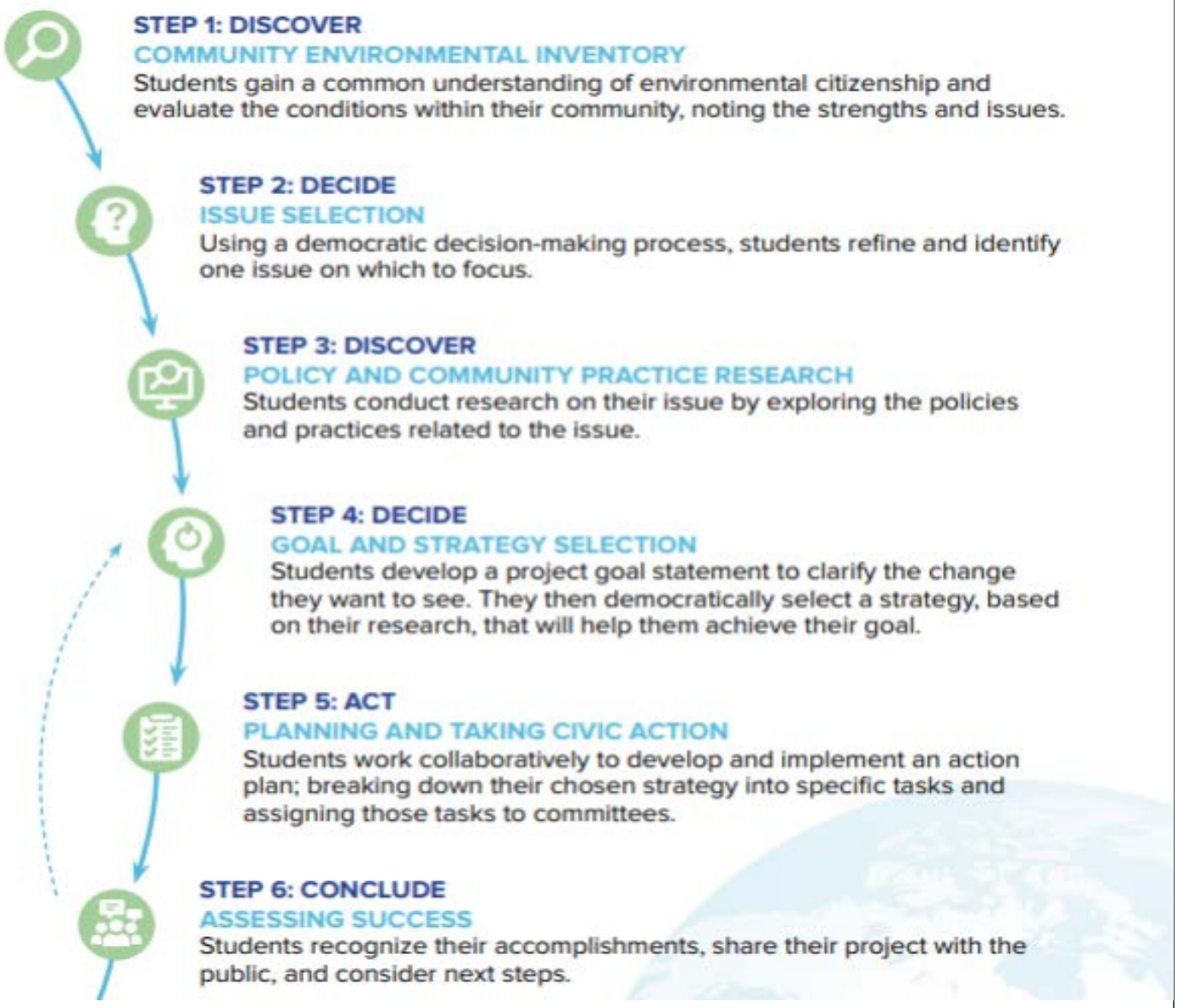
PREPARATION:

Print attached worksheets and be prepared to help prompt Environmental Action Project ideas and/or steer the students in the right direction.

INTRODUCTION:

EARTHFORCE

- A local nonprofit organization whose mission is to "engage young people as active citizens who improve the environment and their communities now and in the future."
- Environmental Action Civics is an approach to teaching that helps young people learn by connecting their lessons to their own experiences and communities, and by practicing the skills and dispositions of citizenship."



GUIDED PRACTICE:

You can support students in brainstorming action ideas and then choosing a single project to carry out as a class or small group in many different ways. These instructions describe one way of how you might transition from the "Moving from Claims" to "Informed Action" worksheet with the "Choosing an Action Project" worksheet. Adapt and create alternatives that meet your class's needs.

1. Using the "Moving from Claims to Informed Action" worksheet provides space for students to brainstorm possible solutions to their environmental issue. The prompts on the left-most column can be helpful in flushing out concepts. This can be done individually or in pairs, and ideally students come up with at least three distinct ideas. Encourage innovative and divergent thinking.

2. Organize students into five small groups to discuss and debate their ideas. The focus is now on convergent thinking. Task them with developing a single idea they would want to carry out in order to take action on the issue. By the end, they should have a succinct one-sentence description of their action project idea.

3. Using the Choosing an Action Project worksheet, each of the five groups will briefly pitch their idea to the whole class. Each idea is written into one of the boxes of the grid.

4. Introduce the concept of criteria, or a set of "standards" on which decisions are based, in order to make a decision about which project to move forward with. The class will use these standards to narrow down the options and arrive at a final selection. It can help for there to be teacher-created criteria as well as student-created criteria. Examples of teacher-created criteria may include restrictions around timing (e.g., the project must be completed in two class periods) or funding (e.g., the project must cost less than $50). Encourage students to think about what they value most when they create criteria. Examples of student-created criteria may be around impact (e.g., will this make substantial change in our community) or interest (e.g., will this project be fun to work on). Add the criteria into the boxes in the left-most column of the grid.

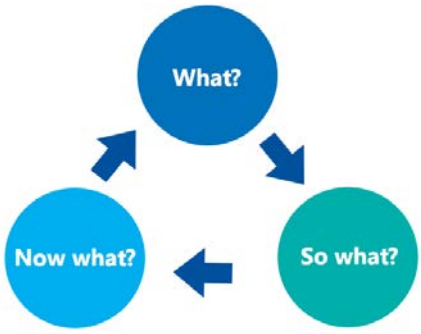
5. Finally, engage the class in voting on the action project ideas listed at the top against the criteria that were written along the side. This can be done as a large class discussion or students can vote individually by placing dot stickers or check marks in the appropriate boxes. Tally the results. One strategy may stand out as the clear winner. If one does not emerge naturally, students may need to establish additional criteria or use a different kind of voting technique to come to consensus. Or perhaps, students can brainstorm a way to merge the ideas and execute aspects of both.

ASSESSMENT OF LEARNING:

Austin Campus Environmental Action Conference

At the end of the school year, the students will present their Environmental Action Projects at Environmental Action Conference. Their presentation might look like a tri fold poster that teaches us about their Driving Questions, their Student-Selected Adventures, and the outcomes of their Environmental Action Project through text, pictures, and artifacts. It could even include a multimedia presentation. Stakeholders in GISD, our partner programs, and the Exceptional Experts utilized in each project will be invited.

CLOSING:



After the students have designed, created, and implemented their Environmental Action Projects AND have presented at the Environmental Action Conference, allow for some final reflection time for your students to think back on their entire Island STYLE experience throughout this past school year.

Use the "What? So What? Now What" debrief method. Suggested questions below.

- What are some things that we learned over the first semester?
  - (Content from the various interdisciplinary classroom lessons)
- What did you find interesting from those lessons?
- How did those interests lead to your Driving Question?
- So, what did we do with the Driving Question? How did we answer it?
- What Student-Selected Adventure did we go on? What did we learn?
- So, what did we do with that information? What Environmental Action Project did we create?
- What issue did it address?
- What were the results from that?
- So, now what should we do?
- How do we sustain the solution to this issue?

NOTES:

To print these worksheets or work with an online fillable version please go to:

https://www.noaa.gov/sites/default/files/2022-10/8_NOAA_BWET_MWEE_Environmental_Action_Planning.pdf

For ideas on what other schools have done for their environmental action projects, go to https://www.baybackpack.com/

To learn more about Earth Force please go to: https://earthforceresources.org

ENVIRONMENTAL ACTION PLANNING WORKSHEET

ASKING FOR HELP: *LISTING CONTACTS*

Name: _____ **Class:** _____

Who can help you make your action project a success? You may need to ask for permission to do something, find an expert to help with a specific task, or recruit volunteers from your community or school to help make your project a reality.

Use this first page to list all the people or groups you should contact about your action project. Then use the second page to draft your requests for help. You'll complete the second page for each person or group, so make sure to make enough blank copies before filling in the questions.

	Person/Group	Why do you need their help? (Are you asking for permission? To borrow equipment? For their time and expertise?) Be as specific as possible.
1		
2		
3		
4		
5		

MOVING FROM CLAIMS TO INFORMED ACTION

Name: _____ **Class:** _____

Claim

Question	Solution #1	Solution #2	Solution #3
What action could be taken to address the environmental issue?			
How would this action help to address the issue?			
What resources would you need to make it happen?			

ENVIRONMENTAL ACTION PLANNING WORKSHEET

ASKING FOR HELP: *DRAFTING A REQUEST*

Name: _____ **Class:** _____

Use this page to draft your request for help. Complete this page for each person or group you plan to contact so you can personalize their message and be specific about what you need from them.

Person or Group: _____

Tell them about your project. What problem or issue will it address? Make this personal and connect their values to this project— **why should they want to help?**

What else can you share to get them interested and motivated to help? Think about pictures, videos, news stories, etc., that would connect to their values.

CHOOSING AN ACTION PROJECT

Group/Class: _____

ACTION PROJECT IDEAS	Idea #1	Idea #2	Idea #3	Idea #4	Idea #5
Criteria #1					
Criteria #2					
Criteria #3					

ENVIRONMENTAL ACTION PLANNING WORKSHEET

DRAFTING A REQUEST CONTINUED

Name: _____ **Class:** _____

Why do you need their help? Be as specific as possible (copied and expanded from the table on the previous page).

What are the logistics? Do you need help on a specific day or do you need them to complete something by a specific date? If they are helping on site, tell them the exact times that you would need help and how they should dress. If they are loaning you equipment or signing a permission slip, tell them when and how to deliver these items.

What is the best way to communicate with this person or group (email, phone call, letter)? Include your contact information so they can respond easily and follow up with additional questions.

ENVIRONMENTAL ACTION PLANNING WORKSHEET

MAINTENANCE

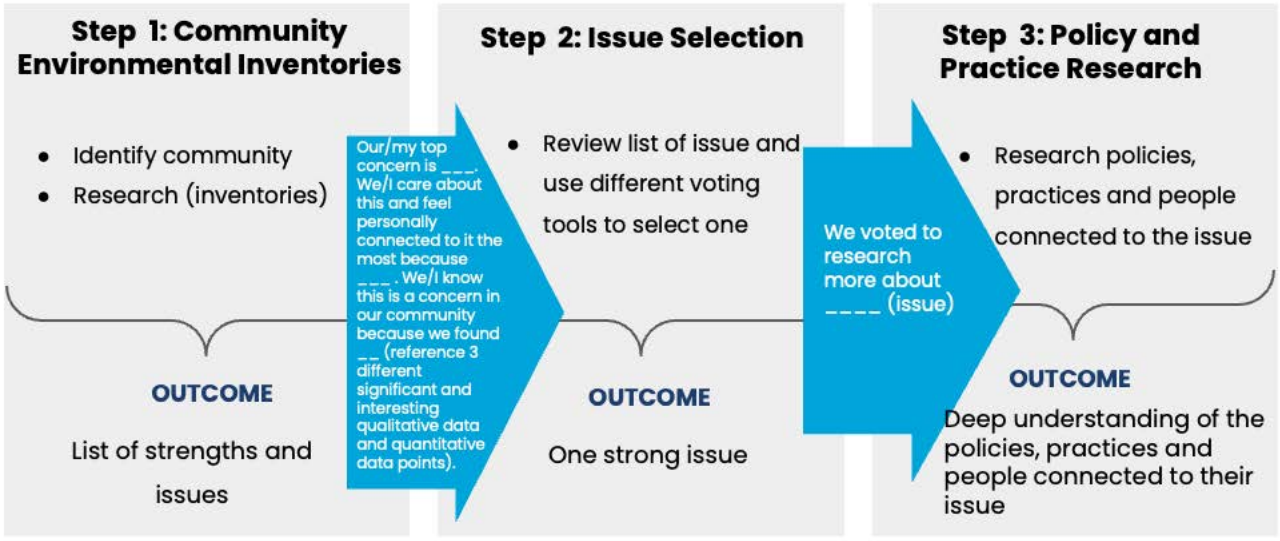
Name: _____ **Class:** _____

Many action projects are not one-and-done deals—they require someone to take care of them for years to come. Use the maintenance table to plan out what needs to happen for the next couple years to keep this project a success. Add additional pages of detailed task instructions or contact information if needed.

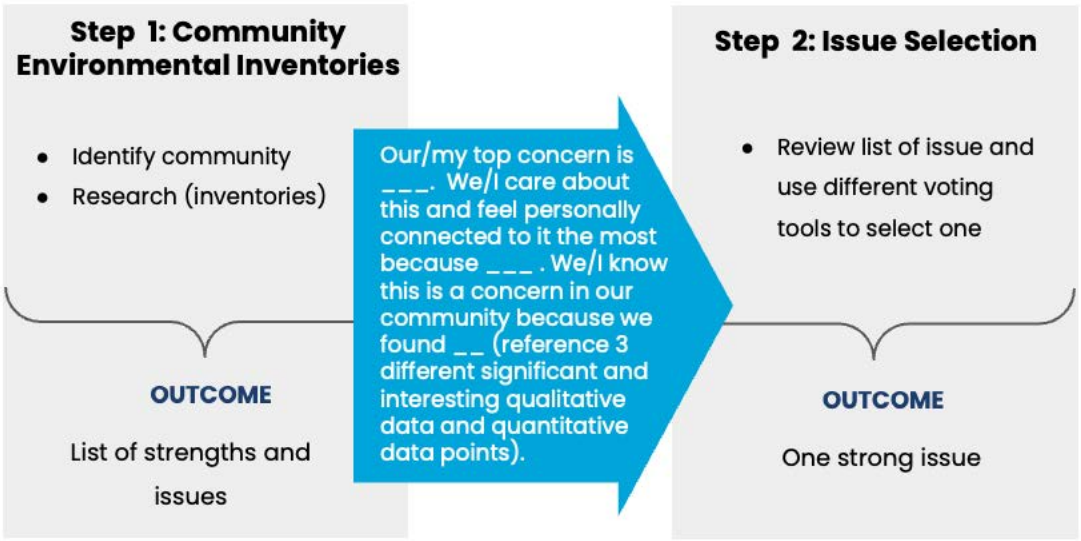
Maintenance Manager: Who will be in charge of this maintenance schedule? Make plans for at least the first year of maintenance. Will it be a student (one of you?), a teacher/staff, a class, or a club?

Maintenance Task	How often? *(weekly, monthly, seasonal, etc.)*

Step 1 and Step 2 (connection to Step 3)



Recapping Step 1 and Step 2



STEP 3:

- Define new concepts - policies, practices, and stakeholders
- Dig deeper - research policies, practices, and people connected to the issue
- Reach out - connect with the people who are directly connected to the issue

ENVIRONMENTAL ACTION PLANNING WORKSHEET

BUDGET

Name: _____ **Class:** _____

What is your budget? Do you need to raise money or look for donations? List all the supplies and equipment you will need to complete your action project.

item	How many?	Total Cost	Will this item be bought, donated, or borrowed? From whom/where?

YOUTH-ADULT PARTNERSHIPS

TIP CARD **19**

GUEST SPEAKERS AND EXPERT VOLUNTEERS

Inviting someone to speak to your group can be a great alternative to an interview or survey. If looking to include multiple perspectives at once, consider a panel or World Cafe set up. Need help finding perspectives? See TIP Card 16 Identifying Stakeholders & Beginning Questions.

Whenever you invite someone to visit your group, consider the following:

PLAN AHEAD

Book your speaker in advance. Choose several possible dates to propose to the speaker or expert volunteer. As you call potential guests and volunteers, explain the purpose for their visit and what you're hoping to learn from them. The more information they have ahead of time the better they can prepare.

CALL TO CONFIRM

Call a few days before the visit to confirm that the guest is coming. Find out if the speaker needs any special materials or equipment (AV hook-up is a big one!)

MAKE SURE YOUR GROUP IS PREPARED

Know what you want to learn from the guest. Prepare questions in advance. If there are any activities or project ideas you're wanting their advice on, make sure everything is good to go.

ASSIGN ROLES

Have someone greet the guest. Designate someone to introduce the speaker. (Make sure this person knows the speaker's background.) Someone also needs to moderate the discussion and thank the speaker at the end.

HAVE A VARIETY OF VIEWPOINTS REPRESENTED

If you are having a panel or World Cafe style discussion, different people usually speak on the same topic or issue. Find out the opinions and expertise of the guests ahead of time so you can make sure there are a variety of ideas presented. **Professionals are used to debating and discussing different points of view. This is a great opportunity to learn from them!**

SEND A THANK-YOU NOTE

Thank your guests for their time either with a written thank-you note or a thank-you email within a day or two of their visit. See TIP Card 31 on Writing Thank-You Notes for more information.

ENVIRONMENTAL ACTION PLANNING WORKSHEET

TASK MANAGEMENT

Name: _____ **Class:** _____

List out the major tasks, in order, that need to happen to complete your action project. Start with the planning and go through completion. Decide when each task needs to be completed for the project to keep moving forward. Assign one or two people to each task. The Task Manager(s) is in charge of making sure their assigned task has happened by the completion date and for sharing updates back to the group or class.

Task	Completion Date	Task Manager(s)