Oceans - Gulf of Mexico

The Gulf of Mexico is one of the most productive waters in the world, and it is among the most threatened by human actions and neglect.

Chapter 12

Grade Levels/Courses

6th, 7th, 8th, Aquatic Science, Environmental Science

Chapter Objectives

Students will:

1. Brainstorm words associated with the Gulf of Mexico.
2. Use the words they generate to write a paragraph about what they know about the Gulf of Mexico.
3. Make a mural illustrating words about the Gulf of Mexico from the list generated by the class.
4. Identify and describe the biotic and abiotic parts of the Gulf ecosystem.
5. Describe some of the micro-habitats that exist in the Gulf of Mexico.
6. Identify producer/consumer, predator/prey, or parasite/host relationships in a marine environment.
7. Describe some adaptations of aquatic organisms found in the Gulf of Mexico.
8. Choose one word that is new to them or of special interest from the class list on the board and do a quick Internet search for information on what that word tells about the Gulf of Mexico.
9. Work in groups of four to combine information and to report on their research on the Gulf of Mexico.
10. Read the chapter and answer the questions.
11. Describe how different environments support different varieties of organisms.
12. Identify and diagram how energy flows in saltwater aquatic systems including food webs.
13. Evaluate the effects of human activities on the environment including habitat restoration projects, species preservation efforts, nature conservation groups, hunting, fishing, ecotourism.
14. Generate a list of actions people could take to protect Gulf ecosystems.
15. Make predictions, observations, and diagrams about layering of different temperatures and salinities of water.

16. Plan and implement an investigation to show how different salinities and temperatures of water cause currents in the ocean.
17. Identify how their model is similar to and how it is different from real currents in the ocean.
18. Identify the limitations of their model.
19. Identify the role of oceans in the formation of weather systems such as hurricanes.
20. Explain how ocean currents are important to the ocean food web.
21. Use a model to demonstrate how waves form.
22. Test variables to see how different depth of water, wind speed, and obstructions in the water such as an island change the patterns of waves.
23. Explain and diagram wave action.
24. Identify how the model is like waves in the ocean and how it is different from waves in the ocean.
25. Identify the limitations of their model of waves.
26. Research one organism that lives in the Gulf of Mexico.
27. Identify the common and scientific names of the organism.
28. Identify the source of energy of the organism.
29. Determine if the organism is endangered or threatened and what caused the species to become endangered or threatened.
30. Create a product to illustrate what they learned in their research about their organisms.
31. Demonstrate the use of course apparatus, equipment, techniques, and procedures.
32. Predict effects on the living and nonliving components of an aquatic ecosystem of chemical, organic, physical, and thermal changes caused by humans.
33. Observe and describe invertebrates and vertebrates seen on a trip on a bay trawler.
34. Analyze the cumulative impact of human population growth on an aquatic system.
35. Use safe practices and conservation of resources in the lab and field.
36. Collect data on soil and water, chemical, physical, and biological characteristics of an estuary or beach, and record information in tables.
37. Draw conclusions based on data.
38. Make connections between evaluating Gulf of Mexico habitats and careers in aquatic science.

Texas Essential Knowledge and Skills in Science

6.1 A, B; 6.2 A, C, D, E; 6.3 B, C; 6.4 A, B; 6.9 A, B; 6.12 C, D, E, F; 7.1 A, B; 7.2 A, C, D, E; 7.3 B. C; 7.4 A, B; 7.5 C; 7.8 C; 7.10 A; 7.11 A, B; 7.12 A; 7.13 A, B; 8.1 A, B; 8.2 A, C, D, E; 8.3 B, C; 8.4 A, B; 8.10 A; 8.11 A, B, C

Aquatic Science: 1 A, B; 2 E, F, G, H, J; 3 B, E; 5 C, D; 6 B; 7 C; 8 A; 9 C; 10 A, B; 11 A, B; 12 A, B, D

Environmental Science: 1 A, B; 2 E, F, G, H, I, K; 3 B, E; 4 A, B, E; 5 B; 6 C, E; 7 D; 8 B; 9 E

Materials Needed

Activity 12.1

Science Journals
Pencils/Pens
Computers
Internet access
Art materials for mural
Long strips of butcher paper

Activity 12.2

Student Guide
Science journals
Pencils/Pens
Art materials

Activity 12.3

Science journals
Pencils/pens
For Each Group of 4 Students
A wooden block or large book
Clear baking dish, clear plastic shoebox, or aquarium
50 ml beaker or baby food jars (possibly up to 5)
Pitcher of ice water
Yellow, blue, and red food coloring
Salt
800 ml of room temp water
Access to hot tap water
Colored pencils

Activity 12.4

Science journals
Pencils/pens
For Each Group of 4 Students

1 or 2 containers such as a 13 inch X 9 inch Pyrex baking dish

Ruler

1 container, about 4-5 inches deep or larger, such as clear plastic boxes or aquariums

1 electric hairdryer to generate wind

Water

Large rock

5 large marbles

Ring stand (if available, to hold hair dryer)

Activity 12.5

Library

Computers

Internet access

Science journals

Pencils/pens

Activity 12.6

Science journals

Pens/pencils

Rulers

Garden spades or shovels

Stopwatches, watches or clocks

Safety goggles

Soil Test kits may contain tests for pH, phosphorus, nitrates, and potassium. (available from science supply catalogs and sometimes from local hardware and garden stores)

Water quality test kits, probes, meters or other equipment may include thermometer, pH kit, conductivity meter, dissolved oxygen kit, nitrate kit, or other tests or probes that are appropriate.

High school students should also have secchi disc, stop watch, salinity test

Binoculars

Field Guides

Garbage bags for litter pick up

Disposable gloves for litter pick up

One copy of each of the following for each student or have students make their own tables:

- Check list for field trip
- *Soil Sampling—Percolation and Characteristics* student instructions - data sheets

- *Physical Indicators of Pollution* information sheet and data table
- *Invertebrates & Vertebrates as Water Quality Indicators* information sheet
- Aquatic plant adaptations instructions and information sheets, and data table
- Bird count and adaptations data table
- Litter and Debris Tally Sheet
- Student made data tables for Soil and Water chemistry based on the tests that students use
- Gulf Boat Trip data sheet

Special Instructions

Texas A & M University at Corpus Christi has a field trip boat, the Karma, for the Floating Classroom Program. You can contact them at: (361) 825-3460 or go to their website at: http://floatingclassroom.tamu.edu/StudentCruises/ArrangingYourTrip.html

The University of Texas Marine Science Institute in Port Aransas also has a boat, the Katy, which takes classes out on the bay. You can contact them at: (361) 749-6729, ext. 3 or check out their website at:

http://www.utmsi.utexas.edu/outreach/visiting-class.html

Coastal Bend Bays & Estuaries Program has activities available at the Nueces Delta Preserve. You can call (361) 673-6829 or check out their education website at: http://nuecesdeltapreserve.org/. Email address: mailto:education@cbbep.org.

Padre Island National Seashore also has school field trips. Contact the park Education Specialist at (361) 949-8068 or visit their website at:
http://www.nps.gov/pais/forteachers/index.htm

Texas State Aquarium may be able to help with the estuary investigation. Contact their educator at (361) 881-1200 or 1(800) 477-GULF or visit the website at:

http://www.texasstateaquarium.org/

The Lower Colorado River Authority's Outdoor Education and Recreation Programs at Matagorda Bay Nature Park has field trips and public programs. For additional information call (800) 776-LCRA, Ext. 4778.

http://www.lcra.org/parks/outdoor_programs/index.html

All of these organizations have programs and are also able to set up special arrangements to meet your needs.

Safety Precautions

Do not let any part of the hair dryer touch the water!!

Wear goggles for handling hot water and chemicals.

Vocabulary

- Abiotic
- Adaptations
- Algae bloom
- Anaerobic
- Artificial reefs
- Barrier islands
- Bay
- Beach
- Benthic
- Biodiversity
- Biotic
- Cetaceans
- Chemosynthesis
- Chemosynthetic
- Climate
- Cold seep
- Conservation
- Consumer
- Contaminants
- Coral reef
- Current
- Density
- Detritus
- Estuary
- Extinction
- Filter feeders
- Gulf of Mexico
- Host
- Hydric soils
- Hydrophytes
- Hypoxic
- Mainland
- Manatee

- Marine
- Micro-habitats
- Parasite
- Pelagic
- Percolation
- Photosynthesis
- Plankton
- Predator
- Prey
- Producer
- Salinity
- Sand bars
- Shellfish
- Swash zone
- Temperature
- Trophic levels
- Wave
- Wind

Enrichment

Project Aquatic Wild

- Whale of a Tail
- Marsh Munchers
- Wetland Metaphors
- When a Whale is Right
- Sea Turtles International
- Mermaids and Manatees
- Net Gain, Net Effect
- Water We Eating
- Plastic Jellyfish
- Turtle Hurdles
- Kelp Help

Videos

Texas The State o f the Gulf by Texas Parks and Wildlife Department

Guest Speakers

While on the field trip to the Gulf of Mexico, students may have the opportunity to interact with a variety of people in careers that are in organizations that will help facilitate the field trip.

- Marine biologist
- Ornithologist
- Science Educators
- National Park Service Rangers

Organizations

- Texas A & M University at Corpus Christi: Hart Institute for Gulf Studies
- Texas A & M Galveston
- The University of Texas Marine Science Institute
- Coastal Bend Bays and Estuaries Programs in Corpus Christi
- Padre Island National Seashore
- Texas State Aquarium
- Lower Colorado River Authority Outdoor Education and Recreation Program at Matagorda Bay Nature Park

Lesson 12.1: ABC's of The Gulf

Essential Concept

The Gulf of Mexico is a biologically diverse and beautiful place where many people come for recreation.

Objectives

1. Students will brainstorm words associated with the Gulf of Mexico.
2. Students will use the words they generate to write a paragraph about what they know about the Gulf of Mexico.
3. Students will draw a mural illustrating words from the Gulf of Mexico list generated by the class.
4. Students will identify and describe the biotic and abiotic parts of the ecosystem.
5. Students will describe some of the micro-habitats that exist in the Gulf of Mexico.
6. Students will identify producer/consumer, predator/prey, or parasite/host relationships in a marine environment.
7. Students will describe some adaptations of aquatic organisms found in the Gulf of Mexico.
8. Students will choose one word that is new to them or of special interest from the class list on the board and do a quick Internet search for information on what that word tells about the Gulf of Mexico.
9. Students will work in groups of four to report on their research on the Gulf of Mexico.

TEKS

6.2 C; 6.12 E; 7.2 C; 7.10 A; 8.2 C; 8.11 A

Aquatic Science: 2 J; 10 B

Environmental Science: 2 K

Estimated Time

2 class periods

Materials

Science Journals

Pencils/Pens

Computers

Internet access

Art materials for mural

Long sheet of butcher paper

Special Instructions

List A, B, C's on the board to prepare for your discussion so that students can add a word for each letter.

Procedure

1. Brainstorming with the ABC's

- **How many have been to the Gulf of Mexico for a vacation or a day at the beach?**

Give those students who have been to the Gulf a few minutes to tell what they did on their trip.

Ask students to work in pairs to make a list of the ABC's in their science journals. They will work together to brainstorm a word that tells something they know about the Gulf of Mexico for each letter of the alphabet. They have about 10 minutes to generate as many ideas as they can.

When time is up, call on each pair to come up one at a time and put one of their words on the letters on the board. Ask the students to explain the word they chose and how it relates to the Gulf of Mexico. Continue around the room until everyone has had a chance to add a word to the list. If all letters have a word, students can still add new words to some of the letters. Some ideas may include: Artificial reef, barrier island, currents, dolphins, estuary, fish, grouper, habitat, invertebrate, jellyfish, Kemps ridley sea turtle, etc. When you discuss each word it will give you a good idea of students prior knowledge about the Gulf of Mexico.

2. Using Our ABC Words

Ask each student to write a short paragraph in their science journals about what they know about the Gulf of Mexico using some of the words in their list. Students should include something about the biotic and abiotic parts of the ecosystem, a description of some of the different habitats that exist in the coastal area, some producer/consumer, predator/prey, or parasite/host relationships in a marine environment, and adaptations of aquatic organisms found in the Gulf coastal area.

3. New Information

Ask students to choose one word that they don't know or that they are most interested in from the class list on the board. They will use that word along with *Gulf of Mexico* and *Texas* to do a quick *Google Search* and print out a short article to read and report to the class on what they learned. **For Example: Jellyfish in the Gulf of Mexico in Texas.**

Students can work in groups of four to share their information and then combine the information from all group members to provide a quick "slice of life" about the Gulf of Mexico. (Reports may be done on the same day or may be continued the next day.)

4. Extension: Making a "Word" Mural

Ask students to use the words they generated as topics for drawing a mural of the Gulf of Mexico. Provide a long strip of butcher paper tacked to the wall and art supplies and allow the class to work on the mural either as a group or individually when they finish their work. Each student should pick one word from the ABC list (Example: artificial reef, barrier island, currents, dolphins, estuary, fish, grouper, habitat, invertebrate, jellyfish, Kemps ridley sea turtle, etc.) and incorporate a drawing representing that word in the mural. Display the finished product in the hall.

Vocabulary

- Abiotic
- Adaptations
- Biotic
- Consumer
- Gulf of Mexico
- Host
- Marine
- Micro-habitats
- Parasite
- Predator
- Prey
- Producer
- Other words may vary depending on your class discussion

Lesson 12.2: Reading and Research

Essential Concept

The Gulf of Mexico is, biologically, incredibly diverse, and requires our help in safeguarding its aquatic ecosystems.

Objectives

1. Students will read the chapter and answer the questions.
2. Students will describe biotic parts of an ecosystem in which organisms interact.
3. Students will describe how different environments support different varieties of organisms.
4. Students will identify and diagram how energy flows in saltwater aquatic systems including food webs.
5. Students will describe producer/consumer, predator/prey relationships in marine ecosystems.
6. Students will evaluate the effects of human activities on the environment including habitat restoration projects, species preservation efforts, nature conservation groups, hunting, fishing, and ecotourism.
7. Students will generate a list of actions they could take to protect Gulf ecosystems.

TEKS

6.2 C, D; 12 E; 7.2 C, D; 7.5 C; 7.10 A; 8.2 C, D; 8.11 A

Aquatic Science: 2 J; 11 A; 12 B

Environmental Science: 2 K; 9 E

Estimated Time

Varies—class time may be provided or reading may be assigned as homework. Allow at least 40 minutes for in-class questions and discussion, and generating a list of actions needed to protect Gulf ecosystems.

Materials

Student Guide

Science journals

Pencils/Pens

Art materials

Procedure

1. Student Reading

Have students read *Chapter 12: Oceans–The Gulf of Mexico*. Introduce vocabulary terms as needed.

2. Questions to Consider

Assign the *Questions to Consider* as homework or use them in a cooperative learning activity.

1) Which states share Gulf waters? Which other countries share the Gulf?

Five states share the Gulf waters: Florida Alabama, Mississippi, Louisiana, and Texas. Mexico and Cuba are countries that share the Gulf

2) What are some of the industries in the Gulf? How can people in these industries help keep the Gulf waters healthy for aquatic life?

The Gulf is an intense oil and gas development site and contains many of the U.S.'s largest ports and most active shipping lanes. In addition it provides some of the worlds largest commercial and recreational fisheries and is well known for the seafood that is harvested in Texas. Tourism is another big contributor to the economy of the Texas Coast. Keeping pollution out of the water and air, curtailing over-fishing, keeping litter out of the environment, and leaving endangered species undisturbed are all things that these industries must do to keep the Gulf waters healthy for aquatic life.

3) What influence does the Mississippi River have on the Gulf of Mexico? What is a hypoxic zone? How are hypoxic zones formed? How can they be prevented?

One of the most important influences on aquatic ecosystems is the Mississippi River, which accounts for nearly 90% of all freshwater inflow to the Gulf. The watershed for the Mississippi River includes 31 states and 2 Canadian provinces. The natural flow from the Mississippi River has always influenced productivity in the Gulf. Freshwater inflow provides nutrients that are carried by currents throughout the Gulf. The nutrients promote growth of phytoplankton. These are primary producers that form the base of an extensive food chain including zooplankton, macro-invertebrates, fish, whales, sea turtles, sea birds and many other forms of marine life.

The hypoxic zone is also called the "dead zone". This is an area of very low to no dissolved oxygen. Many species can experience stress or die as a result of this low dissolved oxygen. Hypoxia adversely affects production of seafood and other aquatic life as food webs are disrupted and organisms at all trophic levels are harmed.

The hypoxic zone is formed because human activities have added wastes, pollutants, fertilizers, and extra sediments to the flow of the Mississippi River. Increased amounts of sediment and nitrogen and phosphorus fertilizers in the Mississippi River's watershed have caused over-enrichment and direct pollution of Gulf waters. These nutrients create a rapid massive growth of phytoplankton at the water's surface, called an algae bloom. The increase in phytoplankton affects the Gulf food chain, increasing food for zooplankton

and other aquatic life. This phytoplankton production is well beyond the capacity of primary consumers to graze it down and has a relatively short life span, so it dies before it can be consumed. Then it sinks to the bottom where decomposers, such as bacteria, break it down. This happens when the water column is stratified, and temperature and salinity differences prevent the layers from mixing. This isolates bottom waters from being re-supplied with oxygen from the surface. Decomposition by bacteria quickly depletes the dissolved oxygen and creates a hypoxic zone.

The only way to prevent the formation of the hypoxic zone is to cut down on the amounts of nitrogen and phosphorus that run off into the Mississippi River by cutting down on fertilizer used in agriculture, and on lawns and golf courses. Without these nutrients the large algae blooms will not occur.

4) What are some of the ecosystems in the Gulf of Mexico and what kinds of organisms would you find in them?

Many ecosystems are found in the Gulf including seashore beaches, chemosynthetic communities in deep waters near hydrogen sulfide and methane cold seeps, benthic areas, pelagic areas, coral reefs and artificial reefs on oil rigs, coastal rivers and estuaries,

See chart.

Ecosystem	Organisms
Beaches	Sand crabs, nesting sea turtles, clams, marine worms, sand dollars, land animals in dunes
Chemosynthetic communities (cold seeps)	Chemosynthetic bacteria, worms
Benthic areas	Bacteria and macro-invertebrates such as crabs, mollusks, shrimp, and jellyfish
Pelagic areas	Tuna, mackerel, phytoplankton, whale sharks, Bryde's whale, menhaden, marine mammals such as dolphin and whales, sea turtles
Coral and artificial reefs	Invertebrates such as sponges and corals, small fish, groupers, amberjack, and snappers, sea turtles, sea birds, rays, sharks, marine mammals, polychaetes, mollusks, echinoderms, hogfish, puffers, angelfish, hammerhead sharks, algae
Rivers and estuaries	West Indian manatee, many invertebrates, fish, shore birds, migratory and song birds

5) How are oil and gas rigs similar to coral reefs?

Oil and gas rigs are similar to coral reefs because they give invertebrates such as corals sponges, polychaetes, mollusks, echinoderms and other animals the hard surface they need to grow and thrive. Energy from organisms accumulates over time then flows up the food chain as primary producers feed consumers, and predators feed on prey. New habitat is then created for larger predator species, such as snapper, grouper, mackerel, shark, and other fish. Even sea turtles benefit from the new feeding opportunities.

6) What might you see on a Texas beach?

Aquatic life is abundant including burrowing organisms such as clams, marine worms, and sand dollars. There are also sand crabs and occasionally nesting sea turtles, and shore birds. Trash, seaweed, and jellyfish also accumulate along the shore.

7) What are currents? What do they do in the Gulf?

Currents are the part of a body of water continuously moving in a certain direction. Currents create areas of upwelling and mix nutrients in the water that enable primary producers, such as phytoplankton to grow and become food for other organisms.

8) How can you help marine mammals and sea turtles?

We can help marine mammals and sea turtles by conserving fresh water, limiting use of fertilizers, herbicides, and other pollutants, volunteering for beach clean up or turtle patrol, joining a conservation organization, and helping educate others about good conservation practices.

3. Challenge Questions

Scientist Sylvia Earle refers to the Gulf of Mexico as America's Sea.

- **Do you agree? What responsibilities come with that title?**
- **How can you help protect the Gulf of Mexico's ecosystems from harm?**

Work as a class to generate a list of actions that people can take to help protect Gulf ecosystems. Be sure to include the effects of human activities on the environment that might improve the ecosystem such as habitat restoration projects, species preservation efforts, nature conservation groups, hunting, fishing, and ecotourism.

- **How have conservation projects made a difference in the Gulf coast area?**
- **What would you say to students from the states of Montana, Ohio, Minnesota, and Missouri about their role in protecting the Gulf?**

(Students may generate a number of ideas. See answer to #8 above. Midwestern areas are the farming areas of the country. Like all of us, these states need to be able to use less fertilizer and other chemicals on their farms. Research is important in helping these farmers learn ways to maintain good crops for economic survival while taking care of the environment.)

4. Using What We Learned

Work with a partner to choose one habitat in the Gulf of Mexico and diagram or make a model of the flow of energy through living systems in a food web with at least 10 different organisms. Indicate in your diagram or model how larger quantities of organisms at lower tropic levels are needed to support the organisms at higher trophic levels.

Vocabulary

- Algae bloom
- Artificial reefs
- Barrier islands
- Beach
- Benthic
- Biodiversity
- Cetaceans
- Chemosynthetic
- Cold seep
- Conservation
- Contaminants
- Coral reef
- Current
- Extinction
- Filter feeders
- Hypoxic
- Mainland
- Manatee
- Pelagic
- Sand bars
- Shellfish
- Trophic levels

Lesson 12.3: Ocean Currents

Essential Concept

Ocean currents are divided into two types based on the forces that drive them. Most currents in the upper kilometer of the ocean are driven by wind. Mixing, affected by density due to temperature and salinity, drives deeper currents.

Objectives

1. Students will make predictions, observations, and diagrams about layering of different temperatures and salinities of water.
2. Students will plan and implement an investigation to show how different salinities and temperatures of water cause currents in the ocean.
3. Students will explain how currents in the Gulf of Mexico help bring more nutrients for phytoplankton.
4. Students will identify how their model is similar to and how it is different from real currents in the ocean.
5. Students identify the limitations of their model.
6. Students will identify the role of oceans in the formation of weather systems such as hurricanes.
7. Students will explain how ocean currents are important to the ocean food web.

TEKS

6.1 A, B; 6.2 A, C, E; 6.3 B, C; 6.4 A, B; 6.9 A, B; 7.1 A, B; 7.2 A, C, E; 7.3 B. C; 7.4 A, B; 8.1 A, B; 8.2 A, C, E; 8.3 B, C; 8.4 A, B; 8.10 A

Aquatic Science: 1 A, B; 2 E, F, G, H, J; 6 B; 8 A

Environmental Science: 1 A, B; 2 E, G, H, I, K; 6 C; 8 B

Estimated Time

1 class period

Materials

Science journals

Pencils/pens

For Each Group of 4 Students

A wooden block or large book

Clear baking dish, clear plastic shoebox, or aquarium

50 ml beaker or baby food jars (possibly up to 5 jars)

Pitcher of ice water

Yellow, blue, and red food coloring

Salt

800 ml of room temp water

Access to hot tap water

Colored pencils

Safety Precautions

Wear goggles and be safe with hot water.

Procedure

1. Density Gradients

In our last chapter we looked at how salinity gradients form when salt and fresh water mix. Now we will also look at affects of temperature on density.

Ask students to work in groups of four. Prop the clear baking dish, plastic box, or aquarium with 800ml of water on the wooden block. Students should draw a diagram of their set up.

Note: Observations of the experiment should be done with your eye level with the clear container.

Have students measure 40 ml. of water and add 2 drops of yellow food coloring. Add a teaspoon of salt and stir until salt is dissolved.

Have students predict what they think will happen to the saltwater when they pour it into the clear container. Students should write their predictions in their science journals.

Ask students to slowly pour the saline solution into the higher end of the container and observe where the saltwater moves. (The saltwater will flow to the bottom of the container and make a layer under the room temperature water.) Students should use colored pencils to add their observations to their diagrams.

Have students measure 40 ml. of cold water and add 2 drops of blue food coloring. Ask students to write a prediction of where this water will move when poured into the clear container. Then have student pour the cold blue water into the higher end of the container and observe what happens. Students should use colored pencils to add their observations to their diagrams. (Blue cold water will layer between the salt water and the fresh water.)

Have students measure 40 ml. of very hot tap water and add 2 drops of red food coloring. Have students predict where this water will move when poured into the clear container and write it in their journals. Students should pour the hot, red water into the higher end of the clear container and observe what happens. (Hot, red water will form a layer at the top of the water.) Students will use colored pencils to add their observations to the diagram and label each layer.

- **What caused the different layers of water to form in the clear container?** (Salt water and hot, cold, and room temperature water all have different densities.)

- **How might these different densities affect the water in the ocean?** (Cold salt water sinks to the bottom while surface water is warmer and less dense.)

2. Designing an experiment

Ask students to design an experiment to answer the following question:

- **How could this affect the currents in the ocean?**

Whatever ideas students generate, try to allow students to be creative in planning this investigation by providing materials that they will need or allowing them to bring materials from home.

Have students draw and label diagrams showing how they think the movement of water due to density happens in the ocean.

- **How can they set up their experiments to show this movement?**

Example: Students should come up with some variation of the following experiment. In an aquarium of room temperature water, place an empty beaker upside down on the bottom of the aquarium and set a jar of blue cold water on its side on top of it. (Or students may think of using a blue ice cube floating in the water.) Place another upside down empty beaker on the other end of the aquarium, and set a jar of room temperature yellow salt water on its side on top of it. Put a baby food jar or 50 ml beaker of hot, red colored water on its side in the center bottom of the aquarium

The different colors of water will begin to come out of their containers and move through the water. The red water will move up, the blue water will move down, and the yellow water will sink to the bottom. The colors will help you see how all of the water moves creating currents in the aquarium.

Students should use colored pencils to draw arrows to indicate directions of movement of each color of water.

- **What will happen to the water if we leave it as it is?** (Temperatures and salinity will stabilize and the colors will all eventually mix together.)

Watch as currents continue mixing colors and salinity of water. Describe what happens.

- **Why does this stabilization not happen in the ocean?** (Cold dense water sinks to the bottom near Greenland, Norway, and Antarctica. As the cold water mixes with warmer water, more cold water is allowed to sink. Climate controls salinity and temperature of water providing constantly changing conditions. Deeper water is even affected by long-term variability of climate.)
- **How is your experiment a model of ocean currents?** (We can see movement of currents due to differences in density, but on a smaller scale.)
- **How is your model of currents different from the real ocean currents?** (It is smaller and is not a continuous process.) **How is it like real ocean currents? (**There is movement of the water due to differences in density.)
- **What are the limitations of your model?** (It is much smaller than real density currents. It becomes stable when salinity and colors are mixed. It is not very deep, etc.)

Note: Ocean currents are also affected by the bottom topography providing deeper and shallower areas where cold water can sink to different depths and warm water can move into the area to replace the sinking cold water. Also the Earth's rotation creates movement in air (winds) and in water as the Earth spins on its axis affecting currents in the upper kilometer of the oceans.

3. Research Question:

Ask students to do a quick Internet search to find information on hurricanes.

- **Where do hurricanes start?** (answer will vary)
- **What is the role of oceans in the formation of weather systems such as hurricanes?** (Warm water increases energy in hurricanes.)

4. Using What We Learned

Ask students to write a paragraph in their journals explaining how currents in the Gulf of Mexico affect ocean food webs. (Currents bring up more nutrients from the ocean bottom for phytoplankton to survive and increase the food at the base of the food pyramid so that more zooplankton and filter feeders such as oysters and other shellfish and giant whale sharks all have food.)

- **Why are ocean currents important?** (More phytoplankton, increases other organisms, increases biodiversity of ocean ecosystems. More biodiversity provides more stability in the ecosystem.

For High School

Ask students to research El Niño and La Niña and explain how they are affected by and how they affect temperature and salinity in the ocean.

Vocabulary

- Climate
- Density
- Salinity
- Temperature

Lesson 12.4: Wind and Waves

Essential Concept

Most ocean waves are caused by wind.

Objectives

1. Students will use a model to show how waves slow down at the beach.
2. Students will use a model to demonstrate how waves form.
3. Students will change variables to see how depth of water, different wind speed, and obstructions in the water such as an island change the patterns of waves.
4. Students will explain and diagram wave action.
5. Students will identify how the model is like waves in the ocean and how it is different from waves in the ocean.
6. Students will identify the limitations of their model of waves.

TEKS

6.1 A, B; 6.2 C, D, E; 6.3 B, C; 6.4 A, B; 7.1 A, B; 7.2 C, D, E; 7.3 B, C; 7.4 A, B; 8.1 A, B; 8.2 C, D, E; 8.3 B, C; 8.4 A, B

Aquatic Science: 1 A, B; 2 G, H, J

Environmental Science: 1 A, B; 2 E, F, G, H, I, K

Estimated Time

1 class period

Materials

Science journals

Pencils/pens

For Each Group of 4 Students

Slowing Waves

1 or 2 containers such as 13 inch X 9 inch Pyrex baking dish

Ruler

Making Waves

1 container, about 4-5 inches deep or larger, such as clear plastic boxes or aquariums

1 hairdryer to generate wind

Water

Large rock

5 large marbles

Ring stand (to hold hair dryer)

Safety Precautions

Do not let any part of the hair dryer touch the water!!

Procedure

1. Slowing Waves

Get two identical containers or use the same container and conduct 2 trials by repeating the activity with different amounts of water. (A 13 inch X 9 inch baking dish will work.) Fill the container with 2 inches of water. In the other container or on the second trial use only 1 inch of water. Create a single wave in the container by propping the end up on an object like a ruler and letting the container plop down to create one single wave in the container. Have the students clap with the rhythm of the waves bouncing back and forth in the container to help them see in which water depth waves move faster and in which water depth waves continue for a longer time.

- **Which trial or container shows waves going faster?** (The one with the deeper water)
- **Which trial or container shows waves going slower?** (The one with the shallower water)
- **Which wave lasts longer?** (The wave in the deeper water)
- **What is the only difference in the trials or containers?** (The depth of the water)

The deeper wave should travel noticeably faster. The deeper water will have a faster rhythm and will continue for a longer time. The wave in the shallower water "drags" on the bottom of the container and it slows the wave down. The shallow wave will also die out faster. Waves slow down and run into each other as the wave drags on the bottom in shallower water. This is why waves get closer together as they come to the beach.

2. Making Waves

When we see waves coming into the beach, we often don't think about what causes those waves.

- **What do you think causes waves?** (Students may think that waves are somehow connected to ocean currents or tides or that they are somehow produced by the water. Other students may already know that wind causes waves.)

Trial 1

Provide materials to each group. Explain how materials are to be used and safety precautions for using electrical equipment near water. Ring stands should be firmly

holding the hair dryers and should be a few inches away from the container and a few inches higher than the water. No part of the hair dryer should touch the water at any time.

Have students work in groups of 3 or 4. Put 2-3 inches of water in the containers or fill them about ¾ full of water.

Allow water to smooth and quiet.

Make a Prediction

- **What do you predict will happen when the hair dryer blows across the water's surface?** Write your predictions in your science journal.

Set the ring stand at one end of the container. Attach the hair dryer so that it is a few inches from the edge of the container and a few inches above the water.

With the hair dryer on low setting, note the time you turn the wind generator on and let it blow for three minutes.

- **What did you observe.**

Describe what you saw happening to the water.

Describe what happens to the waves as they hit the end and sides of the container.

Note: Try not to slosh water out of the container during your trials. If water begins to slosh out, turn off your "wind generator" (hair dryer).

Trial 2

Make a Prediction

- **What do you think will happen if the winds blow harder?**

Increase the speed of the hair dryer to medium and repeat the steps in *Trial 1*.

Trial 3

Make a Prediction

If you have 3 speeds on the hair dryer, increase the speed and repeat the steps again recording your results.

- **What do you think will happen if the wind is blowing harder?**

Observations

- **What effect did the wind that blew harder have on the surface of the water?** (more and higher waves)
- **How did the water move in relation to the direction of the wind?** (moved in the direction that the wind was blowing)
- **Were their differences in the height of the waves with changes in the force of the wind? What happened?** (stronger wind causes higher waves)
- **What happens to the waves when they hit the end and the sides of the container?** (Waves bounce back and turn to the side on the end. Waves on the side turn back toward the other end of the container.)

Draw a diagram showing the direction of the wind and the behavior of the waves. Label the parts.

Trial 4

Add the large rock to the container to represent an island and repeat the steps again.

Make a prediction

Predict how the island will affect the waves. Draw a picture.

Turn on your wind generator and observe what happens. Write down your observations.

- **Did the waves change when they hit the island? Describe what happens.** (Waves parted and moved around the island on the windward side of the island and ran into each other on the far side of the island.)

Draw a diagram of what happened. Did this agree or disagree with your prediction?

3. Slow It Down to See What Is Happening

Discuss the connection between wind and waves. To help students better observe what the water is doing when waves form, do this activity.

Give each group 5 large marbles. Have them set the marbles touching each other on the desk in a row. Ask students to predict what will happen if they use one of the marbles to gently roll into the end of the row. The marbles represent the water. The student moving the marble represents the wind, providing the energy that moves into the system.)

After students have written down their predictions, have one student in each group roll a marble into the last marble in the row in such a way that the marbles in the row will each bump into the next marble.

- **What happens? Is it what you predicted?** (The marble at the far end of the row will roll away and the others will remain in place.)

Ask each student in the group to take a turn trying this.

- **Why do you think this happened?** (Energy in the rolling marble was transferred to the first marble it hit. The energy from the first marble in the row was transferred to the next marble and on up the row to the last marble. The energy then made the last marble roll away. Wave energy moves through the water in the same way. The energy of the wave transfers through the water molecules and the water stays in one place while the wave energy moves through it and into the next water molecules just as the energy moved through the marbles and into the next marble.

Look at the sidebar on waves in the *Student Guide* to see a diagram of how waves move.

4. Explaining What We Learned

Ask students to write a paragraph in their science journals explaining how wind affects waves. Also ask students to make a diagram of how the wind is moving the wave through the water.

Vocabulary

- Wave
- Wind

Lesson 12.5: Researching Ocean Organisms and Food Webs

Essential Concept

The Gulf of Mexico is a place of incredible biodiversity. These marine organisms interact to transfer energy throughout the ecosystem.

Objectives

1. Student will research one organism that lives in the Gulf of Mexico.
2. Students will describe the organisms and note adaptations that help it survive.
3. Students will identify the common and scientific names of the organism.
4. Students will identify and describe where in the Gulf of Mexico the organism lives.
5. Students will identify the source of energy for the organism.
6. Students will identify the role of the organism in the ecosystem.
7. Students will determine if the organism is endangered or threatened and what caused the species to become endangered or threatened.
8. Students will create a product to illustrate what they learned in their research about their organisms.

TEKS

6.12 C, D, E, F; 7.11 A, B; 7.12 A; 7.13 A; 8.10 A

Aquatic Science: 3 B; 5 C; 10 B; 11 A

Environmental Science: 3 B; 4 B; 6 E

Estimated Time

1 class period and homework for setting up assignment and doing research and project

2 class periods for presentations

Materials

Library

Computers

Internet access

Science journals

Pencils/pens

Procedure

1. Researching Ocean Organisms

Each student will choose an organism from one of the following categories to research in preparation for a field trip to the Gulf of Mexico. Numbers below indicate the number of students who can research that topic so that all categories will be covered. Numbers are set up for a class of 22 and can be adjusted up or down for larger or smaller classes.

These categories can be put on slips of paper and students can draw for their research topic.

1.	Phytoplankton	1
2.	Zooplankton	1
3.	Plants	2
4.	Shellfish	2
5.	Jellyfish	1
6.	Other marine invertebrates	2
7.	Small Fish	3
8.	Large Fish	3
9.	Marine Mammals	2
10.	Sea Turtles	1
11.	Shore birds	2
12.	Other birds	2

Within their categories, students can choose the organism that they wish to research. The only requirement is that students check with the teacher to be sure no other students are researching their organisms.

Students should find an illustration of their organism. This may be a photograph or a drawing.

Research should answer the following questions:

- **Describe your organism.**
- **What adaptations does your organism have to survive in a marine environment?**
- **What are the common and scientific names of the organism?**
- **Where in the Gulf of Mexico does the organism live?** (beach, estuary, bay, ocean, etc.)
- **Where in the water does it live?** (For example: is it benthic, or pelagic, or is it found in a coral reef, or does it live in an estuary or bay, or is it free floating?)
- **Where does it get its energy?** (photosynthetic or chemosynthetic producer, decomposer or consumer) **What level and what kind of consumer is it?**
- **What eats it?**
- **What is its role in the ecosystem?**

- **Is it endangered or threatened? If so, what caused the species to become endangered or threatened?**
- **Is this an organism that we are likely to see on a field trip to the Gulf of Mexico? What are your reasons for thinking we might or might not see this organism?**

2. Gulf Food Web

Cut a Sun from construction paper. Tack it in the middle of the bulletin board.

Ask students to decide where their organisms fit in a Gulf food web.

- **Whose organism would come next in the food web?**

Ask students to come one at a time to tack the illustration of their organism on the bulletin board in the appropriate place in the food web and attach each organism to its source of energy with yarn. **Note: Some organisms may have more than one connection in the food web.** For example: Phytoplankton may be the source of energy for zooplankton, shellfish, marine invertebrates, some kinds of fish, and even whales.

Ask each student to make a diagram in their science journals to show the levels of organization within the ecosystem, including their organism, population, community, and ecosystem.

3. Using What We Learned

Ask students to develop a presentation using the information they researched. This presentation can be developed in a form the student chooses. Students should let the teacher know what type of presentation they propose. The presentation may be in the form of a poster, PowerPoint, poem, essay, art project, story book for young children, musical composition, news story, diarama etc.)

The actual research must be written down to answer all questions and sources cited.

Students will present their research to the class in a 3-5 minute presentation.

Vocabulary

- Bay
- Beach
- Benthic
- Chemosynthesis
- Estuary
- Pelagic
- Photosynthesis
- Plankton

Student Page

Researching Gulf of Mexico Organisms

Within your category, you can choose the organism that you wish to research. The only requirement is that you check with the teacher to be sure no other students are researching your organism.

First: Find an illustration of your organism. This may be a photograph or drawing.

You must answer the following questions about your organism in writing.

1. Describe your organism.
2. What adaptations does your organism have to survive in a marine environment?
3. What are the common and scientific names of the organism.
4. Where in the Gulf of Mexico does the organism live? (beach, estuary, bay, coral reef, ocean, etc.)
5. **Where in the water does it live?** (For example: is it benthic, or pelagic, or does it live in an estuary or a coral reef, or is it free floating?)
6. Where does it get its energy? (photosynthetic or chemosynthetic producer, decomposer, or consumer) What level and what kind of consumer is it?
7. What eats it?
8. What is its role in the ecosystem?
9. Is it endangered or threatened? If so, what caused the species to become endangered or threatened?
10. Is this an organism that we are likely to see on a field trip to the Gulf of Mexico? What are your reasons for thinking we might or might not see this organism?

Using My Research:

Students will present their research to the class in a 3-5 minute presentation.

Develop a presentation using the information you researched.

This presentation can be developed in a form that you choose.

You should let the teacher know what type of presentation that you propose.

The presentation may be in the form of:

- poster
- PowerPoint
- poem
- essay
- art project or diarama
- story book for young children
- musical composition
- news story
- other idea that you may generate

Student page

Rubric for Products and Presentations

Criteria	Quality 20 pt	Quality 16 pt	Quality 14 pt	Quality 10 pt
1. Did I get my audience's attention?	Creative Beginning	Average Beginning	Slow Beginning	Inadequate Beginning
2. Did I tell the purpose of my product?	Purpose told with details.	Purpose told with few details.	Purpose told with no details.	Purpose is not clear.
3. Did I make the presentation clear and detailed?	Presentation creative, clear and interesting with many details	Presentation clear, but has few details	Presentation is clear, but has no details.	Presentation is unclear.
4. Was art and/or written work interesting and done neatly	Art and/or writing are interesting and done very neatly.	Art and/or writing are interesting but not done very neatly	Art and/or writing are interesting, but are not neat.	No art was created and/or no writing was created.
5. Did your product provide correct information and was it presented in a manner appropriate for the subject?	Information was correct and product was clearly appropriate for the subject.	Information was correct and product was somewhat appropriate for the subject.	Information was not correct, but product was appropriate for the subject.	Information was incomplete or information was not correct and product was not appropriate for the subject.
OR If your product was for younger children, it is age appropriate and is appropriate to the subject. Information was correct	Product was very appropriate for the age of the child and the subject. Information was correct.	Product was somewhat appropriate for the age of the child and the subject. Information was correct.	Product was appropriate for the subject, but not appropriate for the age of the child. Information was correct.	Product was incomplete or not appropriate for the age of the child and the subject. Information was incomplete or incorrect.

Total Possible Points 100

Lesson 12.6: Field Trip to the Gulf of Mexico

Essential Concept

The Gulf of Mexico is a precious resource that supplies valuable habitat and requires protection.

Objectives

1. Students determine the soil percolation rate and observe the color, texture and odor of the soil.
2. Students use water and soil chemistry test kits and equipment to identify soil and water chemistry in a local estuary or beach.
3. Students demonstrate the use of course apparatuses, equipment, techniques, and procedures.
4. Students collect quantitative data from an aquatic environment, including pH, salinity, temperature, mineral content, nitrogen compounds, and turbidity.
5. Students identify ways human activity can affect aquatic environments.
6. Students will predict effects on the living and nonliving components of an aquatic ecosystem of chemical, organic, physical, and thermal changes caused by humans.
7. Students observe and describe invertebrates and vertebrates seen on a trip on a bay trawler.
8. Students will analyze the cumulative impact of human population growth on an aquatic system.
9. Students use safe practices and conservation of resources in the lab and field.
10. Students collect data on soil and water, chemical, physical, and biological characteristics of an estuary and/or beach, and record information in tables.
11. Students draw conclusions based on data.
12. Students make connections between evaluating Gulf of Mexico habitat and careers.

TEKS

6.1 A, B; 6.2 A, C, D, E; 6.4 A, B; 6.12 E; 7.1 A, B; 7.2 A, C, D, E; 7.4 A, B; 7.5 A, B; 7.8 C; 7.10 A; 7.11 A; 7.13 A, B; 8.1 A, B; 8.2 A, C, D, E; 8.4 A, B; 8.11 A, B, C

Aquatic Science: 1 A, B; 2 E, F, G, J; 3 E; 5 C D; 7 C; 9 C; 10 A, B; 11 A, B; 12 A, B, D

Environmental Science: 1 A, B; 2 E, F, G, H, K; 3 B, E; 4 A, B, E; 5 B; 6 E; 7 D

Estimated Time

These activities can be done as an all day field investigation. If you do not live near the coast and are coming for the field trip, you might want to make it a Friday, Saturday and possibly Sunday field trip so that you can visit an estuary, beach, and take a boat trip. If you can afford a boat trip out on the Gulf, that would be a great addition to the field trip.

Prices vary, but it may be possible to get businesses to sponsor the cost of a boat trip for the class.

You will need one class period for review of data and writing Field Report (reports can be finished as homework).

Materials

Science journals

Pens or pencils

Rulers

Garden spades or shovels

Stopwatches, watches, or clocks

Safety goggles

Soil Test kits may contain tests for pH, phosphorus, nitrates, and potassium. (available from science supply catalogs and sometimes from local hardware and garden stores)

Water quality test kits, probes, meters or other equipment. Kits, meters or other equipment may include thermometer, pH kit, conductivity meter, dissolved oxygen kit, nitrate kit, or other tests or probes that are appropriate.

High school students should also have secchi disc, stop watch, salinity test

Binoculars

Field Guides

Garbage bags for litter pick up

Disposable gloves for litter pick up

One copy of each of the following for each student or have students make their own tables.

Student Check List

Soil Sampling—Percolation and Characteristics student instructions and data sheets

Physical Indicators of Pollution information sheet with data table

Invertebrates & Vertebrates as Water Quality Indicators information sheet and data table

Estuary an beach plant adaptations instructions and information sheets, and data table

Bird count and adaptations data table

Litter Data table

Gulf Boat Trip data sheet

Student-made data tables for Soil and Water Chemistry based on tests that students use

Special Instructions

If you're making a special trip to the coast and would like to set up some special arrangements, you might want to contact one of these organizations. You will need to make arrangements well in advance. Costs vary.

Be sure to invite parents to accompany the students. You will need at least 1 adult for each small group of 4 students.

Texas A & M University at Corpus Christi has a field trip boat, the Karma, for the Floating Classroom Program. You can contact them at: (361) 825-3460 or go to their website at: http://floatingclassroom.tamu.edu/StudentCruises/ArrangingYourTrip.html

The University of Texas Marine Science Institute at Port Aransas also has a boat, the Katy, which takes classes out on the bay. You can contact them at: (361) 749-6729, ext. 3 or check out their website at: http://www.utmsi.utexas.edu/outreach/visiting-class.html

Coastal Bend Bays & Estuaries Program has activities available at the Nueces Delta Preserve. You can call (361) 673-6829 or check out their education website at: http://nuecesdeltapreserve.org/.

Padre Island National Seashore also has school field trips. Contact the park Education Specialist at (361) 949-8068 or visit their website at: http://www.nps.gov/pais/forteachers/index.htm

Texas State Aquarium may be able to help with the field investigation. Contact their educator at (361) 881-1200 or 1(800) 477-GULF or visit the website at: http://www.texasstateaquarium.org/

The Lower Colorado River Authority's Outdoor Education and Recreation Programs at Matagorda Bay Nature Park has field trips and public programs. For additional information call (800) 776-LCRA, Ext. 4778: http://www.lcra.org/parks/outdoor_programs/index.html

All of these organizations have programs and are also able to set up special arrangements to meet your needs. Prices vary, but are reasonable.

Obtain Soil Testing kits and prepare students for using these tests. A practice can be done using soil from the school grounds before going into the field. Data from the school grounds can be compared with data from the field sites at the Gulf of Mexico.

Safety Precautions

When collecting trash, use extra care when handling glass. Wear gloves. Only adults should pick up glass.

Stress field safety (See *Field Trip Guide Lines* at the beginning of the curriculum guide.) Always wear long pants and closed toe shoes for outdoor activities.

Wear goggles when using chemicals.

Procedure

1. Salt Water Ecosystems Field Trip

This field trip will be different from any others you might have taken since you will be assessing the characteristics of salt water ecosystems. Depending on the amount of time you have available, you can use all of these assessments or choose key assessments to

help you make comparisons with the data you have already collected about freshwater ecosystems. It is important that you collect some of the same data as you have collected for freshwater ecosystems so that students can make the comparisons.

Activities can be set up as stations at the field site and students can rotate through all stations. You will need at least one adult at each station.

2. Preparing Students for the Field Trip

Explain to students that this field investigation has many parts. You will be calling on all the skills learned throughout the year.

Some data tables are set up so that students just have to fill in the data. Students will need to make other data tables in their journals. All questions should be answered in their science journals.

One part of the trip might be made to an estuary such as the Nueces Delta Preserve and another part to a beach such as the Padre Island National Seashore. You may also be able to visit the Laguna Madre side of Padre Island National Seashore to visit a hypersaline area, visit a beach on Padre Islandand/or take a boat trip to trawl in the bay or in the Gulf.

3. Studying Soil in an Estuary and/or Beach

Students will look at various characteristics of estuary and beach soils.

Provide each student with a copy of *Soil Sampling—Percolation and Characteristics*.

See example below.

Lead the class through the procedure.

SOIL SAMPLING— PERCOLATION AND CHARACTERISTICS

Directions

Collect data at an estuary and on a beach. If possible go to the Laguna Madre side of Padre Island National Seashore to visit a hypersaline environment.

1) If there is standing water at the site, use a ruler to measure the depth of the standing water. Measure in centimeters from the soil surface to the top of the water and record the result. If there is standing water**, do not dig a test hole**.

2) If there is no standing water at the site, dig a hole 30 centimeters square and 30 centimeters deep using a spade or shovel.

At the beach, dig a hole back from the tide line to measure percolation. Dig another hole in the tidal area and compare the percolation rate for each.

- **What is the color and texture of the soils at the estuary and at the beach?**

3) Measure the rise in water level in the hole during an approximate 30-minute period. If the hole fills more quickly, record the time it takes to fill with water.

4) Calculate percolation rate in centimeters per minute and record it.

5) Examining Soil Texture and Color. While waiting**,** examine some of the hydric soil

from the hole. When soil is saturated the space between the bits of dirt is filled with water. This leaves little or no room for air, giving the soil a grayish color and a gooey texture. These gray, blue, even black, estuary soils also may have irregularly shaped reddish-brown or orange-yellow mottles, indicating the presence of iron in the soil. Record your observations in the table under color and texture. Beach soils will be different from soils in an estuary.

6) Soil Odor. In the water, tiny creatures break down dead plant and animal matter called detritus. Because the detritus layer settles beneath the water and is not exposed to air, special kinds of decomposers are needed. Anaerobic bacteria, which do not need oxygen to live, break down the detritus. They produce sulfur-containing compounds, which smell like rotten eggs. Remove a small piece of soil from the hole. Crush this piece between thumb and forefingers and smell it to determine if hydrogen sulfide is present. Record your observations.

7) Cleaning up. Fill in your soil holes when you are done!

Have students compare their results and place the completed data sheets (found as the end of this lesson) in their science notebooks.

4. Soil and Water Chemistry

Students will collect soil and water chemistry data and make observations using soil testing kits and water testing kits. Don't forget to wear goggles when handling chemicals.

Students will need to make their own data tables based on the test they will conduct.

The water testing kit may include pH, salinity, nitrates, dissolved oxygen, and phosphorus. The soil testing kit may include tests for nitrates, phosphorus, potassium and pH.

Make a data table to record your results at three sites at the estuary. (If you go to the Laguna Madre, be sure to use the soils at that site for one of your entries.) Also record data for three sites at the beach.

- **How does the chemistry of estuary and beach soils compare to the soil at your school?**

5. Physical and Biological Indicators of Water Quality

Students should look at the *Physical Indicators of Pollution* instruction sheet, water temperature, turbidity, color, odor, foaming, and conductivity.

Have students also look at the *Invertebrate and Vertebrate Water Quality Indicators* information sheet. If you are in a saline environment, you will have different invertebrates from what you found in freshwater ecosystems. Use a field guide to help you identify these organisms. The more diversity you find, the healthier the ecosystem.

- **Where does the water come from to this estuary or beach ecosystem?**

Example: Freshwater inflows to the Nueces Bay come from the Nueces River.

Make a list of human activity near the estuary or beach. Have students analyze the cumulative impact of human population growth on this estuary or beach ecosystem. Students should predict how human activities impact physical, chemical, and thermal

changes in the water, which will affect the living and nonliving components of the wetland ecosystem.

Note: It helps if you have something like the *TEXMAPS Coastal Bend Atlas* to help to identify land use in the area. Industrial locations are labeled on the maps.

Example: The land near the Nueces Delta Preserve and Nueces Bay has two Flint Hills Resources Oil Refineries, Qualitch Steel Corporation, Dredge Material Placement Areas, Citgo Oil Refinery, Valero Oil Refinery, and the Nueces Bay Power Plant. Padre Island National Seashore is near large ranches and near housing areas.

- **How might this impact changes in the estuary or beach over the coming years?**

6. Plant Adaptations in a Wetland

Use the *Estuary or Beach Plant Adaptations* instruction, information and data sheets to investigate the ways that plants are able to survive in an estuary or beach environment

All plants need sunlight, oxygen and a way to reproduce. Hydrophytes, those plants that live in water-logged soils, have adapted unique ways to survive. Use your eyes and hand lens to observe closely and use the *Estuary or Beach Plant Adaptation* information sheets to help you answer these questions.

1) **Find a plant living in an estuary or on a beach. Notice its size and shape. Describe or draw it in your journal.**
   - **In what habitat is it living?**
   - **How does its size and shape enable it to live in an estuary or on a beach?**
   -
2) **Find a plant living in an estuary or on a beach. Feel its texture. Describe it.**
   - **How does its texture help it survive in an estuary or on a beach?**

3) **Cut the stem of a plant crosswise. In your journal, draw or describe what you see. Use your hand lens to look closely.**
   - **How does what's inside help the plant obtain oxygen.**

4) **Look at the leaves. Describe or draw what they look like in your journal.**
   - **Does their shape or position help the plant get sunlight or oxygen? How? Does the shape or position help them compete with other plants? How?**

5) **Can you see flowers (or other reproductive parts)? Describe or draw them.**
   - **How are they adapted for reproduction in a estuary or beach environment?**

6) **Dig up one small plant whose species is found in abundance in the estuary or beach and look at its roots. Describe or draw a picture of the roots.**
   - **How are these roots suited for living in hydric soils?**
   - **If this is a salty wetland, how is this plant adapted for living with salt water?**

5. Making Observations of Bird Adaptations and Taking a Bird Count

Provide binoculars and field guides for students to look for birds. Students should use their journals and write down the name of the bird (or a description and look for the name of the bird in a field guide later), and tally the number of each type of bird that is seen. **Note any adaptations that birds exhibit to survive in estuary or beach environment.**

- **How many different types of birds did you see?**
- **Were there fewer or more birds at the estuary or beach than at any of the other aquatic ecosystems you have visited?**
- **Are there fewer or more birds than at the school grounds?**
- **What kinds of adaptations did you find and what are the ways these adaptations help birds survive in an estuary or beach?**

7. Litter and Debris Tally

Safety Note: Warn students not to pick up glass. Ask them to have an adult pick up any glass they see.

Have a contest to see which group can pick up the most litter. Ask students to use disposable gloves and garbage bags to pick up litter in the estuary or beach. Each group should have **2 garbage bags:** one bag for recyclables and one bag for non-recyclables. Use the data sheet provided to tally the number of each type of material (glass, plastic, etc.) you find in the litter. Recycle items that are recyclable.

Weigh the bags and find the average weight picked up per student. Determine how much litter could have been picked up if every student in the school came to the estuary or beach and picked up an equal amount of litter and debris.

- **Which items were recyclable?**
- **What was the largest thing you found?**
- **What was the smallest thing you found?**

8. Boat Trip in the Bay

Your trip may include observation of marine mammals that might be nearby and a variety of organisms brought up in the trawl net. You will need to record a description, adaptations and the number of each type of organism.

9. Field Study Report

Review data and answers to questions as a class and help students set up data tables and graphs as needed. Have students work in their groups to use all of the information you

gathered to **write a report comparing the estuary and beach with other aquatic ecosystems where you have collected data**.

Divide the report into four sections:

1) Physical Characteristics of the Estuary and Beach (or bay or the Gulf)
2) Chemical Characteristics of the Estuary and Beach (or bay or the Gulf)
3) Biological Characteristics of the Estuary and Beach(or bay or the Gulf)
4) Conclusions drawn based on your data about the similarities and differences in the estuary and beach and another freshwater aquatic ecosystems you have studied.

- **What affects would urbanization and other human activities or natural occurrences such as migration, storms or other natural changes have on an estuary or beach?**
- **If you found polluting chemicals in soil or water, were you able to determine the causes as point source or non-point source pollution?**
- **What types of things could we do to take care of the estuary and beach?** (or bay or the Gulf)

10. Careers in Marine Science

Ask students to research careers in marine science on the Internet and relate careers to their experiences gathering data at the estuary or beach. Search for careers in marine science first. Then search specific entities such as Coastal Bend Bays and Estuaries Program, Texas A & M University, The University of Texas Marine Science Institute, Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, Natural Resource Conservation Service. Write a paragraph in your science journal about opportunities in marine science careers and education needed to qualify.

Vocabulary

- Anaerobic
- Detritus
- Hydric soils
- Hydrophytes
- Percolation

Student page

Student Check List for Field Activities

Directions

Collect data and fill in the data tables provided.
Answer the questions in your science journal.
Make 2 more data tables–one for soil chemistry and one for water chemistry.
Check off each activity as you finish it.
Put all data sheets in your science journal.

1. Soil Sampling–Percolation and Characteristics
2. Soil Chemistry (make your own table)
3. Water Chemistry (make your own table)
4. 4 Physical Indicators of Pollution
5. Invertebrates and Vertebrates
6. Estuary and Beach Plant Adaptations Drawings and
7. Descriptions
8. Plant Adaptations Data Table
9. Bird Data Table
10. Litter and Debris Tally
11. Gulf Boat Trip

Student page

INSTRUCTIONS FOR SOIL SAMPLING PERCOLATION AND CHARACTERISTICS

Objective

Determine the soil percolation rate and observe the color, texture and odor of the soil.

Directions

Collect data at an estuary and on a beach. Record your data on the data table on the next page.

1) ***If there is standing water at the site***, use a ruler to measure the depth of the standing water. Measure in cm. from the soil surface to the top of the water and record the result. If there is standing water**, do not dig a test hole**.
2) ***If there is no standing water at the site, dig a hole*** 30 cm square and 30 cm deep using a spade or shovel.

   At the beach, dig a hole back from the tide lines to measure percolation. Dig another hole in the tidal area and compare the percolation rate for each.
3) ***Measure*** the rise in water level in the hole during an approximate 30-minute period. If the hole fills more quickly, record the time it takes to fill with water.
4) ***Calculate percolation rate*** in centimeters per minute and record it.
5) ***Examining Soil Texture and Color.*** While waiting**,** examine some of the hydric soil from the hole. When soil is saturated the space between the bits of dirt is filled with water. This leaves little or no room for air, giving the soil a grayish color and a gooey texture. These gray, blue, even black, estuary soils also may have irregularly shaped reddish-brown or orange-yellow mottles, indicating the presence of iron in the soil. Record your observations in the table under color and texture.
6) Beach soils will be different from the soils in an estuary. Record separate data for beach soils.
   - **What is the color and texture of the soils at the estuary and at the beach?**
7) ***Soil Odor.*** In the water, tiny creatures break down dead plant and animal matter called detritus. Because the detritus layer settles beneath the water and is not exposed to air, special kinds of decomposers are needed. Anaerobic bacteria, which do not need oxygen to live, break down the detritus. They produce sulfur-containing compounds, which smell like rotten eggs. Remove a small piece of soil from the hole. Crush this piece between thumb and forefingers and smell it to determine if hydrogen sulfide is present. Record your observations.

8) Cleaning up. Fill in your soil holes when you are done!

Student page

Data for Percolation Rate

SOIL SAMPLING— PERCOLATION AND CHARACTERISTICS

Group: _____
(names)

Date: _____

Location:_____

Water level change after 30 minutes: _____ cm.

Percolation rate = water level change after 30 minutes ÷ 30 = _____ cm. per minute.

Soil Characteristics

Site	Depth of standing water (centimeters)	Percolation rate (centimeters per minute)	Color	Texture	Odor

Student Page

Physical Indicators of Pollution

Some stream conditions may be indicated by observations of **physical indicators** of water pollution such as color, odor, and foaming.

Color of Water

Green color may indicate the possibility that nutrients from fertilizer or manure runoff may be flowing into the stream and feeding algae.

Orange-red color may indicate the possibility of acid draining into the creek from mining or industrial waste.

Light brown (muddy or cloudy) color indicates sediment caused by erosion, which may come from ground that is disturbed and left open upstream.

Yellow color coating the streambed may indicate sulfur entering the creek from industrial waste or some operation using coal.

A multi-colored *sheen* on the water may indicate oil floating on the water and may come from ***nonpoint source runoff*** from cars and roads or dumping of oil along the stream.

Yellow brown to dark brown may indicate acids released from decaying plants such as dead leaves collecting in the stream. This color is common in streams that drain marshes or swamps.

White cottony masses on the creek beds indicate the possibility of a fungus found in sewage. Check for sewage or other organic pollution.

Odor

The smell of **rotten eggs** is an indicator of sewage pollution, but may also be present in swamp or marshy land.

A musky smell may indicate the possibility of untreated sewage, livestock waste, algae, or other conditions.

A *chlorine* smell may be caused by a near-by sewage treatment plant chlorinating their effluent.

Foaming

White foam greater than 1-3 inches high may indicate the presence of detergents from industrial or residential waste entering the creek.

Conductivity

If you have a conductivity meter, it can indicate the presence of inorganic solids such as chloride, nitrate, and sulfate, (ions which carry a negative charge) and phosphates such as sodium, magnesium, calcium, iron, and aluminum (ions which carry a positive charge). Organic compounds such a oil, phenol, alcohol, and sugar do not conduct electricity very well and therefore have a low conductivity when in water.

Student page

Data for Physical Characteristics of Wetlands

Water sample Site	Temperature (^{o}C)	Color	Odor	Foam	Conductivity	Turbidity
A						
B						
C						
D						
E						
F						
G						

Student page

Invertebrates and Vertebrates

Invertebrates

Record the invertebrates that you find in estuaries and on the beach. Use a field guide to identify these invertebrates. Estuaries are nursery grounds for various shellfish so you may find many small invertebrates in the shallow water or hiding in plant cover.

Vertebrates

If there are no fish or evidence of other vertebrates in or near the water, it may indicate that urban runoff, sewage, or toxins are entering the water.

You may be lucky enough to see jellyfish or dolphin in the bay. Note their adaptations and behaviors.

Invertebrate Species & Tally	Description	Name of Vertebrates Present	Vertebrate Description & Adaptations	Vertebrate Behavior

Student page

Estuary and/or Beach
Plant Adaptations Drawings and Descriptions

All plants need sunlight, oxygen and a way to reproduce. Hydrophytes, those plants that live in water-logged soils, have adapted unique ways to survive. Use your eyes and hand lens to observe closely and use the "Estuary or Beach Plant Adaptation Sheet" to help you answer these questions.

1. **Find a plant living in an estuary or beach. Notice its size and shape. Describe or draw it in your journal.**
   - In what habitat is it living?
   - How does its size and shape enable it to live in an estuary or beach?

2. **Find a plant living in a estuary or beach. Feel its texture. Describe it.**
   - How does its texture help it survive in an estuary or beach?

3. **Cut the stem of a plant crosswise. In your journal, draw or describe what you see. Use your hand lens to look closely.**
   - How does what's inside help the plant obtain oxygen.

4. **Look at the leaves. Describe or draw what they look like in your journal.**
   - Does their shape or position help the plant get sunlight or oxygen? How? Does the shape or position help them compete with other plants in some manner?

5. **Can you see flowers (or other reproductive parts)? Describe or draw them in your journal.**
   - How are they adapted for reproduction in an estuary or beach?

6. **Dig up one small plant whose species is found in abundance in the estuary or beach and look at its roots. Describe or draw a picture of the roots.**
   - How are these roots suited for living in hydric soils?
   - How are these plants adapted for living with salt water?

Wetland Plant Adaptations	Advantage	Examples
Salt-Tolerant Plants		
gummy, hairy, waxy skin	to prevent salt absorption	cinquefoil, sea thrift gumweed, pickleweed,
holds water in cells	to maintain water supply	pickleweed
oxygen-rich layer around roots	to obtain oxygen	cordgrass
exudes salt crystals	to get rid of excess salt	saltgrass
salt drops on tips of leaves	to get rid of excess salt	pickleweed
large, hardy seeds to keep salt water from flowing in	to maintain salt balance in cells	pickleweed
low, sprawling form	to reduce water loss from wind exposure	pickleweed, jaumea
small flowers	uses little energy	sedges, rushes, bulrushes
parasitic	to obtain nutrients from other plants	salt marsh dodder
Bog Plants		
sticky, sweet smelling	to attract insects for nutrients	sundew, pitcher plant
leaves upright,	to reduce surface area for drying out from exposure to the sun	Labrador tea, cranberry
thick, fuzzy, rolled leaves,	to prevent water loss from evapotranspiration	Labrador tea
live symbiotically with fungi	to obtain nutrients	orchids, heath plants

Student page

Plant Adaptations Data Table

Species	Location	Size	Shape	Texture	Stem Cross section	Leaves	Flowers	Roots	Salt Adaptation

Student page

Bird Data Table

Bird Name	Tally	Location	Adaptations	Advantage for Survival	Migratory or Resident

Questions:

1. How many different types of birds did you see?
2. Were there fewer or more birds at the estuary or beach than at any of the other aquatic ecosystems you visited?
3. Are there fewer or more birds on the school grounds?
4. What kinds of adaptations did you find and what are the ways these adaptations help birds survive and reproduce in this estuary or beach?

Student page

Litter and Debris Tally
Record the trash you collect.

Item	Tally	Total
Plastic		
Glass		
Metal		
Paper		
Styrofoam		
Wood		
Cloth		
Other		

Questions:

1. Which items are recyclable? Mark an R by the recyclable items.
2. Which was the largest item you found?
3. Which was the smallest item you found?

Student page

Gulf Boat Trip

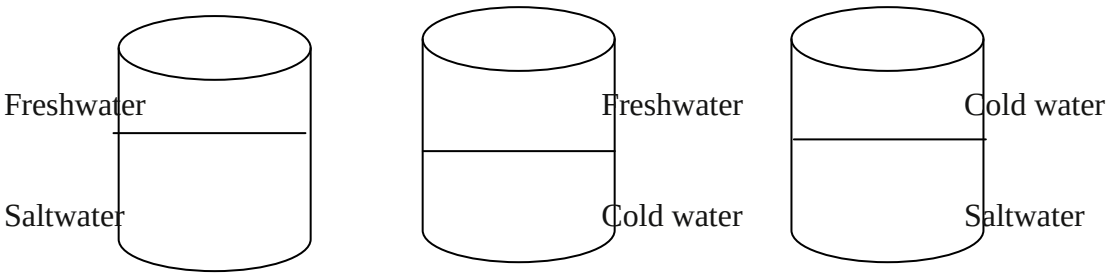
NAME of ORGANISM	DESCRIPTION	ADAPTATION	TALLY

Chapter 12 Assessment

Directions

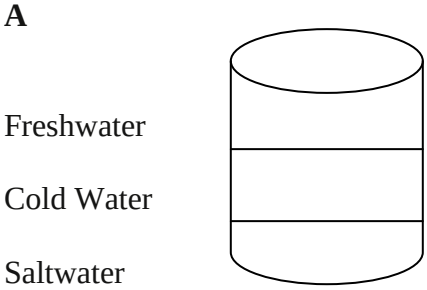
Select the best answer for each of the following multiple-choice questions.

1. The diagram below shows one container with freshwater and saltwater, another container with cold water and freshwater, and another with cold water and saltwater.

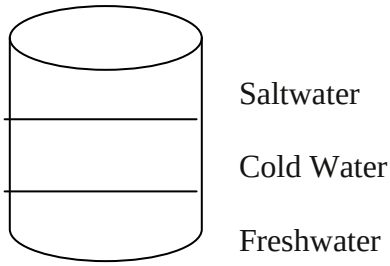


Which diagram shows what would most likely happen if freshwater, saltwater, and cold water were all placed in one container?

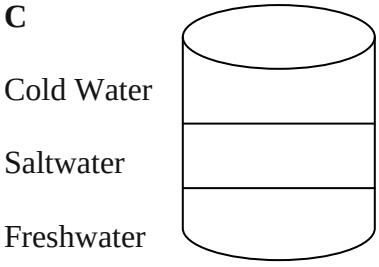
A



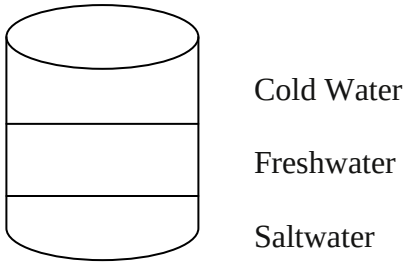
B



C



D



2. A fish has a flat speckled body. How does the appearance of this fish most likely help it survive?

A It helps it sneak up on prey.

B The head-on view of this fish attracts predators.

C The flat body allows this fish to live in deeper water.

D Predators have a hard time seeing this fish when it hides on the bottom.

3. A type of organism is missing from the food chain below.

? clam blue crab people

Which statement about the type of organism that correctly completes this food chain is <u>NOT</u> true?

A It is unable to move from one place to another.

B It produces its own food.

C It breaks down nutrients from decaying organisms.

D It gets its energy from the sun.

4. Waves are caused by:

A Currents

B Wind

C Tides

D Properties of Water

Chapter 12 Assessment

Write your own answer for each of the following questions.

1. Explain what a hypoxic zone is and how it is formed?

2. Where is a hypoxic zone in the Gulf of Mexico? What are its effects?

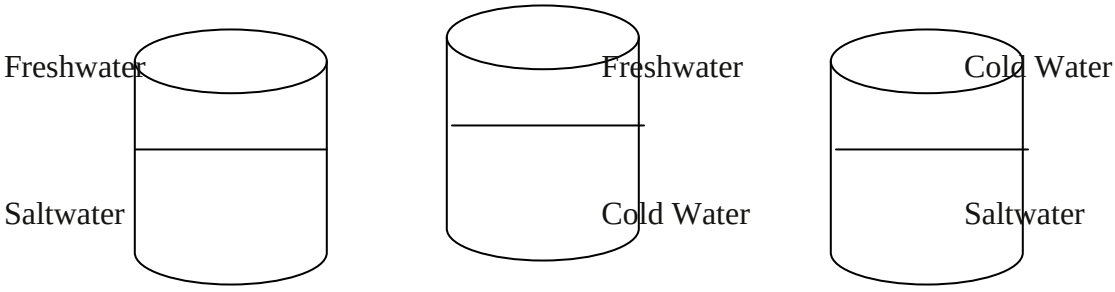
3. Draw a food web for pelagic areas in the Gulf of Mexico.

Chapter 12 Assessment Answer Key

Directions

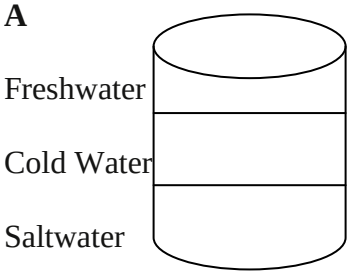
Select the best answer for each of the following multiple-choice questions.

1. The diagram below shows one container with freshwater and saltwater, another container with cold water and freshwater, and another with cold water and saltwater.



Which diagram shows what would most likely happen if freshwater, saltwater, and cold water were all placed in one container?

A



2. A fish has a flat speckled body. How does the appearance of this fish most likely help it survive?

D Predators have a hard time seeing this fish when it hides on the bottom.

3. A type of organism is missing from the food chain below.

? clam blue crab people

Which statement about the type of organism that correctly completes this food chain is <u>NOT</u> true?

C It breaks down nutrients from decaying organisms.

4. Waves are caused by:

B Wind

Chapter 12 Assessment Answer Key

Write your own answer for each of the following questions.

1. Explain what a hypoxic zone is and how it is formed?

A **hypoxic zone** is often called the "dead zone." This is an area of very low to no dissolved oxygen.

Human activities add wastes, **pollutants**, fertilizers, and extra **sediments** to the flow of the Mississippi River. The additional materials, especially increased amounts of nitrogen and phosphorous fertilizers, have caused over-enrichment and direct pollution of Gulf waters that has upset the natural balance of aquatic production.

The nutrients create a rapid massive growth of phytoplankton at the water's surface. This results in a biomass of primary producers far beyond what would occur naturally, often called an **algae bloom**. The increase in phytoplankton then affects the Gulf food chain, increasing food for zooplankton and other aquatic life. But the amount of phytoplankton produced in such a short time is well beyond the capacity of **primary consumers** to graze it down to a balanced level. Phytoplankton have a relatively short life span, so much of the phytoplankton dies before it can be consumed. After dying the phytoplankton organisms sink down to the bottom where **decomposers**, such as bacteria, break them down.

At the time of year this usually happens, the water column is stratified, meaning that temperature and salinity differences between surface and bottom water layers prevent the layers from mixing. This isolates bottom waters from being resupplied with oxygen from the surface. The **plankton** that has sunk to the bottom is decomposed by **bacteria**, but large amounts of **dissolved oxygen** are consumed by this process and the dissolved oxygen is quickly depleted. The result is creation of a **hypoxic zone.**

2. Where is a hypoxic zone in the Gulf of Mexico? What are its effects?

The hypoxic zone is where the Mississippi River feeds into the Gulf of Mexico. The zone expands from the mouth of the river and into the Gulf along the coasts of Louisiana and Texas each summer. Hypoxic zones occur elsewhere in the world's oceans, but the one in the Gulf is now the second largest on Earth, sometimes extending all the way from Texas to Florida.

This is an area of very low to no dissolved oxygen. Organisms capable of swimming away such as fish and shrimp may leave the area, but life that lives in or on the bottom has nowhere else to go. They experience stress or die as a result of this low dissolved oxygen. **Hypoxia** adversely affects production of seafood and other aquatic life as food webs are disrupted and organisms at all **trophic levels** are harmed. Hypoxia can last for several months until the water layers mix, which can happen due to storms or when the water cools in fall and winter.

3. Draw a food web for pelagic areas in the Gulf of Mexico.

Answers will vary. The answer may include something like the following:

- The food web always starts with the Sun. Phytoplankton get energy from the Sun.
- Phytoplankton are eaten by jellyfish. Jellyfish are eaten by sea turtles.
- Phytoplankton are eaten by mullet. Mullet are eaten by dolphins.
- Phytoplankton are eaten by Zooplankton. Zooplankton are eaten by squid. Squid are eaten by Mackerel. Mackerel are eaten by tuna. Tuna are eaten by sharks.