Watersheds and the Land

Everyone lives in a watershed. Everything that happens on the land in a watershed affects the water

Chapter 3

Grade Levels/Courses

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

Chapter Objectives

1. Students will work together to generate a definition of watersheds.
2. Students will identify their watershed address.
3. Students will look at changes to water, an abiotic part of the environment on which all living things depend, and how those changes affect living things.
4. Students will discuss changes in water in a watershed caused by erosion.
5. Students will discuss changes in water in a watershed caused by various human uses of the land.
6. Students will explain how a technological solution to a problem can have both benefits and drawbacks such as risks or unintended consequences, and support the explanation using a specific example of aquatic resources in Texas.
7. Students will use a topographic map to find the height of a geographic feature.
8. Students will use a topographic map to help them create a model of a watershed. Students will look at problems on the school grounds that might affect the watershed.
9. Students will predict where water will flow off of the model watershed.
10. Students will predict where water will accumulate in the model watershed.
11. Students will identify factors that contribute to how water flows in a watershed.
12. Students will decide where to build a house in the watershed model based on the places where water will flow and where it will accumulate.
13. Students will look at the effects of pollution in different places in a model watershed.
14. Students will define point-source and non-point source pollution.

15. Students will take part in a scavenger hunt to look at land use and pollution where water flows from the school grounds into the watershed.
16. Students will describe the impact of erosion and sedimentation on aquatic resources in Texas.
17. Students make a map of the school grounds showing erosion and pollution problem areas and will show on the map ways they think the class could help alleviate problems.
18. Students will identity Texas' natural physiographic regions and explain how land type may affect Texas' aquatic resources, wildlife and recreation in and around water.
19. Students will analyze data on maps to formulate reasonable explanations related to interrelationships among geology and hydrology of regions of Texas.
20. Students will describe biotic and abiotic parts of an aquatic ecosystem.
21. Students will explain the relationship between the watershed and the water body into which it drains.
22. Students will draw conclusions about the relationships among the characteristics of physiographic regions, watershed, and aquatic environments.
23. Students will read background information on watersheds.
24. Students will answer questions about watersheds
25. Students will draw a poster to inform and motivate the public to take action to control effects of erosion and various pollutants on organisms that live in water.

Texas Essential Knowledge and Skills in Science

6.1 A, B; 6.2 C, E; 6.3 B, C; 6.4 A; 6.12 C, E; 7.1 A, B; 7.2 C, E; 7.3 B, C; 7.4 A; 7.8 B, C; 8.1 A, B; 8.2 C, E; 8.3 B, C; 8.4 A; 8.9 C; 8.11 B, C

Aquatic Science: 2 H, J; 3 B; 4 A; 7 B; 12 A, B, D

Environmental Science: 2 I, K; 3 B; 5 A, B; 9 A

Materials Needed

Lesson 3.1

Science journals

Pencils/pens

Chart paper

Markers

Lesson 3.2

<u>For Each Group of 6 Students</u>

Oil based clay

Scissors

Plastic knife

Topographic Map of Buffalo Hill

Topographic Map of Green Hill Point

Disposable aluminum cookie sheet or rectangular cake pan

Wax paper

2 spray bottles with water

2 two-inch dowels cut in one-foot lengths or other roller to flatten clay

Paper clips for each student

Construction paper

Paper towels

Newspapers

Food coloring (red and green)

Blue, red, yellow, and green colored pencils

For high school: http://www.topoquest.com/ (Source for topographic maps)

Lesson 3.3

Copies of the *What's in Our Watershed?* scavenger hunt and clipboards for each student. If you don't have clipboards, you can use heavy cardboard and a clamp for a clipboard.

Pencils

Science journals

Lesson 3.4

Map 3.1: *Texas River Basins* (watersheds) map

Map 3.2: *Texas River Basins and Major Bays* (watersheds) map labeled

Map 3.3: *Texas Natural Regions* Map

Map 3.4: *Texas Natural Regions and River Basins* (watersheds) map

Map 3.5: *Texas Notable Features*

Download maps here:
http://www.tpwd.state.tx.us/publications/learning/aquaticscience/maps.pdf

For High School

River Basin Map of Texas and *Physiographic Map of Texas* from the Bureau of Economic Geology. The website is http://www.beg.utexas.edu/pubs/pubs-teachers.php

Science journals

Pencil/Pens

Computer and projector or Smart Board (optional)

Lesson 3.5

- Student Guide
- Science journal
- Pens or pencils
- Posterboard
- Various art materials of the student's choice

Safety Precautions

Make sure students understand field trip behavior guidelines

Vocabulary

- Accumulation
- Bays
- Coastal basins
- Drains
- Erosion
- Estuaries
- Eutrophication
- Headwaters
- Hydrological
- Hydrologist
- Impermeable surface
- Intermittent or ephemeral streams
- Land use
- Litter
- Natural physiographic regions
- Non-point source pollution
- Photosynthesis
- Point source pollution
- Pollution
- River basin
- Runoff
- Sediment
- Topographic map
- Topography
- Watershed

Enrichments

Project WET:

- Branching Out!
- Just Passing Through
- Rainy-Day Hike
- Sum of the Parts

Project WILD Aquatic:

- Watershed
- Where Does Water Run?

Teacher Resources

Bureau of Economic Geology

River Basin Map of Texas, Physiographic Map of Texas, Ecoregions of Texas, Geology of Texas, Aquifers of Texas, General Soil Map of Texas, Tectonic Map of Texas, Vegetation/Cover Types of Texas, Industrial Minerals of Texas, and Land-Resource Map of Texas. The website is http://www.beg.utexas.edu/pubs/pubs-teachers.php

Or e-mail at: pubsale@beg.utexas.edu

Texas Parks and Wildlife website for information on the Natural Regions of Texas is http://www.tpwd.state.tx.us/

Guest Speakers:

- Stream Team volunteer to talk about volunteer opportunities and watershed issues.

Service learning:

- Storm drain stenciling
- Litter pickup

Lesson 3.1: What Is a Watershed?

Essential Concept

We all live in a watershed.

Objectives

1. Students will work together to generate a definition of watersheds.
2. Students will identify their watershed address.
3. Students will look at changes to water, an abiotic part of the environment on which all living things depend and how those changes affect living things.
4. Students will discuss changes in water in a watershed caused by erosion.
5. Students will discuss changes in water in a watershed caused by various human uses of the land.
6. Students will explain how a technological solution to a problem can have both benefits and drawbacks such as risks or unintended consequences, and support the explanation using a specific example of aquatic resources in Texas.

TEKS

6.12 E, 7.8 B; 8.11 B

Aquatic Science: 12 A, B, D

Environmental Science: 5 A, B; 9 A

Estimated Time

1- 2 class period

Materials

Science journals

Pencils/pens

Chart paper

Markers

Procedure

1. Do You Live in a Watershed?

Ask the class this question. Have students raise hands to indicate if they live in a watershed. Some students may not know if they live in a watershed or not. Write the word *watershed* on the board.

2. Analyzing Words

Let's look at what the word *watershed* means. Take the word apart. We know that watersheds have something to do with water, because *water* is part of the word.

What could the word *shed* mean? Students may suggest ideas that are far from the topic such as *a small storage building* or *a lean-to*, but probably someone will come up with *something that comes off* as in "The raincoat *sheds* water." Or "The cat *sheds* hair."

So if we know what *water* is and we know that *shed* means *to come off.* Then what would a *watershed* be. (A place where water comes off and flows to other places–it is all the water that drains (comes off) from an area into a body of surface water.)

Therefore, we all live in a watershed. Where would the water in our watershed go? (Runs off into lakes, rivers, ponds, etc. and either eventually reaches the Gulf of Mexico or sinks into the ground and becomes part of the groundwater.)

- **How do you know which watershed you live in?** (Your watershed is the land from which water collects in the nearest stream, river, or lake.)
- **When it rains at your home, what stream, or river does the water travel to?**

Ask students to use a map of Texas to trace the nearest river and find their watershed address.

Example:

My watershed address begins with my yard in Austin, and includes Little Walnut Creek, Big Walnut Creek, Lady Bird Lake, the Colorado River, Matagorda Bay, and the Gulf of Mexico.

Ask students to determine their "watershed addresses". This can be done **with a map** that has streams and rivers or river basins marked or can be done **on the Internet** using the following website: http://cfpub.epa.gov/surf/locate/index.cfm

Students put in their zip code, and the website will take them to the nearest watershed(s). If they click on the watershed, it will take them to a site with a labeled drawing and information about their watershed. Write down the name of the watershed. If they scroll down to "Other Watersheds Downstream" and click on the watershed listed it will tell you the next part of your watershed address. Write this information down. Continue to that site, click on the next "Other Watersheds Downstream" and it will take you to the next part of your address. Continue in this way until you get to a bay, which feeds into the Gulf of Mexico. This list of watersheds will be the watershed address.

Alternate Internet Method:

Students may also go to Google Maps, type in the home address. Students must find the nearest creek or river, you might have to alternate between map and satellite views to find the nearest creek. The creek will be the first part of the watershed address. Ask students to zoom out and follow this creek to where it joins a river, record each river/lake that you find, continue to follow the river to the next watershed until it takes you all the way to the Gulf of Mexico. When all watersheds are listed the student will have the watershed address.

3. Erosion, Non-Point Source Pollution and Point Source Pollution

Watersheds collect the water, an abiotic part of our ecosystem, that makes it possible for humans, plants, animals, and other organisms to live and survive, but water often travels a long way in Texas and a lot can happen to the water before it reaches the Gulf of Mexico.

Make a Chart

Ask students to predict how chemical, organic, physical, and thermal changes in this abiotic part of the environment affect the living things that depend on the water in your watershed. (Write ideas on chart paper and come back to check them at the end of the lesson.)

Have students take notes in their journals as you discuss the following questions.

- **How does what happens on land in the watershed in our area affect the water in [name your local lake, stream, wetland, or estuary]?** (Water draining off of the land in our area may become muddy, or pick up pollutants.)
- **What makes water muddy?** (Soil eroding away and washing into bodies of water)
- **Is muddy water bad?** (Muddy water has sediments. If there are too many sediments in pond or stream water, plants cannot get enough light to grow and will die causing decay and oxygen depletion, killing off other living things.)
- **What other things could happen to the water in your watershed?** (Anything that happens on the land can cause changes in water in our watershed to make it unusable by humans and other organisms in the environment. For example:

All of the following cause non-point source pollution.

1) Loss of plants from overgrazing or drought causing erosion
2) Feces from animals, which adds nitrogen to the water
3) Phosphates from detergents from washing machines
4) Acid rain caused by older unregulated coal fired electrical generating plants
5) Automobile exhaust
6) Oil, gasoline, and tire dust runoff from roads

Both of the following can cause point source pollution.

1) Chemical spills from a factory
2) Water used for cooling at power plants which can release thermal pollution

- **What land uses have you seen along your stream, or river, lake or bay, or along the Gulf of Mexico?** (Ranches, chemical plants, oil refineries, farm fields, feedlots, factories, highways, parks, etc.)
- **How would the ways humans use the land affect the watershed? (**Everything that happens to the land goes into the watershed during rain, runoff, and infiltration. All of the above land uses create changes in the water in our watershed. Even parks contribute litter, runoff and erosion to the environment.)

Go back to read the chart of predictions that students made at the beginning of the lesson. Are there things that students would like to add or change in their ideas of how chemical, organic, physical, and thermal changes in water can affect the living things that depend on this essential abiotic part of the environment?

4. Thinking of the Future of our Watershed

Ask students to write a paragraph analyzing and discussing the following questions. Students should use the information on the class chart to help them think about the questions.

- How do you think that more people living on and using the land would affect the water flowing through a watershed?
- How do human activities such as fishing, transportation, dams, and recreation influence aquatic environments?
- How can a technological solution to a problem have both benefits and drawbacks such as risks or unintended consequences? What might be a specific example of consequences for aquatic resources in Texas.

Vocabulary:

- Drains
- Erosion
- Non-point source pollution
- Point source pollution
- Runoff
- Sediment
- Watershed

Lesson 3.2: Topography and Watersheds

Essential Concept

The topography of the area forms the watershed providing places for water to collect.

Objectives

1. Students will use a topographic map to find the height of a geographic feature.
2. Students will use a topographic map to help them create a model of a watershed.
3. Students will predict where water will flow off of the model watershed.
4. Students will predict where water will pool in the model watershed.
5. Students will identify factors that contribute to how water flows in a watershed.
6. Students will decide where to build a house in the watershed model based on the places where water will flow and where it will pool.
7. Students will look at the affects of pollution in different places in a model watershed.
8. Students will define point-source and non-point pollution.

TEKS

6.1 A, B; 6.3 B, C; 7.1 A, B; 7.3 B, C; 7.8 C; 8.1 A, B; 8.3 B, C; 8.9 C;

Aquatic Science: 2 H; 4 A; 7 B

Environmental Science: 5 A, B

Estimated Time

1 class period

Materials

<u>For Each Group of 6 Students</u>

Oil based clay

Scissors

Plastic knife

Topographic Map of Buffalo Hill

Topographic Map of Green Hill Point

Disposable aluminum cookie sheet or rectangular cake pan

Wax paper

2 Spray bottles with water

2 two-inch dowels cut in one-foot lengths or other roller to flatten clay

Paper clips for each student

Construction paper

Paper towels

Newspapers

Food coloring (green and red)

Blue, red, yellow, and green pens or colored pencils

For high school: http://www.topoquest.com/ (Source for topographic maps)

Special Instructions

Copy topographic maps, collect materials

Safety Precautions

Students should use caution with scissors and plastic knives.

Procedure

1. What Is Topography?

A watershed is all the land that drains water into a particular water body such as a wetland, stream, river, lake, bay, or ocean. Topography is what we call the contours of the land like hills, cliffs and valleys. Notice the parts of the word ("top" like the **surface** of the land and "ography" which means to study or to map). A topographic map shows the contours of landforms and elevations in a watershed. There are 2 simplified maps at the end of the chapter to help students learn to use a topographic map and to understand how it creates a 3 dimensional representation of the land.

Note: For older students, you may want to get professional topographic maps online. One source is http://www.topoquest.com/. You can request a map of your area.

Divide students into groups of 6. Give each group the 2 topographic maps. Have students decide the highest elevation of each landform represented and write the height in their journals.

Each line on the map is called a contour line and is an interval representing a certain amount of rise in elevation. On our simplified maps each interval represents 25 feet.

- **What do these maps tell us about the land?** (Students may notice that some lines are closer together than others. These represent steeper sides of the hill. They may notice that where contour lines are farther apart, there are some flat places on the hill. They may notice that some places are more carved out, which may indicate a softer rock or more exposed soil which is eroding faster than surrounding rock.)
- **What does the map tell us about where water will run off in this watershed?** (Water will flow off of the hills and down into the lower levels to the pan, which represents a valley. Students may notice places where water might accumulate in puddles on the way down the hill, or places where they think water may run off faster than other places.)

2. Building a Model

Each group of 6 students will construct a three-dimensional model of the two hills in a disposable aluminum cookie sheet. Three students from each group of six will use one of the topographic maps to make a model of a high point in the watershed. The two hills will sit in the same pan representing two drainage areas both feeding into the valley (pan). Place one hill at each end of the pan.

Students will use the topographic maps as patterns for their models. Have students cut around the largest contour line on their map with scissors. They will roll out the layers of clay to about ¼ inch thick. **Note:** Put the clay on wax paper to keep it from sticking to the desk, lay the largest layer of the landform (represented by the largest contour line) on the clay and cut around it with a plastic knife then place this layer in the aluminum pan.

Students will roll another piece of clay flat. Cut around the next largest contour line with scissors, lay this on the clay and cut around it with the plastic knife. Stack this layer on top of the first layer of clay.

Students will continue to cut away one contour line at a time from the paper map, use it as a pattern, and cut the clay for the next layer until all of the contour lines have been cut from clay and stacked as they were represented on the map. The clay will then represent the hills and valleys in this watershed.

- **Did your model look like what you expected from looking at the topographic map?**

3. Predicting Runoff in a Watershed

After the clay models are complete, have each group work together to predict how they think water will flow off of the hills and into the valley. Students should write their predictions in their journals.

- **How will water move through your watershed?**

(**Note:** Depending on how carefully students match the orientation and position of each interval, the watershed models may be slightly different in position, height, and slope as well as differences in the relationship between the two hills. Therefore, students may see varying patterns of runoff and accumulation of water between groups.)

Give out the appropriate topographic map to each student for the hill that they helped construct.

- **Where do you predict the most water will run off?** Mark these places on your map with a yellow pencil.
- **Where do you predict water will collect in your watershed?** Mark these places with a blue pencil.

Based on their predictions, where do students think would be the best places to build houses.

Have each student cut a house shape from construction paper and write their name on the back of the house. Using a paperclip, have each student place his/her house in the place on the model where they think they would like to live. Ask students to note with a red pencil on their maps where their houses are located.

4. Modeling Runoff and Accumulation

Have students take turns with the spray bottles squirting water to simulate rain on the hills. Be sure that the rain falls on all parts of the hills.

Have students carefully observe the behavior of the water. Ask them to describe where the water went as it fell on their model watershed. (The water will run down from the high points through the crevices in streams until it reaches the low areas in the watershed, where it will accumulate.)

Have students indicate with a black pencil on their maps where they see water actually running off. Is it in the places that you thought runoff would occur? Then note if their house is in a place where water accumulates or if it is in an area that gets a lot of runoff.

- **Did the water flow where you thought it would?**
- **What factors affected the places where water flows?**
- **Were there some surprises in how water moved or accumulated? What caused these unexpected results?**
- **Did the house they built survive? Was it in a place that might flood or have water run through it?**
- **Were their predictions of where water runoff would occur and where water would collect correct? If not, what was the variable that influenced the runoff and collection that they might not have considered?**
- **Did all of the water run off in the same place? What happened? Why?**

5. Where Does Pollution Go?

Ask students to place 1 or 2 drops of green food coloring to represent pollution at the top of the hills and in 4 other places in their watershed. Simulate rain again. Have students use a green pencil to mark their topographic maps with the locations where they put the pollution and draw lines where the pollution ran off and accumulated.

The colored runoff represents non-point source pollution—water pollution that comes from a broad area or a number of sources.

- **What happened to the pollution when it rained?** (No matter where the pollution is located on the hill, it will accumulate in the water at the bottom of the hill.)

If we had pollution in just one place, perhaps from a factory on the side of a hill, that would represent point source pollution. Add 5 drops of red food coloring to one location in the watershed to represent point source pollution. Provide another rainstorm on the watershed.

- **What happens to the pollution when it rains on the top of the hill?**
- **How do we know if the pollution gets into the water at the bottom of the hill?** (The water will change color from green or red to brown when the two types of pollution mix.)

Emphasize that any pollutant on the land of a watershed will be carried by runoff into the main water body of the watershed.

- **If there is pollution in one part of the watershed, how will other parts be affected?**
- **What do we mean by point-source and non-point source pollution? Compare and contrast them and support the answer using a specific example of each that is relevant to aquatic resources in Texas.**
- **If it only rains in one part of the watershed, are other areas affected in any way?**
- **What are the parts of a watershed system?** (Various levels or elevations of landforms, including hills, valleys, various types of soils, wetlands, streams, springs, rivers, lakes, oceans)
- **How does the watershed affect the water body into which it drains?**
- **How do human activities affect the quality and quantity of water in a watershed?**
- **Why do we need a model to understand watersheds?** (Watersheds cover large areas, which can be observed all at one time. A model makes observation easy.)
- **How is this model like a real watershed?**
- **What are the limitations of the model?** (Clay does not allow any water to soak into the ground to show groundwater accumulation. In addition, clay doesn't erode. The size and variety of landforms is limited, squirt bottles cannot represent a hard rainstorm very well, etc.)
- **What other things would be found in a watershed that were not used in our model**? (Potential sources of pollution may include dumps or landfills, farms or animal-feeding operations, golf courses, farms, lawns, and other places that may use fertilizer, sewage treatment plants and other known point sources. In addition, non-point sources of pollution might include highways and mall parking lots, mines and other areas of land disturbance such as construction sites. Also note features that may have positive impacts, such as forested areas, grasslands, or other less-developed areas.)
- **How would roads affect runoff in a watershed**?
- **How would cities affect runoff in a watershed**?
- **What do we mean when we talk about impermeable surfaces?** (These are hard surfaces where water cannot soak in or get through such as parking lots, buildings, roads, or any paved area.)
- **How would grasses, trees, and other plants affect runoff in a watershed**? (Ask students to talk about any examples they have given and how they could positively or negatively affect the watershed.)

Note Preparation for the Next Class: Have students clean up water, ball up clay for use by other classes, and dispose of used materials properly.

Vocabulary

- Accumulation
- Impermeable surface
- Non-point source pollution

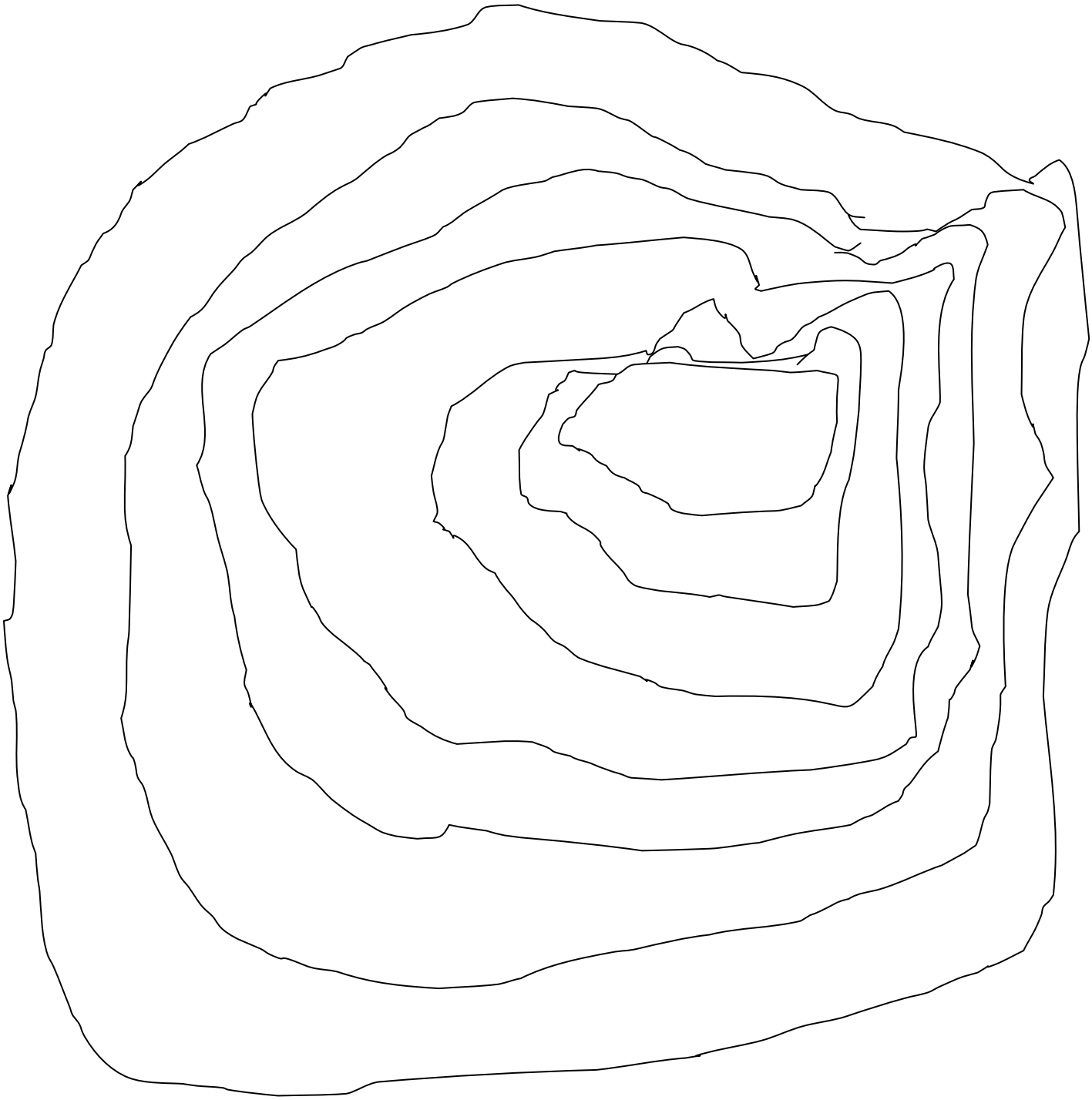
- Point-source pollution
- Runoff
- Topographic map
- Topography
- Watershed

Topographic Map of Buffalo Hill

Each interval = 25 feet

Beginning elevation 100 feet. **North** ↑

How tall is Buffalo Hill?

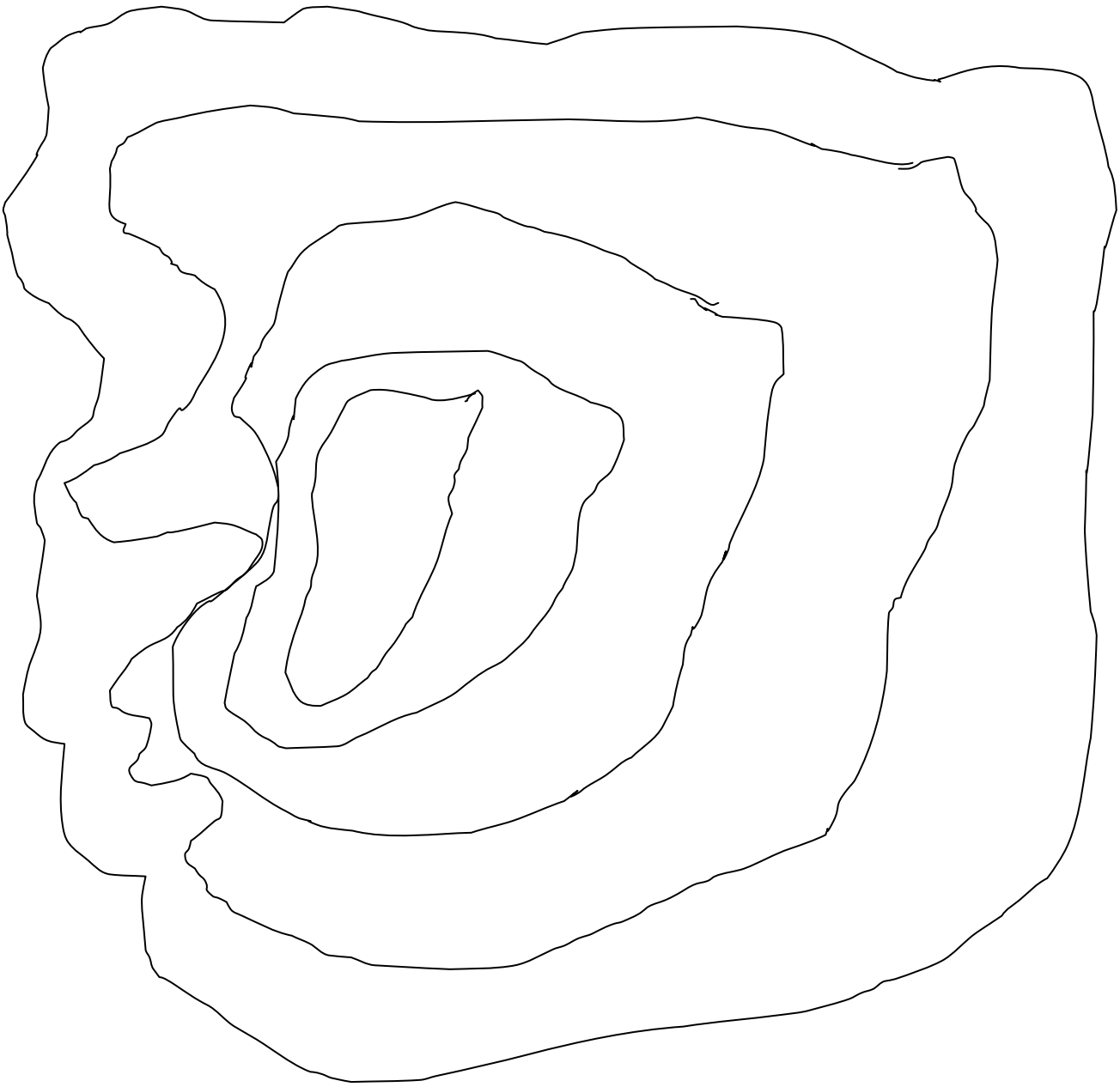


Topographic Map of Green Hill Point

Each interval = 25 feet

Beginning elevation 100 feet. **North** ↑

How tall is Green Hill Point?



Lesson 3.3: Land Use in our Watershed

Essential Concept

School grounds are part of our watershed and we need to maintain the grounds in order to reduce erosion and pollution.

Objectives

1. Students will take part in a scavenger hunt to look at land use and pollution where water flows from the school grounds into the watershed.
2. Students will look at problems on the school grounds that might affect the watershed.
3. Students will define erosion and sedimentation and analyze how human activity affects erosion and sedimentation.
4. Students will describe the impact of erosion and sedimentation on aquatic resources in Texas.
5. Students will define water quality and support their ideas using a specific example of how humans affect water quality in the local Texas watershed.
6. Students make a map of the school grounds showing erosion and pollution problem areas and will indicate on the map ways they think the class could help alleviate problems.

TEKS

6.1 A, B; 6.2 C; 6.12 C; 7.1 A, B; 7.2 C; 7.8 C; 8.1 A, B; 8.2 C; 8.11 B, C;

Aquatic Science: 2 J; 4 A; 7 B; 12 A

Environmental Science: 2 K; 5 A, B; 9 A

Estimated Time

1 Class period and homework

Materials

Copies of the *What's in Our Watershed?* scavenger hunt and clipboards for each student. If you don't have clipboards, you can use heavy cardboard and a clamp for a clipboard.

Pencils

Science journals

Special Instructions

Copy scavenger hunt for students.

Safety Precautions

Make sure students understand field trip behavior guidelines

Procedure

1. What's In Our Watershed?

Note: This is a good activity to do on a day when you have had a recent rain so that students can see where water is accumulating and running off.

Today we are going to conduct a scavenger hunt looking for places on the school grounds where water flows, infiltrates, or accumulates. We are also going to look at land use and places where something could change the quality of water in our watershed. Think about how these changes might affect organisms that live in our watershed.

Pass out student scavenger hunt sheets.

Take the class outside on the school grounds for a hike and scavenger hunt. Remind students that they are standing in a watershed and that everything around them is part of a watershed, because rainwater falls on everything in a watershed.

Teacher Information for the Scavenger Hunt

1) **What land use do you see on the school grounds? (**Land use in your watershed may include land used for buildings, parking lots, athletic fields, lawns, homes, streets, ranches, gardens, forested areas, etc. In short, anything that is on the school grounds or across the road will be in the watershed.)

2) **Where is water collecting or accumulating on the school grounds?** (There may be low places or puddles near gutters or flowerbeds or in open areas where water accumulates. At some schools there may be a stream or pond nearby where water runs off after a rain.)

3) **Do you see signs of runoff?** (Students may see areas that are washed away or where water has flowed out of flowerbeds or gutters, or perhaps where oil and gasoline or trash and litter washed off of parking lots. Have students point out that when rain falls, water flows over all of the surfaces, picking up whatever contaminants or litter may be present as it moves downhill. This is non-point pollution.)

4) **Where is there a place on the school grounds where soil is eroding? Why is this happening?** (If there is an area where students have walked and left a pathway in the soil where no plants are growing, it may have caused some erosion. There may also be places where gutters have allowed water to run, or where there is no grass or other plants, and soil may have washed away, etc.)

5) **What factors influence water flow through the school grounds?** (Elevation, land contours, erosion, impermeable surfaces, etc.)

6) **What are some potential sources of pollution on the school grounds?** (Parking lots, roads, bare places, places that might have been fertilized such as flowerbeds, eroded areas, trash dumpsters, etc.)

7) **What land uses or features may help reduce or contain pollution?** (Grassy areas, berms, or other planted areas between potential pollution sources and any drainage areas, etc.)

8) **How does non-point pollution get in the watershed?** (All runoff flows into ditches and storm sewers, and directly into streams, ponds, rivers or other bodies of water.)

9) **What short or long term changes may happen to the watershed from the runoff from the school grounds?** (Leaf accumulation, fertilizer in flower beds, insecticide spray, drought causing grass to die and wear away, etc.)

10) **How might these changes affect organisms living in the watershed that depend on water for survival?** (Even seemingly innocent changes such as a build up of leaves on the ground in the fall can result in these being washed into streams, around the school grounds. This can add organic matter to streams, causing eutrophication, which can result in an over growth of plants, cutting off light, causing death of plants, using up oxygen in decay and removing oxygen from the water, leaving other organisms short of oxygen and causing stress or death.)

11) **List chemical, organic, physical and thermal changes to the watershed caused by human land use.** (Fertilizer, pesticide, herbicide, dead leaves, erosion, heat from roads and parking lots, etc.)

12) **What effects on living and nonliving components of the ecosystem might we expect from these changes in our watershed?** (Dead leaves decaying and heat from roads and parking lots can cause a depletion of oxygen, suffocating some organisms. Fertilizer can cause aquatic plants to grow and cut off light to the bottom, resulting in dead and decaying plants, and depletion of oxygen. Pesticides and herbicides can kill organisms in streams. Erosion can cause too much sediment to be suspended in water cutting off light for photosynthesis to plants. The loss of plant life could affect the whole food chain, starving many organisms.)

2. Applying What We've Learned

What's the Problem and How Could We Solve It?

Return to the classroom and have students work in groups of 4 for 10 minutes to compare their findings on the scavenger hunt. Then have each group report to the class on one, or two of the questions. Record results on an overhead or on the board. As each group

reports, have the class add new information that has not yet been reported.

- **What are the problem areas on the school grounds?** (Have students look at the data collected on their hikes and find places where there are problems that might affect the watershed.)
- **What are erosion and sedimentation**?
- **How does human activity affects erosion and sedimentation.**
- **What is the impact of erosion and sedimentation on aquatic resources in Texas?**
- **How could we prevent erosion and pollution or reduce their effects on our school grounds?**
- **What is good water quality and what is an example of how humans affect water quality in the local Texas watershed?**

Ask students to **draw a map** of the school grounds indicating problem areas. Have students note on their maps ideas that they have for preventing erosion and pollution such as placement of trash cans in litter prone areas, planting gardens in eroded areas to hold soil in place, putting in small gravel pathways or trails where students tend to walk and wear away plants, etc.

Student's ideas may be something that you can submit to the PTA for projects they can help students work on or that they can help fund, or there may be projects that your classes can work on together on a few weekends or even during class.

Have students add their idea maps to their science journals and staple or tape their scavenger hunt pages in their journals.

Vocabulary

- Accumulation
- Erosion
- Eutrophication
- Impermeable
- Land use
- Litter
- Non-point source pollution
- Photosynthesis
- Pollution
- Runoff
- Watershed
- Watershed

Student Page

What's in Our Watershed?
Scavenger Hunt

1. **What land use do you see on the school grounds?**

2. **Where is water collecting on the school grounds?**

3. **Do you see signs of runoff?**

4. **Is there a place on the school grounds where soil is eroding? Why is this happening?**

5. **What factors influence water flow through the school grounds?**

6. What are some potential sources of pollution on the school grounds?

7. What land uses or features may help reduce or contain pollution?

8. How does non-point pollution get into the watershed?

9. What short or long term changes may happen to the watershed from the runoff from the school grounds?

10. How might these changes affect organisms living in the watershed that depend on water for survival?

11. List chemical, organic, physical, and thermal changes to the watershed caused by human use.

12. What effects on living and nonliving components of the ecosystem from these changes might we expect in our watershed?

Lesson 3.4: Texas Watersheds, Ecoregions and Physiographic Regions

Essential Concept

The physiographic characteristics of an area affect its aquatic resources.

Objectives

1. Students will analyze data on maps to formulate reasonable explanations related to interrelationships among geology and hydrology of regions of Texas.
2. Students will describe biotic and abiotic parts of an aquatic ecosystem.
3. Students will draw conclusions about the relationships among the characteristics of physiographic regions, watershed, and aquatic environments.
4. Students will explain the relationship between the watershed and the water body into which it drains.
5. Students will identity Texas' ecoregions or physiographic regions and explain how land type may affect Texas' aquatic resources, wildlife, and recreation in and around water.

TEKS

6.2 E 6.4 A; 6.12 E; 7.2 E; 7.4 A; 8.2 E; 8.4 A; 8.11 B

Aquatic Science: 2 J; 3 B; 4 A; 7 B

Environmental Science: 2 K; 3 B; 5 B

Estimated Time

1 class period

Materials

Map 3.1: *Texas River Basins* (watersheds) map

Map 3.2: *Texas River Basins and Major Bays* (watersheds) map labeled

Map 3.3: *Texas Natural Regions* Map

Map 3.4: *Texas Natural Regions and River Basins* (watersheds) map

Map 3.5: *Texas Notable Features*

Download maps here:
http://www.tpwd.state.tx.us/publications/learning/aquaticscience/maps.pdf

Science journals

Pencil/Pens

Computer and projector or Smart Board (optional)

The Keep Texas Wild series explores the last wild places in Texas and how we can preserve them. More at http://www.tpwd.state.tx.us/ (optional)

Special Instructions

Maps on the *Texas Aquatic Ecosystems* website can be expanded or contracted as needed. The teacher can then use these as a part of the class discussion, in a PowerPoint, or on the smart board, PowerPoint, and/or print copies for student use.

Note: Physiographic regions and ecoregions are similar. Physiographic regions tend to have more emphasis on the geography, morphology (history of landforms), and climate. Ecoregions tend to have more emphasis on the environmental conditions, including environmental conditions such as geology, soil, and climate, and geographically distinct assemblage of species, natural communities.

Note: For high school students: You might like to get some maps from the Bureau of Economic Geology. They are detailed and have lots of information on the back. These are 8 ½ inches by 11 inches full color maps and the cost is only 25 cents each. So teachers can afford to get several copies of the maps they want to use and laminate copies for each of their small groups. The maps can then be reused for a number of years. The following are some of the maps available: *River Basin Map of Texas, Physiographic Map of Texas, Geology of Texas, Aquifers of Texas, General Soil Map of Texas, Tectonic Map of Texas, Vegetation/Cover Types of Texas, Industrial Minerals of Texas, and Land-Resource Map of Texas.* The website is http://www.beg.utexas.edu/pubs/pubs-teachers.php

Or e-mail at: pubsale@beg.utexas.edu

Procedure

Pass out copies of maps to students to discuss with their groups.

1. Looking at Watersheds in Texas

Display Map 3.1, the *Texas Watersheds* Map, as students work together to answer the following questions:

Point out that the blue lines on the map are the boundaries of watersheds. Have students notice that there are multiple watersheds in Texas.

- **What part of the state has the least water?** (West Texas)
- **What part has the most water?** (East Texas)
- **In what general direction does the water travel?** (to the southeast)

The counties of Texas are shown in the background on the watershed map from TPWD.

- **Do you see some watershed boundaries that cut through some counties? What would that mean?** (Explain that watershed boundaries do not correspond to political boundaries. In other cases the river of a particular watershed may form

a boundary for example the Red River is the boundary between Texas and Oklahoma and the Rio Grande is the boundary between Texas and Mexico. Therefore the watershed boundaries for those rivers cross state or national lines.)

- **Do you see some counties where watershed borders go through counties so that parts of the county are included in one watershed and parts of the same county are included in another watershed?**
- **What does that tell you about the land in that county?** (There are higher elevations in the area of the boundary line and a divide is formed so that water runs off into two different watersheds.)
- **Does this map show streams and rivers in a watershed for a particular river basin?** (No, but we know the streams in our area feed into the river near us so those streams and rivers are all part of the watershed.) Explain that there are multiple smaller watersheds within every large watershed.

2. Locating our Watershed

Look at Map 3.2: *Texas River Basins and Major Bays* (watersheds) map labeled. This map has a color key.

Ask students to look at the key and work together in a small group to label the major river basins/watersheds.

There are also coastal basins in the color key. We will look at those a little later.

- **Can you find the county where you live? Mark it with a small X on your map. (Note:** The print is too small to read so if students can't find their county, provide Texas road maps where they can find their town and then locate the county it is in. Have students mark their county on the Texas River Basin Map.
- **In what river basin/watershed are you located? Use your county mark and the color key to help you find out.**

Now look at the coastal basins. Notice that each forms a bump on the map along the coastline.

- **What do you think those bumps indicate?** (This is where deltas have been built up by the rivers flowing into the bays and estuaries.)

For High School Students

Use the *River Basins Map of Texas* from the Bureau of Economic Geology. Have students look at the map and explain how it is set up and what the blue, black, and red lines mean. (blue is for rivers, black is for river basins, and red lines indicate annual rainfall areas)

Study the rainfall patterns shown on the map.

- **What is the trend in rainfall across the state?** (Less rainfall in the west and more rainfall in the east)
- **How would that trend affect the various river basins?** (More river basins in the east)

- **Given the direction of the flow of the rivers, what can you conclude about elevations in different parts of the state?** (Rivers running to the southeast indicated elevation is higher in the west and northwest and lower in the southeast.)

Look in the blue table at the bottom of the map. Compare the Rio Grande River Basin in the west with the Neches River Basin in the east. (The Rio Grande Basin is l,250 miles long and has an area of 48,259 square miles with 3 reservoirs that can hold 3,772,000 acre feet of water (78 acre feet of water storage per square mile). The Neches River Basin is 416 miles long and has an area of 10,011 square miles with 4 reservoirs that can hold 3,455,500 acre feet of water (345 acre feet of water storage per square mile). This means that The Neches Basin, while $^{1}/_{3}$ the length of the Rio Grande Basin, and ¼ the area, has 1 more reservoir, but a similar amount of conservation storage, but 5 times the acre feet of water storage per square mile reflecting the greater rainfall in that part of Texas.)

Note to the Teacher: Any subset of data in the table can be used for this high school question, or each group might use a different subset of data.

High School: Going Deeper

Have students read the back of the River Basin Map of Texas from the Bureau of Economic Geology and take notes. Each student should come up with at least 3 facts that tell us something of interest about the river basins and their impact on aquatic environments. If you would like to do this in class, you could assign a paragraph or two to each pair of students and have them report back to the class on the important points in their paragraph(s). Give students 10 minutes to read and discuss their paragraph(s). Then follow with reports to the class. Have students take notes in their science journals. Have students use the information to make generalizations about the river basins of Texas.

3. Texas Ecoregions

Give students Map 3.3: *Texas Natural Regions* map. These are the ecoregions used by biologists and are classified by the interacting geology, hydrology, and biology of each area. Assign each group of 2-3 students to go online and research information for one of the eleven natural regions of Texas.

Students should answer the following questions in their report to the class on their assigned natural region. http://texastreeid.tamu.edu/content/texasEcoRegions/

- **How are the geological characteristics of each region related to the hydrological characteristics found there?**
- **How are the hydrological characteristics of each region related to the aquatic environments of the area?**
- **How do the aquatic environments available determine the organisims that are able to live in the area?**

Have each group answer the questions as they share the characteristics of their region

with the class. Ask the class to take notes in their journals on each region.

Based on your notes of the reports to the class, answer the following question in your journals.

- **What are Texas' ecoregions and how might land type affect Texas' aquatic resources, wildlife, and recreation in and around water?**

<u>For High School: Connecting the Ideas</u>

Use the *Physiographic Map of Texas* from the Bureau of Economic Geology. Look at the table at the bottom of the map as you examine the map.

- **What generalizations can you make about the geological, hydrological and biological history of the state?** (The Gulf once covered a good part of the state leaving behind sandy soils and muds, chalks, limestone and dolomites. A long fault line divides the state nearly in half with the uplift to the north away from the Gulf. There are mountains to the west and plateaus to the north. At some point the central part of the state was uplifted and eroded away leaving evidence of many faults, volcanic activity and metamorphism. The northern part of the state is high, flat mesas and plains. This geological history has important influences on stream flow directions and patterns, river valley formations, and soil types. All of this, along with the rainfall data we looked at in the *River Basin Map of Texas*, would influence plants that grow in each area, which in turn influences the types of other organisms that would be able to survive.)

Read the back of the *Physiographic Map of Texas* to get more detailed information and to check your ideas. Make additions to your paragraph when you find data to support other ideas. (This can be done in small groups in class with each group taking one physiographic region, or as a homework assignment.)

- **How might a river change as it flows from one physiographic region to another?**
- **How might a river that flows over many physiographic regions be different as it meets the ocean than one that flows through just one or two physiographic regions?**

If students seem interested, other maps from the Bureau of Economic Geology can provide a source of more information that can provide a rich background for understanding Texas' diverse aquatic ecosystems.

4. Comparing Ecoregions with Watersheds.

If we put the watersheds (river basins) map over the top of the ecoregion map, we would have a map that looked like Map 3.4: *Texas Natural Regions and River Basins* (watersheds) map.

Draw the students' attention to your school's county. Discuss the following questions as a class. Ask students to take notes to use in writing a paragraph in their journals.

- **In which watershed is the school located?**
- **What natural region is the county in?**

- **What influence do these two factors have on aquatic environments?**
- **How do the geological, hydrological, and biological systems relate to the aquatic environments in our county?**

5. Writing About Relationships Between Ecoregions and Watersheds

Have students use the answers to these questions to write a paragraph in their journals summing up what they have learned about the relationship of watershed and eoregions on aquatic environments found in their county.

Extension

Compare Map 3.5, *Texas Notable Features* (which shows geological features in relief) with Map 3.1: *Texas River Basins* (watersheds) map.

- **How are some of the notable features related to river basins?**

Vocabulary

- Hydrological
- Physiographic regions
- River basins
- Watershed

Lesson 3.5: Reading and Research

Essential Concept

Everything that happens to the land affects the watershed and the body of water into which it drains.

Objectives

1. Students will read background information on watersheds.
2. Students will answer questions about watersheds
3. Students will draw a poster to inform and motivate the public to take action to control effects of erosion and various pollutants on organisms that live in water.

TEKS

6.12 E, 7.8 B; 8.11 B;

Aquatic Science 7 B; 12 A

Environmental Science; 5 B; 9 A

Estimated Time

Varies—class time may be provided or reading may be assigned as homework. Allow at least 20 minutes for in-class questions and discussion.

Poster can be done at home as homework.

Materials

Student Guide

Science journal

Pens or pencils

Posterboard

Various art materials of the student's choice

Procedure

1. Student Reading

Have students read *Chapter 3: Watersheds and the Land*. 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) What is a watershed? Which watershed do you live in?

A watershed is all the land that drains water into a particular body of water. Students should know their watershed by the time they do this lesson.

2) How does the watershed affect the water body into which it drains? How do human activities affect the quality of water in a watershed?

What you do to the land, you do to the water. Everything that happens on the land in a watershed affects the water body into which it drains. A stream, pond, or wetland can only be as healthy as its watershed. How we use the land affects the health of our aquatic resources. As water runs downhill, it picks up whatever is on the ground. When it flows through cities or across fields and pastures, water picks up sediment, pollutants and heat. These contaminants flow into a stream, wetland or lake you use to swim in, fish from, or from which your drinking water comes.

3) What is point-source pollution? What is non-point pollution?

Point-source pollution is contamination that can be traced to a single source. Non-point pollution is water pollution that comes from a broad area or a number of sources.

4) What is erosion? What causes it?

Erosion is the wearing away and movement of solid material such as rock, soil, or mud. It is a natural process caused by the forces of wind, water, ice, gravity, and/or living things.

5) What is sediment? Where does it come from?

Sediment is any bit of rock or soil that is suspended or carried in water. It comes from eroding rock, soil, or mud.

6) How does human activity affect erosion and sedimentation?

Human use of land changes it and may lead to erosion, which causes sedimentation.

7) What is the impact of erosion and sedimentation on aquatic resources?

Erosion impacts soil fertility and water quality. Erosion allows sediments to run into aquatic habitats causing deposits in streams and filling reservoirs and can make it difficult for aquatic organisms to get enough light and oxygen to survive.

Erosion can be accelerated by cutting down too many trees, poor grazing practices, or disturbing land for construction. Planting trees and placing erosion controls along streams and rivers are two ways to slow the effects of erosion. Many Texas farmers and ranchers have worked to improve farming and grazing practices and reduce the amount of soil and other sediment in Texas streams.

3. Challenge Question

Ask students to think about the following questions and write a paragraph in their journals to discuss these ideas.

- **How does your location within a watershed affect the quality of water where you live, and how can you influence the quality of water where others live in your watershed**

4. Using What We've Learned: Making a Poster

Ask students to use posterboard and art material of their choice (markers, crayons, water colors, tempera, colláge, etc.) to make a poster depicting the plight of organisms in water where the watershed has brought in too much sediment, pollution, or heat.

Students should show where the contaminant is coming from and how it affects life in an aquatic ecosystem.

The poster should motivate people to help keep water clean and indicate specific actions to take to protect our water.

Note at least 3 sources of information on the back of the poster.

Give students the Rubric for Posters before they start their work so that they know what is expected of them.

Note: If you wish to make this competitive you might have a prize. For example, posters might be displayed in the hallway for a vote on "Student Favorite Pollution Poster" with the winner receiving an "Earth Day" T-shirt or some other prize. Be aware that some students feel threatened by competition. Research shows that girls, in particular, are often uncomfortable in competition. Make the decision on whether to have a competition based on your knowledge of your students.

Vocabulary

- Bays
- Coastal basins
- Estuaries
- Headwaters
- Hydrologist
- Intermittent or ephemeral streams
- Natural physiographic regions
- Non-point source pollution
- Point source pollution
- River basin
- Sediment
- Watershed

Student Page

Rubric for Poster

I. Organization **Total 20 points**

1. Title
2. Clear concise information
3. Organized in a logical way
4. Doesn't need explanation

II. Appearance **Total 30 points**

1. Neat, clean, attractive
2. Easy to read and colorful
3. Information easy to understand
4. Motivates action in keeping the environment clean

III. Accuracy **Total 30 points**

1. Includes at least 1 organism
2. Shows the source of the erosion or pollution
3. Shows the affect of the pollution on the organism
4. Indicates how humans cause the problem

IV. Critical Thinking **Total 20 points**

1. Conclusions are based on logical inferences and generalizations
2. At least three sources of information are noted on the back of the poster
3. Actions people can take to keep water clean are clear

Possible Grand Total 100 points

Chapter 3 Assessment

Directions

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

1. **What is non-point pollution?**
   - **A** A stream that empties into a particular body of water
   - **B** Water pollution that comes from a broad area or a number of sources
   - **C** The movement of solid material such as rock, soil or mud
   - **D** Contamination that can be traced to a single source

2. **What is erosion?**
   - **A** Any bit of rock or soil that is suspended or carried in water
   - **B** Water pollution that comes from a broad area or a number of sources
   - **C** The movement of solid material such as rock, soil or mud
   - **D** All of the above

3. **What is a watershed?**
   - **A** A stream that empties into a particular body of water
   - **B** The area where precipitation first collects in tiny trickles too small to create a permanent channel
   - **C** A stream that flows all year long
   - **D** All the land that drains water into a particular body of water

4. **What is point-source pollution?**
   - **A** A stream that empties into a particular body of water
   - **B** Water pollution that comes from a broad area or a number of sources
   - **C** The movement of solid material such as rock, soil or mud
   - **D** Contamination that can be traced to a single source

5. **What is sediment?**
   - **A** Any bit of rock or soil that is suspended or carried in water
   - **B** Water pollution that comes from a broad area or a number of sources
   - **C** The movement of solid material such as rock, soil or mud
   - **D** None of the above

Chapter 3 Assessment

Directions

Write your own answer for each of the following questions.

1. What is the watershed address of your school?
2. Identify and describe the natural physiographic region in which your school is located.
3. How does human activity affect erosion and sedimentation? Justify your answer using an example relevant to Texas' aquatic resources.
4. Describe the relationship between what happens in a watershed and the water body into which it drains. Support your answer with an example of something that is happening in Texas' aquatic resources.
5. Describe how geological, hydrological and biological parts of an aquatic ecosystem interact.

Chapter 3 Assessment Answer Key

Multiple-choice questions

1. What is non-point pollution?

B. Water pollution that comes from a broad area or a number of sources

2. What is erosion?

C. The movement of solid material such as rock, soil, or mud

3. What is a watershed?

D. All the land that drains water into a particular body of water

4. What is point-source pollution?

D. Contamination that can be traced to a single source

5. What is sediment?

A. Any bit of rock or soil that is suspended or carried in water

Write-in questions

1. What is the watershed address of your school?

Assess locally.

2. Identify and describe the physiographic region in which your school is located.

Assess locally. Refer to Activity 3.4.

3. How does human activity affect erosion and sedimentation and what impact does this have on aquatic ecosystems? Justify your answer using an example you may have read about or seen that is relevant to Texas' aquatic resources.

Answers should include at least one effect of human activity and what impact it has on aquatic ecosystems, and one example of something happening in Texas.

Some possibilities include the following:

Human Activity and Its Effects:

- Deforestation, poor grazing or construction speeds up the natural process of erosion.
- Planting trees and placing erosion controls are two ways to slow erosion.
- Planting trees and other vegetation slows moving water down, and plant roots hold soil and rock in place.

Impacts:

- Sediment can clog streams with gravel and fill reservoirs with sediment.
- Excess sediment blocks out light, killing aquatic plants or preventing their growth.

- Sediment covers up the nooks and crannies aquatic animals live in.
- Sediment smothers fish by clogging their gills and reducing the amount of oxygen in water.

Examples from Texas:

- Texas farmers and ranchers have worked to improve farming and grazing practices to reduce the amount of soil and other sediment in Texas streams.
- Texas developers use silt fences, buffer zones and other erosion controls to reduce the amount of erosion and sedimentation in Texas streams.

4. **Describe the relationship between what happens in a watershed and the water body into which it drains. Support your answer with an example of something that is happening to Texas' aquatic resources.**

   Answers may include:

   Relationship between what happens in a watershed and the water body into which it drains:

   - What you do to the land, you do to the water.
   - Everything that happens on the land in a watershed affects the water into which it drains.
   - A stream, pond or wetland can only be as healthy as its watershed.
   - How we use the land affects the health of our aquatic resources.
   - As water runs downhill, it picks up whatever is on the ground.

   Examples:

   - When it flows through cities or across fields and pastures, water picks up sediment, pollutants and heat. These contaminants flow into a stream, wetland, or lake, affecting the water in which you swim or fish, and you use for drinking.
   - When you flush your toilet, do the laundry, fertilize your lawn or dump used oil on the ground, you are affecting water quality in your watershed.

5. **Describe how geological, hydrological and biological parts of an aquatic ecosystem interact.**

   Answers may include:

   Amount of rainfall and the geology of a particular place including:

   - Topography
   - Rock hardness
   - Soil types
   - Erosional patterns
   - Permeability

   Influence the water characteristics of a place including:

   - The type of water bodies in the area (ponds, creeks, rivers, ground water such as aquifers).
   - Properties of the water such as clarity, and chemistry,.

- Circulation such as the patterns of flow (still to swift).

the water then influences

- What plants can live in that aquatic environment which in turn influences.
- What other organisms can live there.

The geology, soil types, and rainfall amounts also influence:

- What plants can grow on the land along streams and other water bodies, and this influences.
- What other organisms can survive in the land areas along aquatic environments.

In turn, biological organisms influence:

- The erosion of soil and the water in which they live changing the water chemistry and light factors, and the water changes the geology, moving sediments, carving canyons and shaping valleys.