Land Use and Riparian Zone Survey

(Adapted from Texas Aquatic Science Activities, Land Use in Our Watershed and The Hunt for Biodiversity, USU Water Quality Extension Activity Riparian Review, and the U.S. Bureau of Land Management's Riparian Area Management Guide 1737-8)

Classroom time: 20 minutes
Field time: 50 minutes

Purpose

To observe, list and analyze biotic factors affecting a given ecosystem, how land use decisions affect water's impact on the land, and the potential impacts on water quality. Also, students will use field investigation and sampling tools to gather and quantify findings in a field setting. Although this activity describes a riparian area survey, these tools and techniques can be used in a schoolyard investigation and in a variety of other types of study areas.

Summary

Students will identify and observe biotic factors in a riparian ecosystem. This is the green strip (narrow or wide) lying alongside a water body. They will survey the types of vegetation at the water's edge, the function of plants as ground cover and canopy cover, and survey the wildlife in the area. Keep in mind that study areas in urban settings may not resemble wild streams, they may be VERY ephemeral and only flow during or shortly after a rain event, but study of these areas can still reveal much about the health of that portion of the riparian area, and yield many learning opportunities about land use.

Background

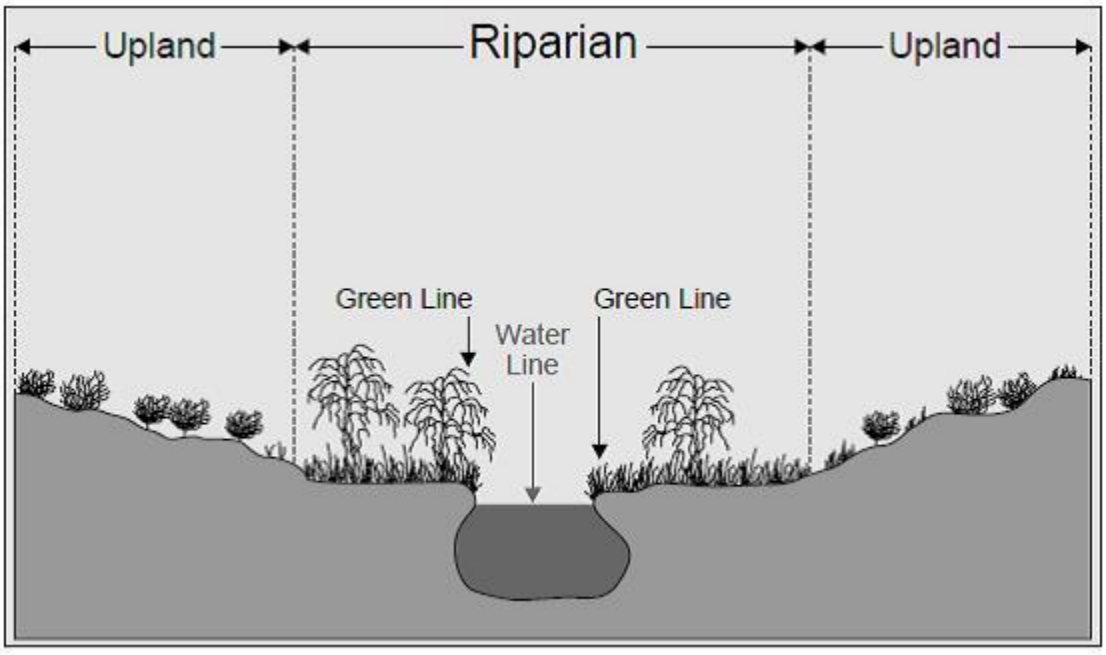
Riparian areas are transition zones between aquatic and terrestrial systems. The plants in this transition zone are uniquely adapted to high water tables and periodic flooding patterns associated with natural aquatic systems. The riparian zone is relatively small when compared to an entire watershed, but are extremely important.

Functions of Riparian Zones

- Bank stabilization and erosion control
- Plant and animal habitat
- Canopy cover
- Nutritive (Organic) input from canopy cover
- Flood control
    - through soils that absorb runoff water,
    - and plants that slow the velocity of runoff,
    - and provide groundwater storage for summertime subsistence and base flows

Classroom Activity

1. Define the term "riparian zone". The riparian zone is the green strip of vegetation along a stream, and includes the animals that live in or use this area. Discuss about why a riparian zone is important to the health of an aquatic ecosystem, natural changes in the riparian zone, and also what humans may do to modify the riparian zone.
2. Define the “Greenline”. The greenline is defined as that specific area where a more or less continuous cover of vegetation is encountered when moving away from the center of an observable channel.



3. Ask the students to list all the biotic (living) factors they can think of in a riparian system (e.g., types of plants, plant species, and animals). How does this community of plants and animals differ from those found in other habitats, like forest, range land, or in your backyard? How are they similar? Learn about plant identification.
4. Explain to the students that they will be going out to a stream site to evaluate the structure and function of the riparian area. These functions include both the riparian vegetation and wildlife. They will also use techniques to observe or find evidence of animal activity.
5. Explain to the students what measurements they will be taking and why.

   • Greenline - they will record the type of vegetation that grows closest to the water’s edge. This is an indication of bank stability.

   • Ground Cover - they will measure types of ground cover in the riparian zone.

   • Canopy Cover - they will measure the amount of shade the riparian plants provide.

   • Wildlife Signs - they will identify animals and signs of animal activity.

Sampling Safety

Kids and water are a natural combination. To ensure the two mix well, consider the following guidelines before going to the stream site.

How do I manage my group in the field?

- Have an adult supervisor accompany each separate group, with six students or less per adult.
- Keep a good line of communication between groups at all times (e.g., stay within hearing distance).
- Be aware of medical considerations.
- Make sure each group has ready access to first aid.
- Know which students are allergic to bee stings and how to handle a reaction.
- Know the causes and early warning signs of hypothermia and heat exhaustion.

What are potentially hazardous conditions?

- Be aware of steep, slippery banks. Holes, vertical banks and other hazards can be especially difficult to see when the banks are very heavily vegetated.
- Scout the area for dangerous trash such as broken glass, rusted wire or metal scraps. Flag areas to avoid, if necessary.
- Scout the area for poison ivy, poison oak and stinging nettles. Make sure everyone in the group can identify these plants.

When is it unsafe to enter the stream?

- Moving water is deceptively dangerous. Don't let students enter water over their knees or water that is moving very fast (more than 1 foot per second).
- If you suspect your stream is seriously polluted, contact your local County Health Department or local Division of Water Quality office to determine if your stream is safe for student monitoring.
- Never sample during a lightning storm and beware of sudden storms higher in the watershed which could produce flash floods.
- Students should not enter the stream without proper clothing (waders, or good wading shoes and a change of clothing).
- Some streams in Texas have whirlpools, drop offs and/or shifting sandbars. Be aware of those hazards, use the buddy system, and bring along a throw able life preserver and whistle to use to alert others.
- Never let students enter water if enough adult supervisors are not present.

What are the chemical safety guidelines?

- Avoid contact between chemicals and eyes, nose and mouth. When opening the chemical packets, always use the scissors provided or tear the packets. NEVER open the packets with teeth.
- You may wish to wear latex gloves and goggles when conducting chemical tests. Gloves and goggles are included in your supply tub. Cover test tubes with stoppers, not fingers, when mixing.
- After handling chemicals, wash hands thoroughly. Use lots of water, and avoid no-water cleaners.

Field Behavior

Volunteer water quality monitoring is a great tool for building appreciation and respect for our natural resources. Consider whether the actions of the entire group – teachers, students, volunteers – work towards this goal. Give careful thought to the following:

How can we help the wildlife and resources of our site?

Groups of people, both small and large, have the potential to impact the aquatic and terrestrial environment in a short amount of time. Follow these guidelines to lessen your impact.

- Choose a site with well-vegetated banks. Avoid bare or unstable banks to minimize erosion.
- Avoid monitoring during particularly wet weather. Wet soils and plants are easily disturbed.
- In the summer, if the water is low, the stream bed may be the best route for walking. The vegetation on the banks will thank you for it!
- Replace rocks and logs that have been overturned – these are homes for many critters.
- Handle organisms gently. They'll appreciate being returned quickly to their homes.
- Place aquatic organisms directly into water-filled containers for study. Keep the containers shaded so the sun doesn't heat the water to harmful levels.
- Look for fish spawning areas – redds. Redds are round or elliptical areas of clean gravel about 1-3 feet long. They provide great opportunities for discussion but avoid walking near them.

What should we know about collecting live samples?

Consider the impact of collecting (permanently removing) macroinvertebrates or other animals and plants from the site. Removal of a few items may have a minimal effect on the environment. However, students learn from the respect leaders show for each individual creature. Discuss the following aspects of collecting with students.

- Disturb animals as little as possible. The best place to learn about them is in their natural environments.
- Encourage your students to investigate freely but collect only with a purpose. Collecting should support instruction or other meaningful activities.
- Ask students to help decide whether and what to collect.
- Collect only specimens that are abundant. Talk with your local Texas Parks and Wildlife Department Regional office to find out if there are any rare or endangered species in or near your stream.

Where to Sample

1. Select a stream

- Involve your students in selecting a stream. This will help foster a sense of ownership for the stream and the program.
- If possible, locate a stream close to your school – walking distance is ideal. Close proximity allows for greater frequency and flexibility in monitoring, and less expense if you have to bus or carpool. The "stream" close to the school, especially in urban areas, may be VERY ephemeral and only flow during and shortly after rain events. Study of this area can still reveal much about riparian health and land use decisions.
- Local resource management agencies can direct you to interesting sites.

2. Select a sampling site

Here is an opportunity to revisit your monitoring goals.

- If you want to represent the water quality of the entire stream, sample a "representative section." This section will have the common forms of vegetation, bank structure and stream shape for that stream.
- If you want to investigate human impacts, such as heavy development, choose a site where you can compare an impacted area with an unaffected area. For example, to isolate the affect of a potential impact, sample upstream of the activity (which will serve as a control site) and just downstream of the impact. You may also want to sample a third site, farther downstream, to determine the range of the impact. A nearby tributary can also serve as a control site.
- Regardless of your goal, your sampling site should be accessible to everyone in your class and safe.

3. Document your site

If you are going to sample your site again, or report your findings, be sure to document your location.

- Obtain a topographic map of your area. Detailed 7.5 minute (1:24,000) "quad" maps are recommended. To obtain one, check with a local resource management agency (UT Dept of Natural Resources) or camping supply store. You can also print quad maps through the US Geological Survey's web site - http://www.water.usgs.gov/.

Organizing Your Group

What factors will influence how you organize your group?

- What you would like your students to gain from sampling? In some programs each student samples many different parameters. In other programsstudents specialize in one or two parameters and then share their findings with the rest of the class.
- How much stream do you want to study? If you wish to monitor as much of a stream as possible (and you have enough adult supervisors) spread separate monitoring groups over a longer distance.
- How much equipment do you have? More equipment allows you more flexibility. For example, you may choose to create specialized sampling teams, such as a "nutrients team," in which several students, with several test kits, take multiple samples of the same parameter.
- How prepared is your group? Proper classroom preparation allows groups more flexibility in the field; students can operate in autonomous groups (with an adult along for safety) and can run more tests in the same amount of time.
- How large is your group? If you have few students (about 10 or less) then you may want to work together in a single group. Larger groups will find it more effective to split-up to avoid distractions.

Sample Roles

Team leader
- Makes sure team members know and accomplish their tasks.
- Makes sure the group stays focused and on schedule.
- Reads sampling directions aloud and makes sure they are followed.
- Conducts a nutrient test.

Assistant team leader
- Assists in measuring the length intervals.
- Assists in measuring width of the stream.
- Double-checks all measurements.
- Helps with stream velocity test.

Recorder
- Holds the notebook and records all information on "Data Collection Sheets."
- Makes sure group agrees on all results.
- Conducts temperature tests.
- Helps identify macroinvertebrates.

Wader
- Measures depth of stream to determine cross-sectional area.
- Assists with velocity test.

- Collects Dissolved Oxygen sample.
- Assists with macroinvertebrate sampling and identification.
- Conducts turbidity test.

Timer/measurer
- Carries stopwatch and times velocity test.
- Carries tape measure and measures distances (places flags at designated intervals)
- Assists with measuring width of stream
- Conducts pH test

Equipment keeper
- Helps carry tub with all equipment in it.
- Distributes equipment.
- Returns supplies and equipment to the tub; ensures all equipment is accounted for.
- Conducts two nutrient tests.

Field Activity

1. Divide your students into groups of no more than six students.

2. Assign each group with a measurement and provide them with the appropriate materials.

Greenline Group supplies:
- Flagging
- Measuring tape
- Greenline sampling instructions
- Greenline worksheet

Ground Cover Group supplies:
- Measuring tape
- Quadrat
- Ground cover sampling instructions
- Ground cover worksheet

Canopy Cover Group supplies:
- Flagging
- Ocular tube
- Measuring tape
- Canopy cover sampling instructions
- Canopy cover worksheet

Wildlife Signs Group supplies:
- Wildlife observation instructions
- Wildlife worksheet
- Field guides (optional)

3. Explain to the students that each group will take a different measurement and will share their data with each other back in the classroom. Review the sampling instructions for each particular measurement.

4. Have the students fill out the site observations section of the student worksheets and then begin their measurements.

5. Have the students record their results onto the student worksheets. You can choose to have one record keeper per group, or have each student record all the information. You may suggest to your students that they take turns conducting the measurements throughout the process.
NOTE: If time allows, you can have each group do more than one measurement.

Greenline Instructions

Time – 30 minutes
Persons – 6 (3 each side)
Materials –
- Flagging
- Measuring tape
- Greenline worksheet
- Plant guide (optional)

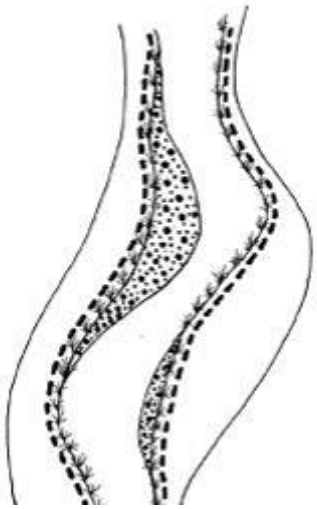
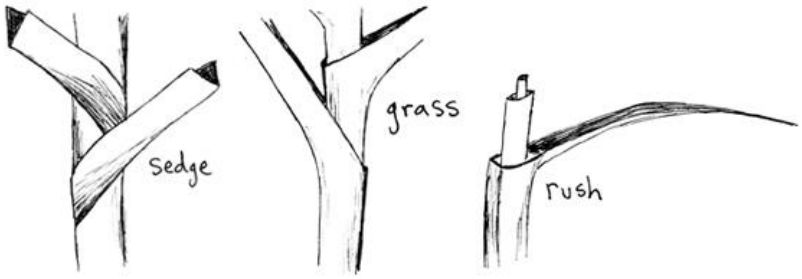


Figure 1 The Greenline Transect

1. Measure a 100 foot stretch along the stream. Place a flag near the water at the beginning and end points.
2. Standing at the first flag, note the vegetation type that is closest to the water and record it in row 1 of the worksheet.
3. Take one pace toward the other flag and stop. A pace is a normal stride you would take while walking. Look toward the water and record the vegetation type closest to the water by placing a slash mark in the appropriate box.
4. Repeat these steps until you reach the other flag.
5. Tally the number of slash marks in each box and record this for each category in row 2.
6. Add up all the observations and record that total in row 3.
7. For each vegetation category, divide the number in row 2 by the number in row 3, and record in row 4. This will give the proportion of the greenline that is made up of that vegetation category.
8. For each vegetation category, multiply the number in row 4 by the factor in row 5 and record in row 6. This will give you the "site score" for each vegetation category. Because sedges and rushes have the strongest roots and prevent erosion the best, they receive the highest factor - "10." Bare ground doesn't prevent erosion so it receives the lowest factor - "1."
9. Add the individual site scores in row 6 to get the "total site score" for that stretch of stream.
10. Compare the site score to the "Site Scores" box on the worksheet to determine the health of the greenline.

Plant Identification Tips

Sedges have edges, rushes are round, and grasses have knees right down to the ground! Forbs are herbaceous flowering plants that are not grasses, sedges, or rushes.



Greenline Worksheet

Name: _____ Group #: _____
Date: _____ Site ID: _____

SITE OBSERVATIONS:
Type of waterbody (e.g., stream, lake, wetland):_____
Water appearance (e.g., clear, brown, foamy, milky):_____
What type of land uses are in the immediate area?_____
What type of land uses are in the surrounding area?_____

	Vegetation Categories				
	Deep Rooted Plants		**Shallow Rooted Plants**		
	Sedges & Rushes	Shrubs & Trees	Grasses	Forbs	Bare Ground
Row 1: Record each observation as a slash mark in the appropriate box.					
Row 2: Total number of observations for each category.					
Row 3: Total number of observations for the entire greenline (sum of all observations in Row 2).					
Row 4: Proportion of each category (divide row 2 vlaues by total in row 3).					
Row 5: Multiply each value in row 4 by the factor in each category. Record in row 6.	X 10	X 8	X 6	X 3	X 1
Row 6: Score for each category.					

Total Score (add up all scores in Row 6):_____

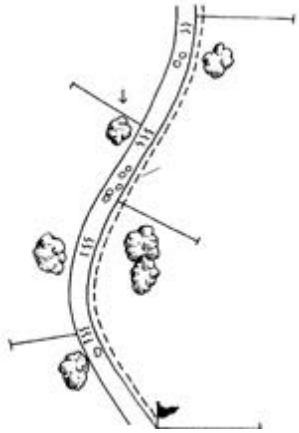
Site Scores
7 - 10 healthy banks
4 – 7 semi healthy banks
0 – 4 unhealthy banks

The higher the score, the more the stream banks will resist erosion.

Ground Cover Instructions

Time – 35 minutes
Persons – 6 (3 each side)
Materials –
• Measuring tape
• Ground cover worksheet

Note: Riparian ground cover transects start at the stream edge and extend 20 paces away from the stream, into the riparian vegetation.



1. You will collect data along five separate transects in your stream stretch, spaced out at approximately equal distances along your stream reach. Each transect should be 20 meters in length. If possible, you should run two transects on one side of the stream and three on the other to get a better picture of the total riparian zone. Refer to the figure to the left for help locating these transects.

2. Begin at your first transect. Starting at the stream's edge, place your quadrat on the ground with one edge touching the transect line.

3. Note the ground cover type you observe. The categories are: live vegetation, litter (dead vegetation or sticks), rocks, or bare ground. Record the types in estimated percentage of coverage for each type. Note that each column on the data chart is for a separate transect.

4. Place the quadrat on the same side of the transect at the midpoint and at the end, for 3 samples per transect. Repeat steps 2 – 3 for each quadrat. Then move on to the second transect. Repeat for all 5 transects.

5. When you've finished with all five transects, add the totals for each row (cover type). This will give you the percentage of each type of ground cover in the riparian zone. To check your math, add your percentages for each ground cover type. They should total 100%.

The percentage of each ground cover type provides a measure of ground cover that can be compared to other sites or used to compare changes over time (between different years or seasons). As a general rule, though, a healthy riparian zone will be covered by a mixture of litter, rock and vegetation. Important exceptions to this are desert streams, which have very sandy banks.

Ground Cover Worksheet

Name:_____ Group #:_____

Date:_____ Site:_____

SITE OBSERVATIONS

Type of water body (e.g. stream, lake, wetland):_____

Water appearance (e.g. clear, brown, foamy, milky):_____

What types of land uses are there in the immediate area?_____

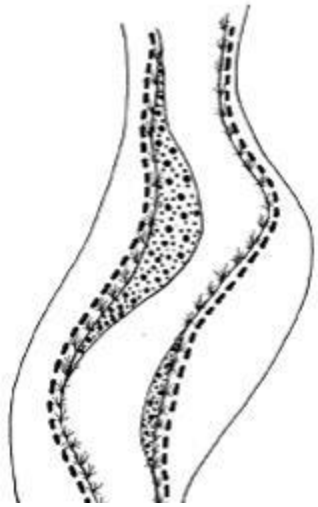
What types of land uses are in the surrounding area?_____

Record the percentage of groundcover by type for each quadrat location. Remember, each quadrat's coverage should equal 100 percent!

Transects Perpendicular to the Stream (3 Quadrats per Transect)																
	Transect 1			Transect 2			Transect 3			Transect 4			Transect 5			Category Total (Average of percentages)
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	
Live Vegetation																
Litter (Dead vegetation or sticks)																
Rocks																
Bare ground																

Canopy Cover Instructions

Time – 30 minutes
Persons – 6 (3 each side)
Materials –
- Ocular tube
- Measuring tape
- Canopy cover worksheet
- Flagging



1. Measure a 100 foot stretch along the stream. Place a flag near the water at the beginning and end points or use the same measurements set out by the greenline group.
2. Standing at the first flag, point the ocular tube straight into the air (90 degree angle) and look through it with one eye. Your partner who is recording data can tell you how to adjust the tube until it is pointing as straight up as possible.
3. Tell the recorder whether the "X" at the end of the tube points at sky (a "miss") or a part of a tree or bush (a "hit"). Record this in the first row on the canopy cover worksheet.
4. Take one pace toward the other flag and stop. A pace is a normal stride you would take while walking. Again, point the ocular tube straight into the air and record a hit or a miss.
5. Repeat these steps until you reach the other flag.
6. Add the total hits and misses and record in the second row.
7. Add the two scores recorded in row 2. This will tell you the "total number of observations" you took along the transect (the greenline). Record this total in row 3.
8. Divide the number of "hits" in row 2 by the total observations in row 3 and multiply by 100. This will give you the percentage of canopy cover for the transect.

Canopy Cover

Name: _____ Group #: _____
Date: _____ Site ID: _____

SITE OBSERVATIONS:
Type of waterbody (e.g., stream, lake, wetland):_____
Water appearance (e.g., clear, brown, foamy, milky): _____
What types of land uses are in the immediate area?_____
What types of land uses are in the surrounding area?_____

	"Miss" (Open sky)	"Hit" (Vegetation)
Row 1: At each step along the water's edge, record with a slash whether you see a "miss" (open sky) or a "hit" (vegetation) in your ocular tube.		
Row 2: Total # of slash marks for each category.		
Row 3: Total number of observations		
Percent canopy cover. Divide total "hits" (Row 2) by total observations (Row 3) and multiply by 100.		

The more covered area available, the more shading the stream receives. This keeps the water cool, provides food for aquatic organisms, and woody debris that falls into the stream provides fish habitat.

Wildlife Sign Instructions

Time – 35 minutes
Persons – 6 (3 each side)
Materials –
• Wildlife worksheet
• Field guides
• Field checklists (optional)
• Magnifying glasses (optional)

Note: Wildlife and birds are shy and may be hard to observe. You may want to send your wildlife observers directly upstream or downstream of your transect so the noise and activity of the vegetation survey won't interfere with their observations. Only do this if it is safe and practical.

1. Slowly walk a 100 foot length along the stream's edge. Look carefully for tracks, scat or other animal signs. Also watch for birds, mammals, reptiles, or amphibians as you walk. Record all species that can be identified by sight or sound on the wildlife signs worksheet. Also note how the wildlife may have been using the riparian area, and the type of observation.

2. Return to approximately the middle of the length of stream you just walked, and walk 20 paces away from the stream's edge. Stand quietly, watching and listening for two minutes. Record all species that can be identified.

3. Slowly walk back toward the stream, looking for tracks, scat or other animal signs. Once you have reached the stream, listen and watch for another two minutes. Repeat this procedure at three points (more if time allows) along the stream.

4. After sampling, spend any extra time investigating the entire site looking for animals or signs of them.

Wildlife Signs

Name: _____ Group #: _____
Date: _____ Site ID: _____

SITE OBSERVATIONS:
Type of waterbody (e.g., stream, lake, wetland):_____
Water appearance (e.g., clear, brown, foamy, milky):_____
What types of land uses are in the immediate area?_____
What types of land uses are in the surrounding area?_____

COMMON NAME	How is it using the riparian area?	TYPE OF OBSERVATION
e.g., American Dipper	e.g., food, shelter, traveling through	e.g., V, O

Types of Observations
V = saw animal
T = track
S = scat
B = bones
O = other sign such as burrow, teeth marks, nests

Discussion Questions

1) **How do the greenline or groundcover measurements help us understand how well the study area soils resist erosion?**

2) **How does the canopy cover affect the physical properties of the stream itself? If your study area was non-riparian, how does the canopy cover affect the vegetation types and percentage of groundcover?**

3) **Why would a stream area be a good habitat for wildlife? Would your study area be a good home to wildlife?**

4) **What land use do you see?**
5) **Where is water collecting or accumulating?**
6) **Do you see signs of runoff?**
7) **Where is there a place where soil is eroding? Why is this happening?**
8) **What factors influence water flow through the study area?**
9) **What are some potential sources of pollution?**
10) **What land uses or features may help reduce or contain pollution?**
11) **How does non-point pollution get in the watershed?**
12) **What short or long term changes may happen to the watershed from the runoff?**
13) **How might these changes affect organisms living in the watershed that depend on water for survival?**
14) **List chemical, organic, physical and thermal changes to the watershed caused by human land use.**
15) **What effects on living and nonliving components of the ecosystem might we expect from these changes in our watershed?**

Discussion Questions (Parenthetical statements are for teacher use in prompting students)

1) **How do the greenline or groundcover measurements help us understand how well the study area soils resist erosion?** (Think about the role roots play in soil stabilization, Fast moving water can cause banks to erode. The greenline is a measure of how well the plants along the water's edge will help the banks resist erosion (bank stability). We determine stability by calculating the proportion of different vegetation types. These are sedges and rushes, shrubs and trees, grasses, forbs, (a non-woody plant that is not a grass), and bare ground. Each vegetation type has a different ability to stabilize the banks due primarily to the depth and density of the roots, and whether they are annuals (die back after one year), or perennials (live through the winter). For example, sedges are perennials that have deep, thick root masses that cling to and stabilize soils, while many annuals have shallow or sparse roots that do not contribute to bank stability.

   In the field, look at the vegetation in areas where serious erosion has occurred compared to areas with stable banks. Think about how different land uses affect vegetation and therefore bank stability.)

2) **How does the canopy cover affect the physical properties of the stream itself? If your study area was non-riparian, how does the canopy cover affect the vegetation types and percentage of groundcover?** (Consider the role shade or full sun plays in the types and density of plants that select to live in your study area. Canopy cover provides shade and is important in keeping water

temperatures low in small headwater streams. Many fish and other aquatic organisms are sensitive to high temperatures, and may disappear from streams that have lost their shade.

The canopy of a stream also represents the leaves and debris that may fall directly into the stream. This external input of material is an important source of food and shelter for the fish and other organisms living in these small streams. The relative importance of canopy cover (both for shade and for input of organic material) decreases as a river gets increasingly larger.)

3) **Why would a stream area be a good habitat for wildlife? Would your study area be a good home to wildlife?** (Consider the evidence of wildlife in your study area and the diversity of plants and habitat)

4) **What land use do you see?** (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.)
5) **Where is water collecting or accumulating?** (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.)
6) **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.)
7) **Where is there a place where soil is eroding? Why is this happening?** (If there is an area where people 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.)
8) **What factors influence water flow through the study area?** (Elevation, land contours, erosion, impermeable surfaces, etc.)
9) **What are some potential sources of pollution?** (Parking lots, roads, bare places, places that might have been fertilized such as flowerbeds, eroded areas, trash dumpsters, etc.)
10) **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.)
11) **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.)
12) **What short or long term changes may happen to the watershed from the runoff?** (Leaf accumulation, fertilizer in flower beds, insecticide spray, drought causing grass to die and wear away, etc.)
13) **How might these changes affect organisms living in the watershed that depend on water for survival?** (Even seemingly innocent changes such as a buildup 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.)

14) **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.) If studying a riparian zone, answers may include: The riparian zone is a very small area compared to the entire land area of a watershed, and humans can have a serious impact on this important ecosystem through different types of activities.

• Clearing: Riparian areas are often cleared for agriculture, logging, or housing and other development. This can lead to destabilized banks, heavy erosion, and loss of stream and riparian functions.

• Introduced species: Many riparian areas are affected throughout the world by introduced species, which take over the riparian area and radically change the habitat. Species such as russian olive, tamarisk, and purple loosestrife may form "monocultures," replacing native plants and resulting in a serious loss of plant and animal diversity and a loss in other riparian functions such as storing and filtering wastes.

• Grazing: While grazing by cattle and other livestock has been shown to be compatible with healthy riparian areas, the type of grazing is extremely important. Most riparian areas can handle short term, "intensive" grazing, with sufficient recovery time. Continuous grazing in a riparian area can limit the plants' abilities to recover and may ultimately lead to loss of vegetation or a change in species.

• Recreation: Recreationalists flock to riparian areas, but may "love them to death." Trampling, multiple trails, wood removal for campfires, and littering all can impair riparian areas.

15) **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.)

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 study area 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.