# Watershed

## Objectives

Students will (1) describe the characteristics of watersheds, (2) discuss the role of watersheds in providing wildlife habitat as well as human habitat, and (3) give examples of watershed conservation.

## Method

Students measure the area of a local watershed, calculate the amount of water it receives each year, and discuss the varied roles the watershed plays in human and wildlife habitat.

## Materials

Six stakes or markers, hammer; two 50-foot (15-meter) measuring tapes, two 100-foot (30-meter) measuring tapes, writing materials, clipboards, large pad of paper for display, local maps showing bodies of water

**Grade Level:** 5–8

**Subject Areas:** Environmental Education, Mathematics

**Duration:** one or more 30- to 60-minute sessions

**Group Size:** small groups of three to five students each

**Setting:** outdoors and indoors

**Conceptual Framework Topic Reference:** HIIIB3

**Key Terms:** runoff, precipitation, watershed, erosion

**Appendices:** Using Local Resources, Outdoors

NOTE: Twine or heavy string can be marked at intervals and used instead of measuring tapes.

## Background

A watershed is an area of land that allows water to flow over or under its surface into a particular body of water. The boundaries of a watershed are determined by the guiding contours of the land surrounding that stream, river, lake, or bay. Because precipitation and its runoff must flow somewhere, all land areas are a part of some watershed. Every home, school, office, business, and industry is part of a watershed.

A watershed is more than just a geological feature. It is a hydrologic system linking all living things within its boundaries. Not only does all plant and animal life depend on the water within each watershed, but also the watercourses are conduits that transport water, organisms, nutrients, and other materials within the system. What affects one watershed eventually affects other sites downstream.

One material moving through the watershed is soil. Because the rivers of a watershed are constantly engaged in the gradual erosion of the highlands that contain it, suspended sediments are part of the natural dynamics. However, human activities can accelerate this process through actions such as land clearing, dam building, farming, and industrial development. Runoff carries the loose soil into the water system, which may affect watershed quality. Significantly increased turbidity can interfere with sunlight transmission, fish respiration, and plant photosynthesis.

Of particular concern are contaminants in the water. Contaminants may be excessive nutrients that overload natural systems, or they may be harmful chemicals introduced into the water.

Both of these problems are often related to agricultural and industrial activities that result in the release of water back into the watershed that has been altered by their use. Fertilizers and pesticides are the major sources of agricultural contamination. Industrial wastewater can contain myriad contaminants from oil to heavy metals.

Contamination of watersheds is a serious problem for humans, but it is as great or greater a problem for wildlife. Most often it is the wildlife—particularly the aquatic wildlife—that suffers the most directly and immediately from contaminated water. Slight changes in pH (acidity) can destroy the natural balance in a body of water. Natural food chains can be damaged for decades by a single contamination.

Water contamination, like water, does not just remain on the surface. As part of the water cycle, watersheds both feed and are fed by ground water. Surface contamination can penetrate into the earth and contaminate water supplies. On a watershed's surface, water can move so rapidly it is often expressed in cubic feet (cubic meters) per second. Below the ground's surface, its movement might be expressed in inches (centimeters) per year. Contaminated ground water can negatively affect a watershed's quality for centuries. Most scientists feel that it is far more economical to prevent contaminants from entering water systems than to clean up pollution after it takes place.

Another human activity that affects watershed systems is the diversion of water from the natural flow of streams, ponds, rivers, and lakes. The growth of human populations in a watershed may result in greater and greater diversion. For example, the need for water and hydroelectric power often motivates the building of dams. Dams may radically alter stream habitat, yet they do provide predictable water supplies for agriculture, domestic uses, and industry. There are obvious benefits and liabilities to consider when making decisions affecting watersheds.

Because watersheds are natural units, they represent a logical basis for managing resources. Traditionally, water quality improvements have focused on specific sources of pollution, such as sewage discharges, or on specific water resources, such as a river segment or wetland. While this approach may be successful in addressing specific problems, it often fails to address some subtle and chronic problems that might contribute to a watershed's decline. For example, pollution from a sewage treatment plant might be significantly reduced after new technology is installed. Yet the local river may still suffer if other factors in the watershed, such as habitat destruction or other sources of polluted runoff, are not also addressed. Managing the watershed unit as an integrated system provides a stronger foundation for uncovering issues that affect it, and it better equips resource managers to determine what actions are needed to protect and restore it.

## Procedure

*Before the Activity*

Select an outdoor site approximately 100 feet (30 meters) square that resembles a small watershed. If possible, there should be a visible drainage pattern. Look around the school or in a nearby park for a site that will suffice. There needs to be enough relief so the students will be able to visualize the watershed concept. OPTIONAL: Research the annual rainfall amounts for your area. Your State climatologist can be found online at www.ncdc.noaa.gov/oa/climate/stateclimatologists.html

1. Using local maps and local stream systems as examples, discuss the concept of a watershed. Topographical maps or raised-relief maps are valuable tools. Emphasize that the size of watersheds varies, from tiny tributaries to river systems as large as the Mississippi. Introduce the concept that a ridgeline is the border between two designated watersheds. Using local maps, show how the boundaries of a watershed can be determined by tracing the ridgelines between adjacent watersheds. To demonstrate this point, use a transparent overlay on a standard paper map, or use water-soluble marking pens on a plastic raised-relief map.

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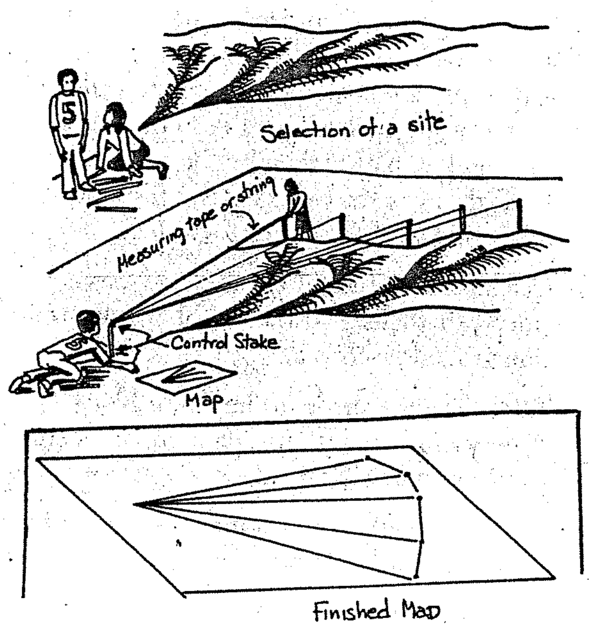


*Diagram A*

2. Explain to the students that they will be going to a small watershed and will be measuring its area in much the same way large watersheds are measured. Show them the equipment that you will be taking along, and explain how five of the stakes will be used to mark the top of the ridgeline of the watershed. Indicate the "control" stake that will represent the bottom of the drainage system. Educators may choose to read the rest of the procedure and illustrate the process of measuring a watershed on the chalkboard before going to the site, or they may use a large pad and markers to review the procedures visually at the site.

3. Upon reaching the site, divide the students into teams of three to five. Determine the ridgeline of the watershed, and drive the stakes or markers along the upper boundary of their watershed. The ridge stakes should be 20 to 40 feet (6 to 12 meters) apart.

4. As a group, have the students determine the location of the control stake at the "bottom" of the watershed. The control stake is the one from which measurements to the other stakes are made. The control stake should be 60 to 100 feet (18 to 30 meters) from the ridge stakes.

5. Begin the measurements that will result in a map of the watershed. Each team should draw a map of this miniature watershed. Ask the students to record their results to scale on a large piece of paper (use about 1/4 or 1/8 inch [1 cm] on the map for each foot [meter] on the ground), as shown in Diagram A. The scale will depend on the size of the paper.

6. Have each team determine the area of the watershed, following these procedures (see Diagrams B and C):

- Turn each triangle segment into a rectangle, and then determine the area by multiplying length times width.

  L × W = Area of a rectangle
  (in square feet/meters)

- Then divide by 2 because the area of the triangle will be 1/2 the area of the rectangle.
- Repeat for each triangle.
- Add the areas of all five triangles together to get the area of the watershed (in square feet or meters).

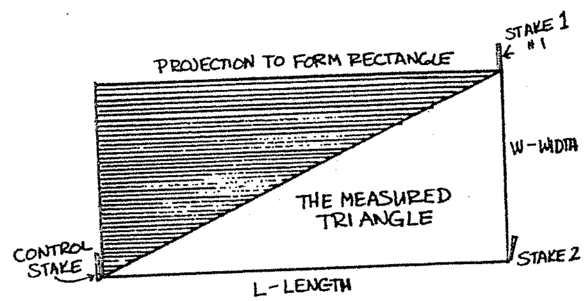


*Diagram B*

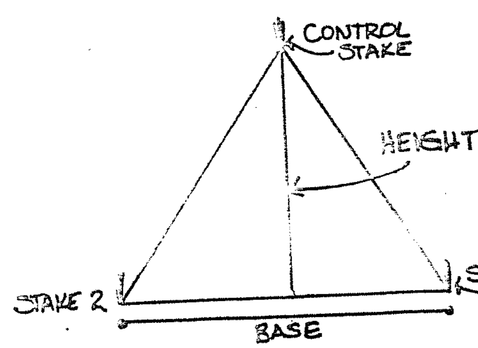


*Diagram C*

Educators may want to use the formula for the area of a triangle: Area = ½ Base × Height

7. As an option, calculate the amount of precipitation that falls on the miniature watershed each year. This is where the value for the annual rainfall is needed. The rainfall value must be expressed in feet (meters) thus:

   Rainfall × Area = Volume of Rain

8. Discuss the following questions with students. How does a watershed work? How does it affect humans? How does it affect wildlife? How is ground water affected by conditions in your watershed? What kinds of things can be done to protect, conserve, and improve watershed quality? What are some of the reasons, if any, to protect and conserve watersheds? What are some of the potential tradeoffs involved? When, if ever, might it seem inappropriate to protect and conserve a watershed? OPTIONAL: Explore an actual watershed where the students live. Identify locations of water diversion from natural pathways, determine the use of the diverted water, and describe the condition of the water when it is returned to the natural drainage.

## Extensions

1. Calculate the total area of an actual watershed in your area using county or state maps.
2. Calculate the total water that falls annually on your watershed.
3. Write a paper on the quality of your watershed.
4. Simulate a watershed. Have students stand in a circle with quart (liter) containers of water, and empty the containers on cue toward the center of the circle. Have the students trace the "natural" paths taken by the water, and see if they can trace the watersheds indicated by the diverse flow pattern.
5. Calculate the amount of rain in gallons (liters) that falls on your school or organization grounds each year.
6. Trace the watersheds of the major North American rivers. Use tracing paper or acetate overlays on large scale maps.
7. On a map, locate the habitat of specific life forms in your local watershed.
8. A noted scientist once remarked that "Human activities speed up the flow of water while nature slows it down." Is this true for the watershed in which you live?

## Evaluation

1. Describe and draw a watershed.
2. How are wildlife habitats related to watersheds? Why are watersheds important to people? Write a short essay in response to these questions.
3. Develop a plan on how to protect, conserve, or restore a watershed.

# Where Does Water Run?

## Objective

Students will describe relationships among precipitation, runoff, and aquatic habitats.

## Method

Students will (1) measure and calculate the area of a study site, (2) calculate the volume and weight of water falling on the study site, (3) determine specific and annual rainfall and runoff, and (4) trace the course of water to aquatic habitats.

## Materials

Writing materials, meter or yardsticks, long piece of twine with marks every yard or meter, rain gauge, local rainfall data; OPTIONAL: calculator, trundle wheel

NOTE: A trundle wheel is a device for measuring linear surfaces. This wheeled device measures yards or meters as it is pushed along a surface. Contact local surveyors or other organizations to check on the availability of trundle wheels in your area.

**Grade Level:** 5–8

**Subject Areas:** Mathematics, Science, Environmental Education

**Duration:** two 45- to 60-minute sessions; one period, if dimensions of the grounds are provided

**Group Size:** any

**Setting:** outdoors and indoors

**Conceptual Framework Topic Reference:** HNIB1

**Key Terms:** runoff, precipitation, volume, area, weight

**Appendices:** Outdoors, Metric Conversion Chart

## Background

Developing an understanding of precipitation and runoff is an important part of understanding the water cycle (see Diagram A). Rainfall is one form of precipitation and is one way water reenters aquatic habitats. Once rain falls upon a surface, water begins to move both laterally outward and vertically downward. Lateral movement is runoff and finds its way into streams, rivers, and lakes. Vertical movement seeps into the soil and porous rock and recharges groundwater supplies.

Runoff waters are necessary to renew the many aquatic habitats that depend on the inflow of water for continuity. Inflow supports aquatic life by preventing lakes from shrinking because of evaporation and by preventing streams from going below minimum flow levels.

Runoff is the dominant way that water flows from one location to another. It is in runoff that many pollutants find their way into moving waters. These types of pollutants are known as "non-point source." Garden insecticides, automobile oils and transmission fluids, paints and exhaust, and such are washed by runoff into streams, rivers, lakes, and oceans. Eventually, this water becomes part of an aquatic habitat.

Runoff is also responsible for the erosion, transportation, and deposition of sediments scoured from the land's surface. Substandard land practices along with development often leave bare ground ready for the topsoil to be washed away. Paving and compacted soil can reduce an area's

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water absorbing ability, thereby increasing runoff. Reduced absorption rates can adversely vegetation and groundwater recharge.

In this activity, the students calculate both the volume and the weight of rainfall and consider relationships between rainfall and runoff, including effects on wildlife and the environment.

### The Water Cycle

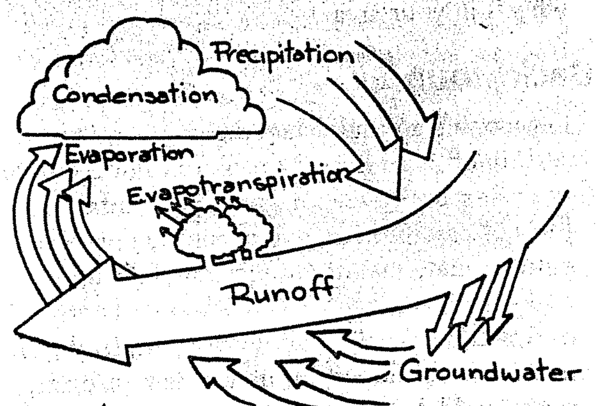



*Diagram A*

## Procedure

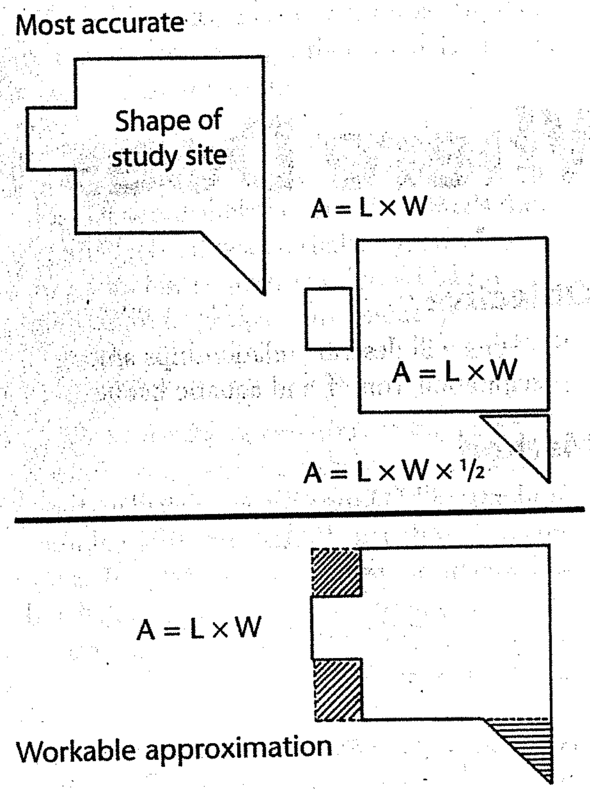
1. Determine the total area of the study site. For this activity, the outer dimensions of the property will be sufficient. There is no need to subtract the area of the buildings because it is assumed that rain falls on them as well.

   The formula for calculating area is
   Area = Length × Width (or A = LW)

NOTE: See the extensions to this activity for metric approximations.

The length and width of the study site must be measured. The students can use a tape measure or a length of twine (approximately 100 feet [30 meters] in length). Mark the twine every 3 feet (meter). The marking can be done with an ink marker, short pieces of string tied every yard, or a knot each 3 feet (meter). If a trundle wheel is available, it is convenient to use for measuring.

The main difficulty with calculating the area in this activity comes from irregularly shaped study sites. Here are a few examples:




2. Once the area of the study site has been established, the next step is to determine the amount of rain that falls in the area. Three options are possible:
   - Calculate the annual rainfall using information from resource agencies (e.g., weather bureau, soil conservation service, local meteorologists, local newspapers).
   - Using a rain gauge, measure the amount of rain over a period of time.
   - Calculate the amount of rain that falls in a given storm.

   When the students have decided on a way to measure the amount of rain that falls during a specified period of time, ask them to calculate the amount. This calculation provides the students with a value for the depth of rainfall on the surface of the land.

3. The next step is to calculate the volume of rainfall. For example, suppose the area of the study site is 50,000 square feet (4,500 square meters) and the annual rainfall is 6 inches or 0.5 feet (15 centimeters or 0.15 meters).

The volume of rain would be

$50{,}000\ ft^2 \times 0.5$ ft of rain
$(4{,}500\ m^2 \times 0.15\ m) =$
$25{,}000\ ft^3$ ($675\ m^3$) of rain

The volume of rain is 25,000 cubic feet (675 cubic meters) of rain.

4. Knowing the volume, the students can now calculate the weight of the rain. Water weighs 62.5 pounds per cubic foot (1,000 kilograms per cubic meter), thus the weight of rain is:

   $25{,}000\ ft^3 \times 62.5\ lbs/ft^3 = 1{,}562{,}500$ lbs
   (or $675\ m^3 \times 1{,}000\ kg/m^3 = 675{,}000$ kg)

5. All measurements and calculations in this activity are intended to impress on students that there are remarkable volumes and weights of water moving through the water cycle. Even short periods of rainfall produce amazing amounts of water. All the water that the students measure eventually finds its way to a wildlife habitat. A major issue of concern is how humans affect the quality and quantity of water that eventually reaches aquatic habitats. Consider and discuss the following questions:
   - Where does the water from rainfall go when it leaves the study site?
   - How much water is absorbed by the different surfaces on the study site?
   - What types of potential pollutants does the water come in contact with?
   - Where is the location of the nearest wildlife habitat that receives the site's runoff?
   - How do people use the water between the time it leaves the site and arrives in the wildlife habitat?
   - What are some of the positive and negative effects that the water may have on the environment at various points on its journey?

## Extensions

1. Obtain a map of the study site from your school or organization, and check it against the accuracy of the one made by the students. Make a copy of the study site map; then use the original map and plot runoff routes on it. Check periodically during rainstorms to identify the drainage patterns. Try to find a way to estimate how much water is draining in specific places.
2. Place a rain gauge on the grounds and measure actual amounts of rain. Repeat your calculations.
3. The contamination of groundwater is also an issue. How might water in the groundwater table or aquifer become contaminated and potentially pose a threat to human health? To the health of other animals, including wildlife? Identify as many possible sources of contamination to groundwater and runoff in your community as possible. What can be, or is being done, to reduce or eliminate these sources and their effects?

## Evaluation

1. Describe at least two relationships among aquatic habitats, precipitation, runoff, and surface water.
2. Identify two human activities that have affected the *quality* of runoff.
3. Identify two human activities that have affected the *quantity* of runoff.
4. Identify two ways that runoff can affect humans.
5. Identify and describe two ways that runoff can affect aquatic wildlife.
6. Write a short list of steps to protect the quantity and quality of runoff water.