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Age Level:
Ages 8 and older

Subject Areas:
Geography, Earth Science, Environmental Science, Mathematics

Duration:
Warm Up: 10 minutes
Activity: 30 minutes
Wrap Up: 10 minutes

Skills:
Analyzing information (comparing and contrasting); Organizing information (plotting data, graphing); Interpreting (relating, summarizing, inferring, drawing conclusions); Applying (designing); Presenting (demonstrating)

Vocabulary:
downstream, headwaters, main stem, precipitation, rain water, runoff, tributary, water flow, watershed

Standards:
Common Core State Standards:
CCSS.ELA-Literacy.RST.6-8.3;
CCSS.ELA-Literacy.RST.6-8.4;
CCSS.ELA-Literacy.RST.6-8.7;
CCSS.ELA-Literacy.WHST.6-8.1e;
CCSS.ELA-Literacy.WHST.6-8.2a;
CCSS.ELA-Literacy.WHST.6-8.2d;
CCSS.ELA-Literacy.WHST.6-8.2f;
CCSS.ELA-Literacy.WHST.6-8.4;
CCSS.ELA-Literacy.WHST.6-8.6;
CCSS.ELA-Literacy.WHST.6-8.10
NGSS: 3-ESS2-1; 3-ESS2-2; 4-ESS2-1; 5-LS2-1; 5-ESS2-1; MS-LS2-3; MS-ESS2-2; MS-ESS2-4; MS-ESS3-4
For additional grade-level and state-specific standards visit www.projectwet.org/cleanandconserve.

Healthy Natural Environments

We all live in a watershed. Can we live upstream and downstream at the same time?

Summary

In this whole-body activity, students investigate how water moves through a watershed and learn how individual decisions affect the health of that watershed.

Objectives

Students will:

- demonstrate the movement of water through a watershed.
- compare and contrast the amount of water flowing through a river and its watershed based on climate (seasonal variations) and weather (precipitation).
- understand how water moves trash and debris through a watershed.
- create a hydrograph based on simulation data.

Materials

Warm Up

- *Wax paper or aluminum foil*
- *Water*
- *Glass or eyedropper*
- *Block (to elevate paper)*

Activity

- *Containers with beads, pea gravel, beans, marbles or similar objects (separated by color)*
- *Large bucket or other large container to collect beads or other objects*
- *Optional: signs on sticks with pictures representing sun, light rain and heavy rain (one of each)*
- *Optional: four chairs*
- *Copies of* ***Graph It!—Student Copy Page***

Making Connections

Children may have heard the term "watershed" but may not understand what it means or how water flows through it. Understanding water's movement promotes awareness of the relationship between water quality, landscape and individual and collective decision-making, including proper trash management.

Background

Often referred to as drainages, basins or catchments, watersheds are the gathering ground of a river system. A watershed is an area of land that drains water toward a common river. Within its boundaries, a watershed includes all of the land, air, soil, surface and ground water, plants and animals, mountains and deserts, cities and farms and people, culture, stories and traditions.

Beginning at the highest elevations of a watershed, runoff (water from rain, melting snow and ice) collects to form rivulets

Water flows from high points to low points throughout a watershed.

that merge into small headwater streams. As headwater streams flow downhill from the sides of the watershed, they gather more water and eventually join to become tributary streams. These tributaries flow into the main stem of a river that, with exceptions such as closed basins, eventually flows to the sea.

During winter in cold climates, precipitation is stored as snowpack (accumulated snow that is condensed and compressed by its own weight). In some mountainous areas, snowpack can reach higher than 20 feet. Very little water will flow into streams at this time; what flow there is generally comes from ground water, springs or periodic snowmelts.

With the arrival of spring and warmer temperatures, the snowpack begins to melt. For several weeks this water—often referred to as the "spring melt" or "spring runoff"—saturates the ground and fills streams. Streamflow will depend on how much snow is present and how fast the temperature rises. If enough runs off at once, flooding can occur at low elevations in the river's floodplain (low area along a river's channel).

Rivers rise as the temperature warms and melted snowpack accumulates downstream. Springs and ground water that have been recharged by melted snow discharge into streams that are also replenished by summer rainstorms. In the dry season, less water flows into rivers and through the streets. However, during the rainy season and heavy rain storms, rain water may carry large amounts of water through a watershed and into rivers, lakes and oceans.

In cities, water from precipitation may collect in gutters and flow downhill through the streets. As the water moves downhill it collects more water from other streets and gutters. Whatever materials are on the streets or in the gutters (e.g., litter, twigs, leaves, oil, road dust) can also be picked up with the water. While some substances decompose, settle out or are filtered by soil, other matter continues to travel long distances downstream into rivers or even all the way to the ocean.

What is a watershed?

A **watershed**, also called a basin, drainage or catchment, is an area of land drained by a river and its tributaries to a common outlet, which may be a closed basin, a larger stream, a lake, wetland, estuary or ocean. (A closed basin is a water body from which water leaves only through evaporation or percolation; there is no surface outlet from this pond or depression, as in the Great Salt Lake, Utah.) Within its boundaries, a watershed includes all of the land, air, surface and ground water, plants and animals, mountains and deserts, cities and farms and people, including their stories and traditions.

Procedure

Warm Up

Ask students if they know what a watershed is. Provide them with the definition.

Once they understand what a watershed is, ask them if they know how water flows in a watershed. (Water flows from high to low in a watershed). Tell students they are going to demonstrate how water flows in a watershed using the following materials: wax paper or aluminum foil, water, a glass or eyedropper and tray to catch the water. Divide students into small lab groups and provide those materials to each. (Optional: Instead of a student investigation, this can be a demonstration.)

Following the steps shown in the "Water on the Move" diagram, guide students through each

Water on the Move

Place a drop of water on a flat sheet of wax paper. Does it run off the paper? If water falls on a flat surface, it may not run off or drain.

In what direction does water flow? Using a piece of wax paper, raise one end. Drop water from a cup onto the paper. It should flow downhill.

How are watersheds divided? Fold your wax paper in the center into a tent. Drip water from a cup onto the peak. Down which side does the water drain? Left, right or both? The peak represents the boundary between two watersheds, and the water flows down whichever side it falls on. Watersheds are divided at their highest points.

Are large watersheds made up of smaller watersheds? Loosely crumple your wax paper. Drop water onto the peak again. Does the water follow a crease or line as it flows? Does it pool in spots? What watershed features could these represent? Large watersheds may contain smaller watersheds.

step, performing it with them as you go.

Use the following questions to guide their investigation or the demonstration:

- Where does water originate in a watershed? (Precipitation.)
- What happens when rain, snow or sleet falls on level ground? (Water infiltrates [soaks into the ground] or puddles.)
- What happens when rain falls on a slope? (It moves from the highest to the lowest point.)
- What primary force moves water in a watershed? (Gravity.)
- Discuss student results.

The Activity
Part 1

1. **Explain to students that they will be modeling the movement of water during different precipitation events.** Note that they will see how water is constantly changing as seasons change and weather affects it.
2. **Assemble students in a branching formation that represents streams/ tributaries and rivers in a watershed.** (See *River Watershed—Teacher Resource Page* on page 37). Students at the top of the "hill" should stand on a chair or arrange students on a slope to simulate the downhill flow of water. There should be four students at the headwaters (standing on chairs) to represent different creeks or river tributaries.
3. **Headwaters streams: At the top of the hill, have two or three students form a short line (fingertip to fingertip, close enough to easily pass beads) leading down the slope.**
4. **Tributary streams: Starting at the headwaters, assemble a line of students leading down slope to represent each of the four tributary streams. These tributaries should touch fingertips and "flow" toward each other, but not connect as a whole yet.**
5. **Main stem of river: Have the remainder of the students line up fingertip to fingertip in a line starting at the river headwaters and connecting the remaining tributaries as the main stem winds downhill.** Explain that these new students represent the river and that all tributaries flow toward it and connect. Have everyone touch fingertips.
6. **At the top of each headwater stream, place a bucket of beads.**
7. **At the bottom of the main stem, place an empty large bucket or other container to receive the beads, representing the sea.**
8. **To help students understand what will happen during this activity, ask students at the top of the headwaters streams to take one bead and hand it to the person below them.** Have

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The Wisconsin River flows into the Mississippi River in Iowa, adding to the main stem of the Mississippi River.

students continue to pass the bead "downstream" until it travels down through the tributaries, the main stem and is deposited in the bucket, representing the mouth of a sea at the bottom. PLEASE INSTRUCT STUDENTS TO ONLY PICK UP ONE BEAD AT A TIME. GRABBING A FISTFUL OF BEADS WILL STOP THE SIMULATION AS THIS WILL CORRUPT THE DATA.

9. **Explain to students that they will now simulate the flow of water through a watershed during a rain storm.** Tell students you will announce various scenarios and they will pass beads accordingly: Light rain (pass one bead at a time), Heavy rain (quickly pass two or three beads at a time), Sun (pass beads VERY slowly). Alternatively you can simulate the melting of snow throughout the year; spring snowmelt is highest with the most flow (quickly pass two or three beads at a time) and winter is lowest with little flow (pass beads slowly).

10. **Begin the scenarios below. Allow each scenario to last one minute (less for small groups). Remove the "sea" bucket after each simulation and set aside to count when finished.** (Optional: Make large signs with symbols for sun, light rain and heavy rain. Attach these signs to sticks and hold these signs up to indicate each scenario. This is especially helpful for large groups.)
    a. Light rain (pass one bead at a time)
    b. Sun (pass beads VERY slowly)
    c. Heavy rain (pass several beads at a time)

11. **At the one-minute mark, all students must stop passing beads. Students may hold onto the beads in their hands and use in the next simulation.** (For smaller groups of students, you may reduce the time to 30 seconds)

12. **Have students look at the bucket representing the sea. What do they notice?** They should answer that the water from all the different tributaries or streams ends up there (represented by different colors of beads or objects).

13. **After the simulations, designate students to count the number of beads in the large bucket for each precipitation event. Record this data on the *Graph It!—Student Copy Page*.**

14. Beads from this bucket may then be returned to the containers at the headwaters of the main stem and tributaries. You may wish to wait and have students graph all data after completing *Part 2*.

Part 2

1. **Add items representing trash such as paper, wrappers, crayons or plastic tops into ONLY TWO of the starting buckets.**

2. **Repeat step 10 from *Part 1*, but tell students they should also pass the trash items in addition to the beads.**

3. **Have students look at the bucket representing the sea again. What do they notice? Is there trash in the sea? (Yes.)** Ask students if all the streams had trash in them (They should say no.) Even though

only two of the streams had trash in them, trash from any part of the watershed (including cities) can end up polluting the water.

4. **After the simulations, designate one student to count the number of beads in the large bucket at the mouth of the main stem. Designate a second student to count the trash items. Record this data on the** *Graph It!—Student Copy Page*.

5. **Does the amount of trash in the sea correlate to the amount of water moving through the watershed?** (Does the amount of trash increase with the amount of water flow?) Discuss why this could happen.

6. **Discuss ways to prevent trash from entering the watershed.** Behaviors include recycling to reduce trash; ensuring trash is placed in bins with lids; picking up trash from the street to prevent the movement of trash in water runoff.

Wrap Up

- Have students describe their location in the watershed simulation. Based on their experience, what is the function of a headwaters stream? What is the importance of a tributary? What is the role of the main stem in the watershed?
- Have students review the hydrograph they produced. How do the seasons and weather influence the flow of water through the watershed?

Photo © Vladimir Melnikov–Shutterstock

Tributaries flow into the main stem of a watershed emptying water, sediment and pollutants into the river.

ActionEducation™

Have students research recycling and trash management in your community. What can be recycled locally and what should be properly disposed of in a designated trash receptacle? Organize a playground or community clean-up to collect trash that might otherwise enter the watershed through runoff. Before recycling or disposing of the trash they pick up, have students take pictures of what they collected. Use the pictures to create signs reminding their fellow students to protect their watershed by making good decisions about where to put their trash.

WATERSTAR

The WaterStar recognition program encourages students and educators to contribute to a positive water future by learning about water and taking appropriate local action.

Report what you've learned and done at www.projectwet.org/waterstar.

Assessment

Have students:

- reflect on the amount of water entering the watershed during a rainstorm. (*Part 1*)
- assess how water moves trash into water sources. (*Part 2*)
- understand how to prevent trash from moving into water sources. (*Part 2*)
- demonstrate the movement of water through a watershed. (*Part 1 and Part 2*)
- compare and contrast the amount of water flowing through a watershed based on precipitation or season. (*Part 1*)
- compare the amount of water and pollutants flowing through a watershed based on water flow. (*Part 2*)
- create a hydrograph based on simulation data. (*Part 1 and Part 2*)

Presenter Tips

For younger children: Complete the *Warm Up* and *Part 1* without the graphing component. Alternatively, you could also complete the hydrograph component as a class.

For walk-up festivals: Ask participants if they know what a watershed is. After defining it with them, perform the steps in the *Warm Up* shown in "Water on the Move" to demonstrate how water flows from high to low in a watershed.

Extensions

Have students create other scenarios on the river affecting water flow. For example, construct a dam on a tributary stream by placing a bucket between students. Capture water in the dam during the spring runoff and release it later in the summer. Discuss how dams are used to capture water during periods of high flow and then release it slowly for purposes such as irrigation and hydroelectric power generation throughout the rest of the year.

Have different weather events occur in different tributaries. How does a rain event involving a single tributary affect the river? How do hot and dry conditions in primary or secondary tributaries affect the main stem?

Choose a spot along a local waterway to observe streamflow seasonally and see how it changes.

Compare the hydrograph from simulation to a hydrograph produced using actual data.

Resources

Books and Journals

Bodzin, Alec and Louise Shive. 2004. "Watershed Investigations." Science Scope, 27 (7), 21-23.

Endreny, Anna Henderson. 2010. "Urban 5th Graders Conceptions during a Place-Based Inquiry Unit on Watersheds." Journal of Research in Science Teaching, 47 (5), 501-517.

Jason Academy. 2004. Earth Science: River Systems Teacher & Student Manual and CD-ROM. Needham Heights, MA: Jason Academy.

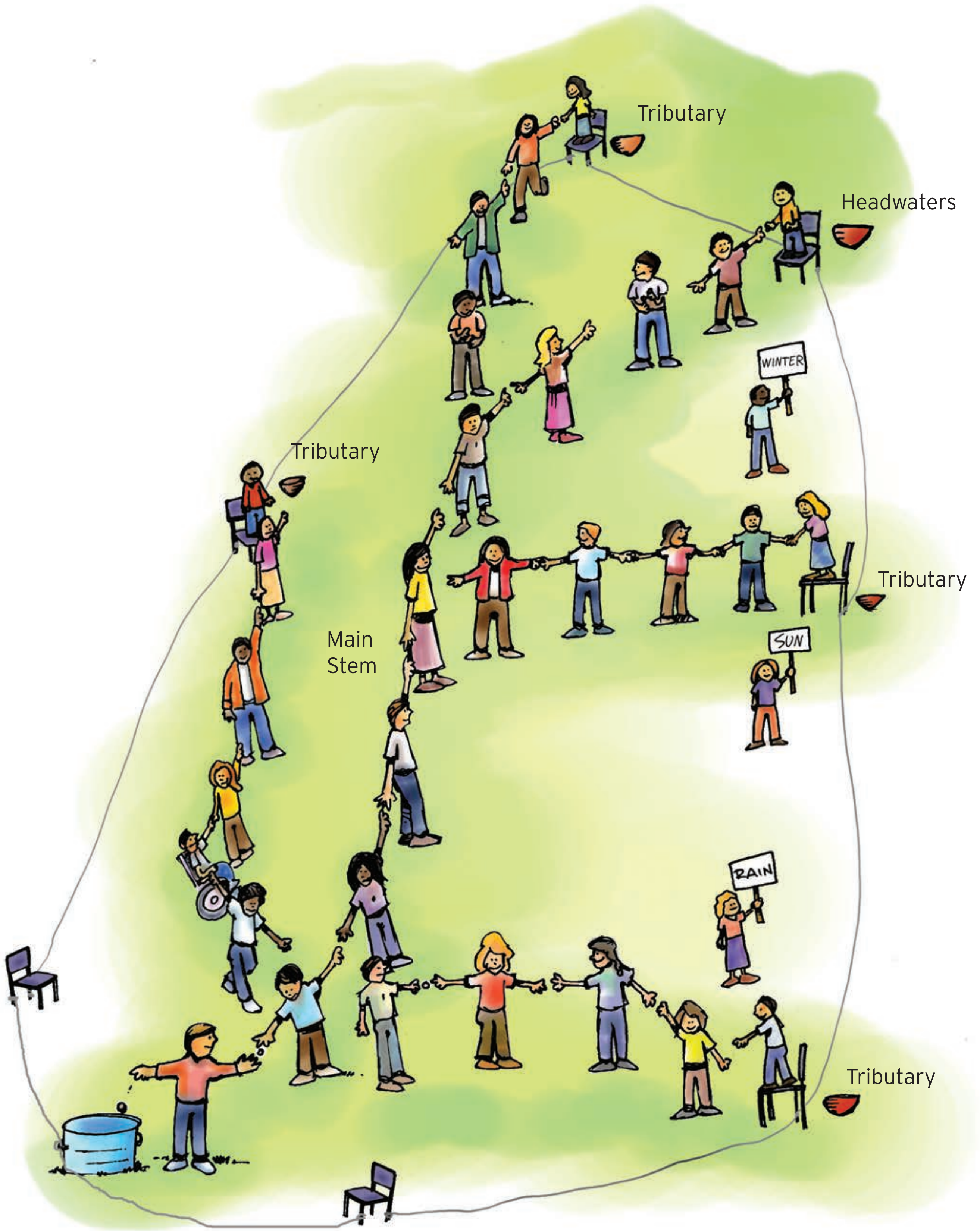
Websites

United States Environmental Protection Agency. Surf Your Watershed. By entering location parameters, students and teachers can see the watershed in which they live. http://cfpub.epa.gov/surf/locate/index.cfm. (Accessed January 9, 2015.)

United States Environmental Protection Agency. What is a Watershed? A definition and description of a watershed. www.epa.gov. (Accessed February 22, 2013.)

United States Geological Survey. Science in Your Watershed. Using maps, students and teachers can see their local watershed and find items of interest that pertain to it. http://water.usgs.gov/wsc/. (Accessed January 9, 2015.)

River Watershed—Teacher Resource Page



Graph It!—Student Copy Page

Directions

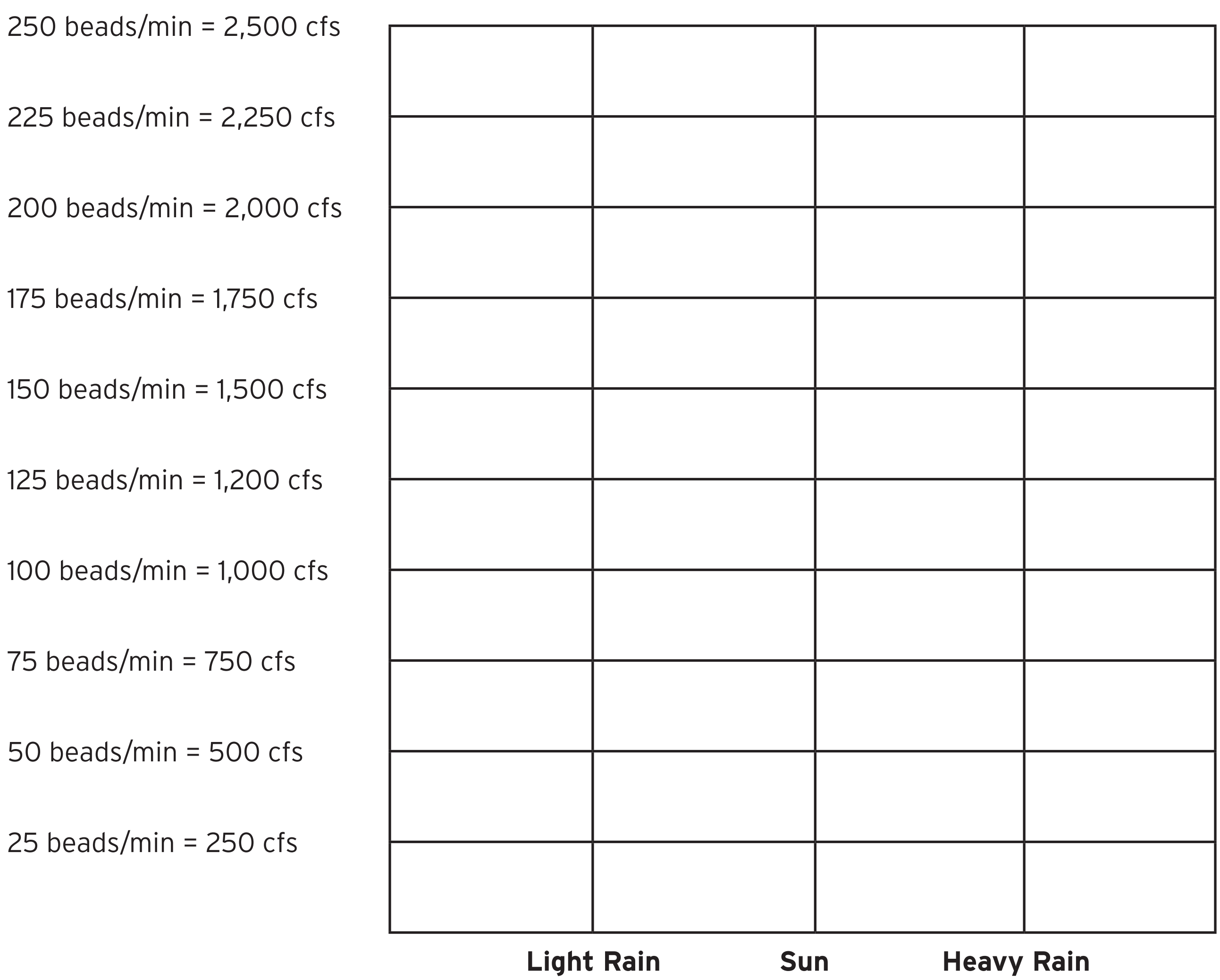
In the chart below, record the class simulation streamflow data for each season.

	Part 1	Part 2	
Weather	Number of beads	Number of beads	Number of trash pieces
Light Rain			
Sun			
Heavy Rain			

Hydrograph for Class Simulation of Blue River Flow

Now, graph your results below for water flow (number of beads). The number of beads includes an "equivalent" measure in cubic feet per second (cfs), which is the measure used for water in motion. (1 cubic foot per second = 7.4805 gallons flowing by a particular point in 1 second.)

Water Flow



Hydrograph, Part 2

Using the hydrograph below, graph your results for water flow (number of beads) using the left side axis as a measurement. Graph your numbers for trash flow (number of items of trash) using the right side axis. Use different color or dotted lines to distinguish between the two data sets.