# Blue River

*"You can never step into the same river twice . . ."*

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## Grade Level
Upper Elementary, Middle School

## Subject Areas
Geography, Earth Science, Environmental Science

## Duration
Preparation time: 15 minutes
Activity time: Part I: 30 minutes; Part II: 30 minutes; Part III: 30 minutes

## Setting
Outdoors or classroom (depending on number of students)

## Skills
Analyzing information (comparing, contrasting); Interpreting; Presenting (demonstrating)

## Charting the Course
"River Talk" introduces watersheds, their parts and functions. Through "Seeing Watersheds," students map watershed boundaries and water flow. In "Blue River," students demonstrate how water flows in a watershed. In "Back to the Future," students analyze and interpret streamflow data. "Color Me a Watershed" illustrates how watershed changes over time affect runoff. "Sum of the Parts" explores the concept, "We all live downstream." In "8-4-1, One for All," students demonstrate how water users work cooperatively. Finally in "Make-a-Mural," students create a mural depicting their own watershed.

## Vocabulary
watershed, headwaters, tributary, main stem, runoff, snowpack, rivulet, drainage, basin, closed basin, floodplain, downstream, spring, ground water, spring melt, streamflow, gaging station, hydrograph, catchment


## Summary
**Students participate in a whole-body exercise to simulate the movement of water through a river and its watershed.**


## Objectives
Students will:
- describe the major components of a watershed.
- demonstrate the movement of water through a river and its watershed.
- compare and contrast the amount of water flowing through a river and its watershed based on climate (seasonal variations) and weather (precipitation).
- create a hydrograph based on simulation data.

## Materials
### Parts I and II
- *Copy of* ***Blue River Watershed***
- *200-500 pony beads, pea gravel, beans, marbles or similar objects* (depending on the number of students)
- *Large bucket or other large container to collect beads or other objects*
- *One-gallon pails or similar containers* (one for each headwaters stream)
- *Signs on sticks with pictures representing snow, rain, sun and each of the seasons* (optional)
- *Four chairs*
- *Length of rope or string*

### Part III
- *Copies of* ***Graph It!*** (one per two students)

## Making Connections
Students will likely have heard the term "watershed," but may not understand how water flows through a watershed and how that flow differs in spring, summer, fall and winter or as a result of local weather.

## 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. The boundaries of watersheds can be identified on a map by tracing a line along the highest elevations (often a ridge) between two drainage areas. Large watersheds often contain many smaller watersheds.

Beginning at the highest elevations of a watershed, runoff (water from rain, melting snow and ice) collects to form rivulets 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, precipitation is stored as snow in snowpack (accumulated snow that is condensed and compressed by its own weight). In some mountainous areas, snowpack can build 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 fall, as temperatures cool and precipitation diminishes, streamflows decrease until winter arrives, bringing with it precipitation in the form of snow. The cycle repeats.

Weather events, such as rain storms or times of low precipitation, and hot temperatures can change river flow. When these natural events occur, hydrologists using monitoring equipment track how a rain event in a tributary can change main stem river flow downstream.

## Procedure

### ▼ *Warm Up*

- Write on the board the following quotation: "You can never step into the same river twice . . ."
- Ask students if they believe it is a true statement and to explain their answer.
- Provide the following definition of a watershed.
- Write the following statement on the board as an interpretation of the saying: **If a watershed drains water toward a common river, that river is constantly changing because the water that flows into it**

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 the 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, such as the Great Salt Lake, Utah.) 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, including their culture, stories and traditions.

*The Great Salt Lake in Utah is an example of a closed basin.*

PHOTO CREDIT: © Bring Chase / Dreamstime.com

**is constantly changing.**

- Tell students that they will have an opportunity to test this idea.

## *The Activity*

### Part I

1. **Ideally, assemble students on a gently sloping hill to help reinforce the idea that water flows from higher to lower elevations.** If a hill is unavailable, students can assemble on gymnasium bleachers or a similar location. On flat land you can create two signs: "High Point" and "Low Point." Place High Point at the headwaters and Low Point at the mouth.
2. **Assemble students in a branching formation to simulate streams in a watershed. (See Teacher Resource Page—*Blue River Watershed*). If students have conducted the activity, "Seeing Watersheds," they may recognize they are forming the Blue River, its headwaters and four 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.** This forms the headwaters for the Blue River. Have students at headwaters for each of the four tributaries stand on a chair.
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: Ask students what element of a watershed is still missing.** How will all the headwaters and tributaries join? Have the remainder of the students line up fingertip to fingertip in an S-shaped 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.**
8. **Tie the rope or string from the large bucket to each of the four chairs.** Explain to students that this rope shows the watershed boundary and everything within the rope is part of this watershed; everything outside of the rope is part of different watershed(s).

### Part II

1. **To help students understand what will happen during this activity, instruct students at the top of the headwaters streams to pick up one bead and hand it to the person below them.** Have 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 ocean, 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.**
2. **Explain to students that they will now simulate the flow of water through a watershed during the seasons. Tell students that they will do each simulation for one minute.** Then, begin the following scenarios: (Optional: Make large signs with symbols for snow, rain, sun and each of the seasons. Attach these signs to sticks and hold these signs up to indicate each scenario. This is especially helpful for large groups.) If necessary, ask a student to be the timekeeper announcing when to start and when to stop passing beads. **When the timekeeper announces the end of one minute, all students must stop passing beads.** Students may hold onto the beads in their hands and use in the next simulation.
3. **After each simulation, designate a student to count the number of beads in the large bucket at the mouth of the main stem. Record this data on the *Graph It!* Student Copy Page.** Beads from this bucket may then be returned to the containers at the headwaters of the main stem and tributaries.
4. Winter: **When the timer announces "Go," students begin to pass beads slowly (they could count to three before passing the bead on) downstream to simulate the very low flows typical of streams in winter.** Remember, during this cold time of year, precipitation is stored in its frozen form, snowpack. After one minute and each simulation, record the number of beads on the ***Graph It!* Student Copy Page**.

5. **Spring: Spring melt! Temperatures rise and begin to melt the winter snowpack. Have students pass beads quickly.** "Tributary streams" and the "main stem" students will need to pass beads as fast as they can. Inevitably some beads will be dropped or spilled. Don't worry. They represent the flooding which occurs when a stream channel exceeds its capacity.
6. **Summer: The winter snowpack has melted and run off; streamflows decrease.** Instruct students to slow down and pass beads at a leisurely pace. Instruct "tributary" and "main stem" students to pick up beads that dropped during flooding and pass them downstream. This represents floodwaters receding and flows returning to normal.
7. **Summer Storm: Simulate an isolated summer storm by quickly passing beads through one headwater stream for 20 seconds.** What did this do to the flow in the main stem? Many people are surprised to learn that a storm can drop significant amounts of rain in one part of a watershed while other parts remain dry.
8. **Fall: Streams generally have low flows during the fall months. Have students pass beads slowly, but not quite as slowly as the winter pace (counting to one or two instead of three).**
9. **Weather Event: Simulate different weather events in different parts of the watershed, such as heavy rains or hot and dry conditions.** Observe how these conditions affect the flow in the main stem. Can these conditions be related to local weather or recent flood?

### Part III

1. **Discuss with students the flow of water recorded at the mouth of the river for each season.**
2. **Remind them that streamflow (amount of water passing through) is measured at several spots along a river, called gaging stations (measuring stations). This data is then represented in hydrographs (charts).**
3. **A hydrograph records the streamflow at one spot on the river over a period of time in cubic feet per second (cfs) or cubic meters per second (cms).**
4. **Students can view data from gaging stations in their own watershed by visiting the USGS website,** http://waterdata.usgs.gov/nwis/rt.
5. **Have students record the data from their simulation and complete the hydrograph on the Student Copy Page—*Graph It!*** Hydrographs can show streamflow averages, including daily, weekly, monthly or yearly calculations, depending on the data collected and the period of time over which it was obtained.
6. **Have students work in pairs to complete their hydrograph.**

## ▼ *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?

## ▼ Project WET Reading Corner


Castaldo, Nancy F. 2006. *River Wild: An Activity Guide to North American Rivers.* Chicago, IL: Chicago Review Press.

Learn about rivers using hands-on activities and suggestions for community projects.

Collier, Michael. 2008. *Over the Rivers: An Aerial View of Geology.* New York, NY: Mikaya Press.

Aerial photographs of some of the largest river systems in the United States give students a feel for the magnitude and potential impact these rivers can have on American life.

Ganeri, Anita. 2009. *The World's Most Amazing Rivers.* Chicago, IL: Raintree Publishers.

This book looks at 10 different rivers that are the highest, longest, widest and most unusual in the world.

Harrison, David L. 2002. *Rivers: Nature's Wondrous Waterways.* Honesdale, PA: Boyds Mill Press.

Starting in the mountains, take a journey on a river as it goes to the sea, including information on the water cycle, pollution, etc.

Lewis, Meriwether and William Clark. 1805. *The Journals of Lewis and Clark* (200th Anniversary Edition). New York, NY: Signet Classics.

Historical account written by Lewis and Clark of their travels to find the headwaters of the Missouri River and the Pacific Ocean.

Nirgiotis, Nicholas. 1993. *West by Waterway: Rivers and U.S. Expansion.* London, UK: Franklin Watts.

Read the history of the westward expansion across the United States by traveling on river waterways.

Project WET Foundation. 1999. *Big Rivers*. Bozeman, MT: Project WET Foundation.

Illustrated children's booklet discussing some of the largest river watersheds in the United States.

Available by download only: http://store.projectwet.org/index.php/big-rivers-download.html.

Tillman, Ned. 2009. *The Chesapeake Watershed*. Baltimore, MD: Chesapeake Book Company.

The author takes us back to his childhood memories of the Chesapeake and as a scientist, shares his knowledge of the area and ways to use it wisely.

Twain, Mark. 1953. *The Adventures of Huckleberry Finn.* New York, NY: Dodd, Mead & Co.^

Teenager Huckleberry Finn and the escaping slave, Jim, travel the Mississippi River meeting many unusual people on their journey.

Walker, Sally M. 2002. *Life in an Estuary*. Minneapolis, MN: Lerner Publications Co.

Study the plants and animals found in the Chesapeake Bay where rivers meet oceans and human impact affects all life there.

^Listed on one or more state reading lists.

## Assessment

Have students:

- explain the parts of a river system (***Part I***, steps 3-5).
- describe the movement of water through a watershed during each season (***Part II***, steps 2-8; ***Wrap Up***).
- describe how local weather can affect stream systems in a watershed (***Part II***, step 9; ***Wrap Up***).
- create a hydrograph based on data from the Blue River simulation through the seasons (***Part II***, steps 3-8; ***Part III***, steps 5-6).

## 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 students use a different colored bead for each tributary to assess their individual contributions to the river.** For example, 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?

**Have students draw a map of the watershed they created.** Have them mark and name their location during the activity.

**Have students write a river song or chant to sing during this activity as they pass beads through their watershed.**

**Have students return to the saying, "You can never step into the same river twice . . ." Tell them that a Greek philosopher, Heraclitus of Ephesus, wrote these words about 2,500 years ago. Remind students that this is not the complete quotation. Based on their recent experience, ask them how they would complete it.** Write their suggestions on the board. Tell them that the complete quotation reads, "You can never step into the same river twice; for new waters are always flowing onto you." Ask students how this supports the simulation; that is, through the water cycle from rain, snow or sleet, new waters flow through the headwaters to the tributaries, refreshing the main stem or river.

## Teacher Resources

### Books

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

Project WET Foundation. 2005. *Discover a Watershed: The Missouri Educators Guide*. Bozeman, MT: Project WET Foundation.

Project WET Foundation. 2005. *Discover a Watershed: The Colorado Educators Guide*. Bozeman, MT: Project WET Foundation.

### Journals

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

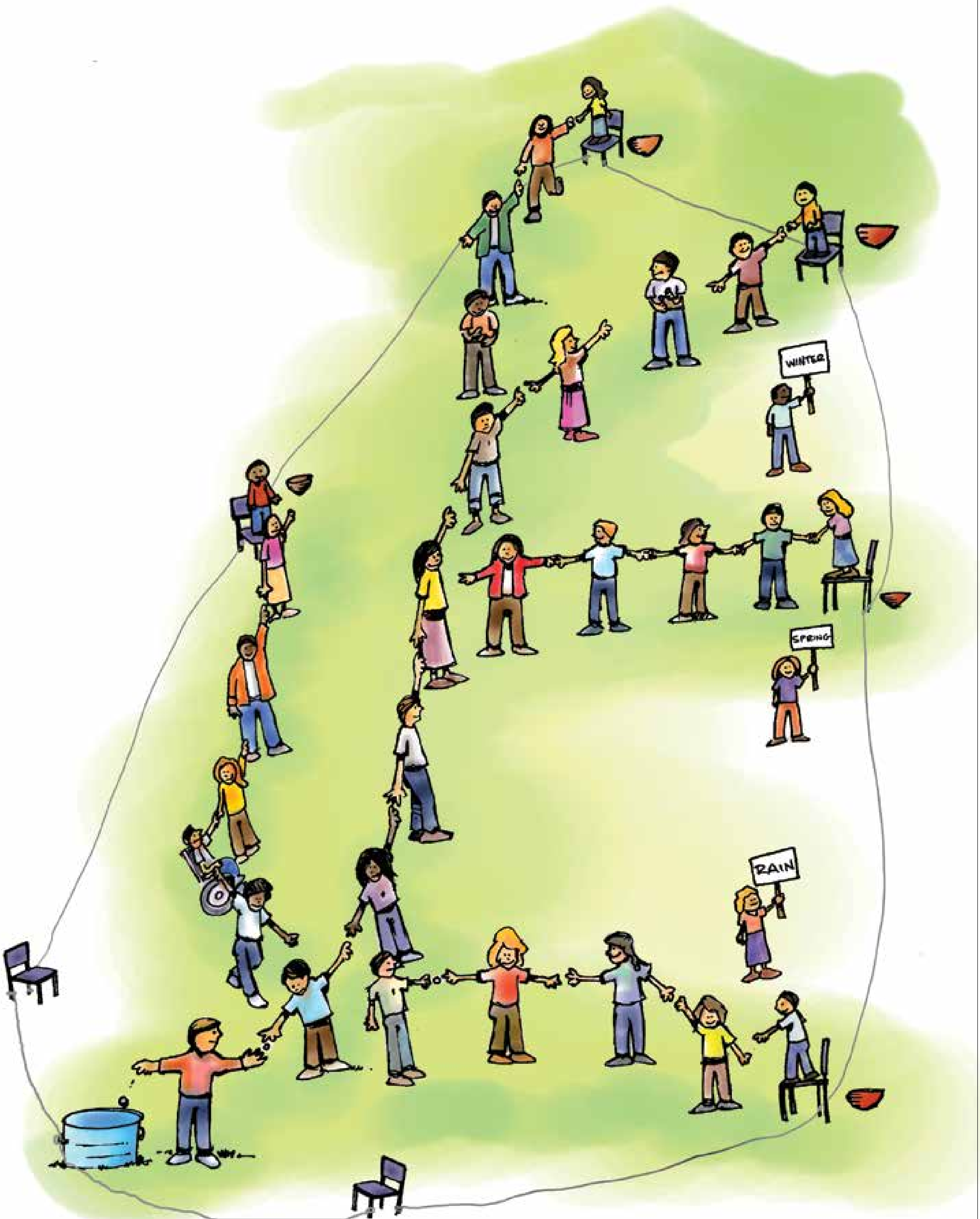
Endreny, Anna Henderson. 2010. "Urban 5th Graders Conceptions during a Place-Based Inquiry Unit on Watersheds." *Journal of Research in Science Teaching*, 47 (5), 501-517.

### Websites

United States Environmental Protection Agency. Surf Your Watershed. By entering location parameters, students and teachers can see the watershed in which they live. www.epa.gov/surf. Accessed December 13, 2010.

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 December 13, 2010.

Assemble students as shown below for Parts I and II.



## How is water measured in a river?

The amount of water in a river changes daily, seasonally and year to year. Hydrologists measure the river's streamflow (amount of water passing through) at gaging stations (flow measuring stations) and make hydrographs (charts). A discharge hydrograph records the streamflow at one spot on the river over a period of time in cubic feet per second (cfs). Rainfall amounts and data from stream gaging stations help hydrologists plan for the needs of water users within a watershed, including: drinking water; water for crops and livestock; manufacturing and shipping products; fish and wildlife; and recreation.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*Stream gages are used to measure the depth of water in a specific location.*

Directions:
In the chart below, record the streamflow for each season from the simulation.

Imagine that this is a seasonal average and that each bead equals 10 cfs.

### DATA

| Season | # of beads | # of beads X 10 cfs = total cfs |
|---|---|---|
| Winter | | |
| Spring | | |
| Summer | | |
| Fall | | |

Graph your results below.
In which season is the greatest streamflow? The least? Why?
Record your data on the graph below for each of the seasons:

| | | | | | | |
|---|---|---|---|---|---|---|
| 500 Beads / Min | = | 5000 cfs | | | | |
| 450 Beads / Min | = | 4500 cfs | | | | |
| 400 Beads / Min | = | 4000 cfs | | | | |
| 350 Beads / Min | = | 3500 cfs | | | | |
| 300 Beads / Min | = | 3000 cfs | | | | |
| 250 Beads / Min | = | 2500 cfs | | | | |
| 200 Beads / Min | = | 2000 cfs | | | | |
| 150 Beads / Min | = | 1500 cfs | | | | |
| 50 Beads / Min | = | 500 cfs | | | | |
| **Hydrograph for YOUR Blue River** | | | **Winter** | **Spring** | **Summer** | **Fall** |

To see a hydrograph with data from a gaging station on a river in your watershed, go to: http://waterdata.usgs.gov/nwis/rt.