River Systems and the Water Cycle

GRADE LEVEL
Grades 6-8 (Middle school)

SUBJECTS
Science/Earth Science

ESTIMATED TIME
Two or more 50-minute sessions

"As it leaves the Rockies and moves downward over the high plains towards the Missouri, the Platte River is a curious stream."

OVERVIEW

This lesson is about water and how it figures in Earth systems. It uses Loren Eiseley's essay, *The Flow of the River*, and the students' own inquiry through online tools provided by the US Geological Survey to develop in them an understanding of river systems and watersheds. Through that knowledge, it seeks to enlarge their understanding to include the whole water cycle and the connections between different Earth systems.

MATERIALS AND TECHNOLOGY

- Copies of the essay "The Flow of the River" in *The Loren Eiseley Reader* for every student;
- Computers with Internet connectivity; and
- Posters or other graphics of the water cycle (included in this Lesson Plan and available online at the USGS website)

Other Resources:

- Any grade appropriate Earth Science textbook.
- The USGS website, especially its various pages relating to water such as: the Water Science School, http://water.usgs.gov/edu/, Water Resources Education page, http://water.usgs.gov/education.html, Water Resources web site, http://www.usgs.gov/water/, Science in Your Watershed, http://water.usgs.gov/wsc/, Water Education Posters, http://water.usgs.gov/outreach/OutReach.html.

PREPARATION

1. Read Eiseley's essay, "The Flow of the River," and make sure there are enough copies of *The Loren Eiseley Reader* for each student (available for loan from your ESU).

2. Browse the USGS website pages listed above.
3. Make copies of handouts for all students.

INSTRUCTIONAL PLAN

STUDENT OBJECTIVES

In this series of lessons, students will

- discover that the water in a river comes from a watershed area upstream and passes downstream into larger, more inclusive river systems, ultimately reaching the sea;
- apply this understanding of rivers and watersheds to their own local area;
- describe how rivers are part of a greater water cycle with many reservoirs and connecting processes; and
- describe the connections between the hydrosphere and other "spheres" of Earth systems with special attention to connections with the biosphere.

SESSION ONE: WATERSHEDS

1. Have students read "The Flow of the River," p. 17-25 in *The Loren Eiseley Reader*.

2. Ask students to focus first on the opening portion of the essay wherein Eiseley describes floating in the Platte River in western Nebraska and imagining being part of the flow of the river with his "fingers touching…brooks of snow-line glaciers" and "at the same time flowing toward the Gulf" (p. 18). Discuss what he is saying about rivers and river systems. (Consider the sources of the water in rivers and where it is going.)

3. To visualize this in a more concrete way, have students go to the U.S. Geological Survey (USGS) and find the Streamer webApp, http://nationalmap.gov/streamer/webApp/welcome.html. Following the instructions for Streamer, zoom in to an area of western Nebraska along the Platte River, probably the North Platte River, to represent the place Eiseley refers to in the essay (The teacher can help direct students to the right general area.). Click on the Trace Upstream button in the app and then click on a point on the North Platte River somewhere along the selected stretch of the river. The app will highlight all the streams and rivers that contribute to the flow of the North Platte River at that point.

   Have the students note where the upstream flows come from. Next, click on the Trace Downstream button in the app and click on the same point on the North Platte River. The app

will highlight the path followed by the flow of the North Platte River from that point on. Where does the water go?

4. Encourage students to apply Streamer to various rivers and streams to trace them upstream and downstream and see what patterns are revealed. This research can be made more personal by selecting the stream closest to the students' school or home (teachers can help direct students to these areas). Discuss the patterns observed by the students. What generalizations can be made about the patterns observed? What do these patterns represent? (The upstream trace reveals the area drained by that river and its tributaries (its watershed); many small drainages contribute to the same large river; almost all (for a few exceptions look in south central Wyoming or around the Great Salt Lake or Death Valley) rivers flow, ultimately, to the sea; etc.)

   If they haven't selected it already, make sure the students apply the Upstream Trace to the end point of the Mississippi River where it enters the Gulf of Mexico. This will reveal the entire drainage basin/watershed of the Mississippi.

5. Have students read about watersheds at the USGS web page on that topic (http://water.usgs.gov/edu/watershed.html). Discuss the significance of watersheds or drainage basins as systems that gather rainwater and concentrate surface runoff as it flows downslope, eventually all the way to the oceans.

SESSION TWO: WATER CYCLE

1. Consider the implications of river systems and watersheds. Ask how river systems, if they are continually conducting water from the area of the watershed down to the sea, they do not run out of water. Where does the water come from?

2. Use this discussion to introduce the water cycle and the concepts of the hydrosphere, the various reservoirs of which it is comprised, and how water is transferred from reservoir to reservoir. Have students consult the USGS web page on the water cycle at http://water.usgs.gov/edu/watercycle.html and the poster there to identify these reservoirs and how they are connected. The poster is also included with this guide and is available for download from the USGS at http://water.usgs.gov/outreach/OutReach.html. The same diagram without labels for use in assessments is available at http://water.usgs.gov/edu/watercycleprintnotext.html.

3. From an understanding of the hydrosphere, all the water on Earth distributed among reservoirs of varying size, introduce the concept of Earth as a system consisting of various "spheres"; in addition to the hydrosphere, the geosphere (solid Earth), the atmosphere (our gaseous envelope) and the biosphere (all living things on Earth). Have the students look at all the reservoirs in the water cycle and identify which are included in the other "spheres" of the Earth.

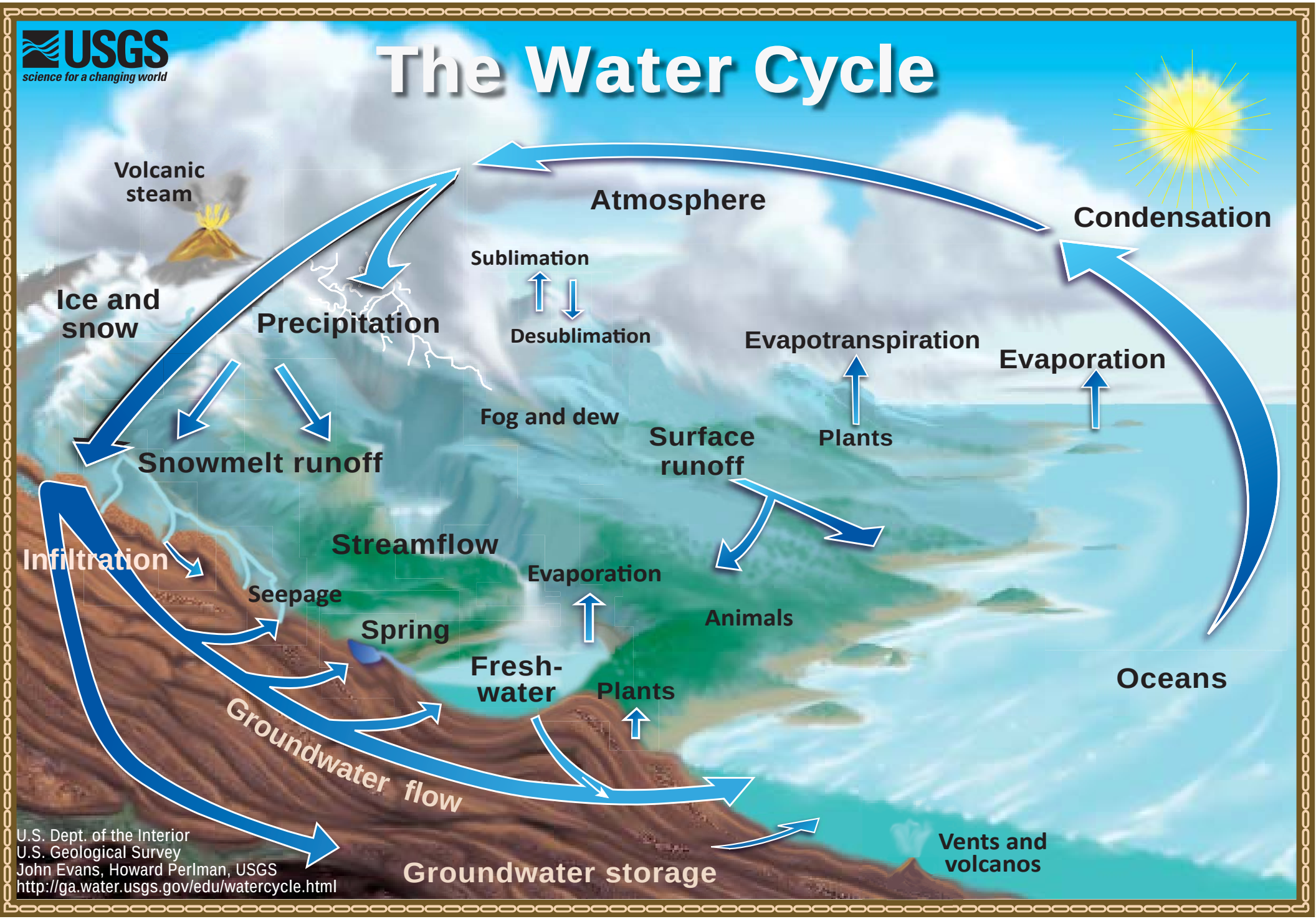
4. Consider the biosphere in particular. The latter part of "The Flow of the River" refers to this connection, as in the statements that, "Turtle and fish … are all watery projections, concentrations" and "I was three fourths water" (p. 20).

   Have the students consider and research the questions: What percentage of various organisms, plants and animals, consists of water? What percentage of the water on Earth is represented by water in living organisms? How do various organisms, plants and animals, gain and lose water; i.e. what processes connect them to other reservoirs in the water cycle? Ask students to consider the importance of water to living organisms, including humans.

ENRICHMENT

Eiseley also hints at other connections between Earth systems when he says the flow of the river represents the "immense body of the continent … flowing … grain by grain … down to the sea." (p. 19). The river carries more than water. Ask the students to consider what the bottom of a river like the Platte is like; what is on the bottom of the river. What happens to the sediment on the bottom and suspended in the water? Where does the sediment go? Where did it come from?

Have the students discuss how the hydrosphere in the form of the river interacts with the geosphere. (Erosion that carves mountains and valleys, transport of sediment produced by erosion, deposition of sediment in valleys and eventually in the sea at the mouth of a river.)


USGS
science for a changing world
The Water Cycle
Volcanic steam
Atmosphere
Condensation
Sublimation
Desublimation
Ice and snow
Precipitation
Evapotranspiration
Evaporation
Fog and dew
Plants
Surface runoff
Snowmelt runoff
Streamflow
Infiltration
Evaporation
Seepage
Animals
Spring
Fresh-water
Plants
Oceans
Groundwater flow
Vents and volcanos
Groundwater storage
U.S. Dept. of the Interior
U.S. Geological Survey
John Evans, Howard Perlman, USGS
http://ga.water.usgs.gov/edu/watercycle.html

USGS
science for a changing world

WaterWatch—Maps, Graphs, and Tables of Current, Recent, and Past Streamflow Conditions

WaterWatch (http://water.usgs.gov/waterwatch/) is a U.S. Geological Survey (USGS) World Wide Web site that displays maps, graphs, and tables describing real-time, recent, and past streamflow conditions for the United States. The real-time information generally is updated on an hourly basis. WaterWatch provides streamgage-based maps that

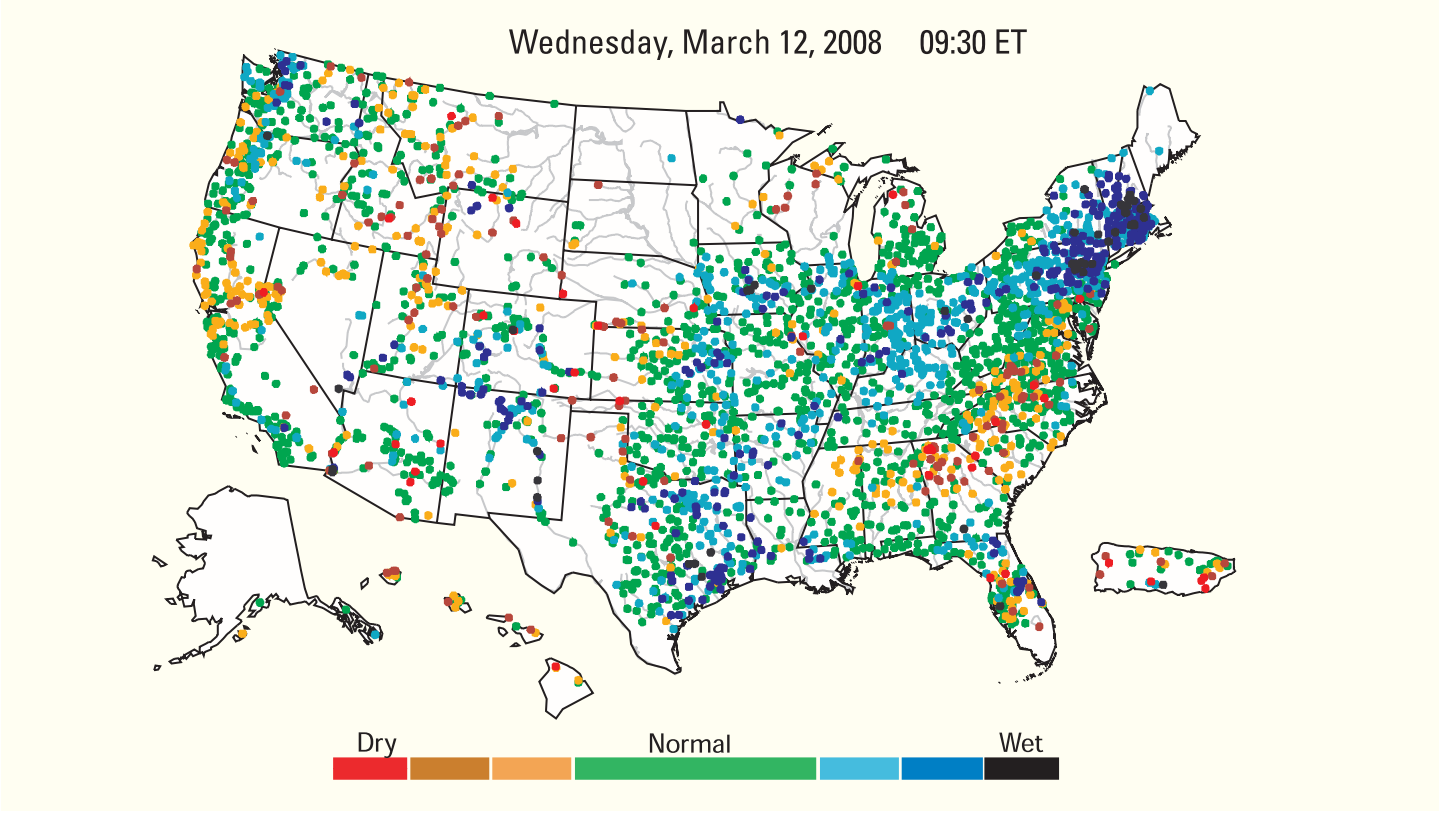
- Show the location of more than 3,000 long-term (30 years or more) USGS streamgages;
- Use colors to represent streamflow conditions compared to historical streamflow;
- Feature a point-and-click interface allowing users to retrieve graphs of stream stage (water elevation) and flow; and
- Highlight locations where extreme hydrologic events, such as floods and droughts, are occurring.

The streamgage-based maps show streamflow conditions for real-time, average daily, and 7-day average streamflow. The real-time streamflow maps highlight flood and high flow conditions. The 7-day average streamflow maps highlight below-normal and drought conditions.

WaterWatch also provides hydrologic unit code (HUC) maps. HUC-based maps are derived from the streamgage-based maps and illustrate streamflow conditions in hydrologic regions. These maps

- Show average streamflow conditions for 1-, 7-, 14-, and 28-day periods, and for monthly average streamflow;
- Highlight regions of low flow or hydrologic drought; and
- Provide historical runoff and streamflow conditions beginning in 1901.

WaterWatch summarizes streamflow conditions in a region (state or hydrologic unit) in terms of the long-term typical condition at streamgages in the region. Summary tables are provided along with time-series plots that depict variations through time. WaterWatch also includes tables of current streamflow information and locations of flooding.



U.S. Department of the Interior
U.S. Geological Survey

Printed on recycled paper

Fact Sheet 2008–3031
April 2008

How to access WaterWatch products:

1. Menu Bar

One way to access WaterWatch products is through a bar containing multiple pull-down menus, as well as ***Special Features*** and **Contents** links. The pull-down menu items are organized into **Current Maps/Graphs, Flood Watch, Drought Watch, Recent/Historical Maps/Graphs, Geographic Area,** and **Additional Information**.

2. Contents

A second approach to accessing WaterWatch products is to use the Contents listing at http://water.usgs.gov/waterwatch/?m=sitemap, where the current suite of products are listed by type: maps, graphs (plots), or tables. Additional links are available.

Maps

- Current Streamflow (National and State)
- Current Flood and High Flow (National and State)
- Current Hydrologic Drought (National and State)
- Current Hydrologic Hazards (User Selected Area)
- Daily Streamflow (National and State)
- Animation of Daily Streamflow (National, October 1999 to Present)
- 7-, 14-, and 28-Day Average Streamflow (National and State)
- 7-, 14-, and 28-Day Average Below Normal Streamflow (National and State)
- Monthly Average Streamflow (October 2002 to Present)
- Interactive Viewer of Recent Streamflow (2003 to Present)
- Interactive Viewer of Monthly and Annual Runoff (1901-2002)
- Google Earth Current Streamflow (National, Regional, and State)
- Google Maps Current Streamflow (National, Regional, and State)

Graphs (Plots)

- Current, Daily, and 7-Day Average Streamflow (National, Regional, and State)
- 7-Day Average Below Normal Streamflow (National, Regional, and State)
- Interactive Viewer of Computed Annual Runoff (1901-2002; Regional)

Tables

- Current, Daily, and 7-Day Average Streamflow (National, Regional, and State)
- Current Locations Above Flood Stage
- Interactive Retrieval of Flood and High Flow Information (May 2005 to Present)
- Monthly Flood Report (January 2008 to Present)
- Computed Median Runoff (National and State, 1900 to Present)
- Streamgage Statistics Retrieval Tool (For all USGS Streamgages for the Period of Record)

Miscellaneous

- Recent Streamflow Map Archive
- Annual Streamflow Summaries (Water Year 2006 to Present)

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