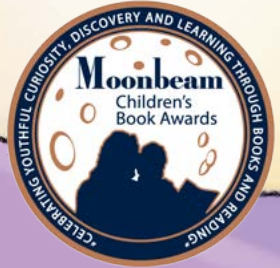


Discover the Yellowstone River

Illustrations by Peter Grosshauser



MAP THE YELLOWSTONE

MEASURE THE
YELLOWSTONE

RIVER OF TIME

RIVER OF
CHANGE

THE WILD
YELLOWSTONE

YELLOWSTONE
MARKETPLACE

YELLOWSTONE
WATERSHED
HEALTHY HABITS

Project
wet
Water Education for Teachers



MAP THE YELLOWSTONE

From the **headwaters** (start of the river) near Younts Peak, just outside America's first national park, the Yellowstone River cuts through mountains, canyons, badlands and plains on its way to the **confluence** (river junction) with the Missouri River near Fort Buford, North Dakota. The longest undammed river in the **contiguous** (adjoining) 48 states, the Yellowstone attracts people from around the world—many hoping to fish the river's cold mountain waters in search of trout or to find walleye and paddlefish in the warmer, slower section on the plains.

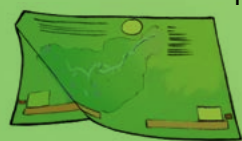
The Yellowstone River has long been known for its abundance of wildlife. In fact, the Crow Indians (who have lived in the area for centuries) called it the "Elk River"—although the Minnetaree Indian term "Yellow Rock River" is the one that stuck.

Today, the river is in three states—Wyoming (WY), Montana (MT) and North Dakota (ND)—and more than 300,000 people call the Yellowstone River **watershed** (all of the land and ground water beneath that contributes water to the river) home. The Yellowstone River watershed supports a wide variety of **agricultural** (farm and ranch), energy development, home, business and recreational uses.

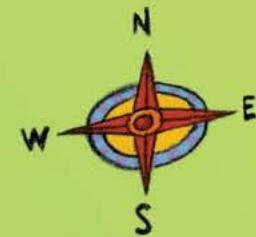
Helena, MT

It's All Downhill

All of the water in the Yellowstone River watershed flows downhill and eventually ends up in the Yellowstone River. Try folding the page like a tent along the dotted line. This ridge represents the **Continental Divide** (the high point on land where water flows to the Pacific Ocean on one side or Atlantic Ocean on the other) and the boundary of the Yellowstone River watershed. It shows that the rivers flow from high elevations to low. Watersheds are divided at their highest points.



The Yellowstone River watershed covers parts of Wyoming, Montana and North Dakota.



Fort Buford, ND—Confluence or mouth of the Yellowstone River

Did You Know?

The Yellowstone River is 678 miles (1,091 km) long and is part of the Rocky Mountain and Great Plains geographic regions.

The Yellowstone River drops 10,304 feet (3,141 m) from headwaters to confluence—almost two miles!

The Yellowstone River watershed drains 70,000 square miles (181,299 square km)—a land area about the size of Oklahoma.

Temperatures within the watershed can get above 100 degrees F (approx. 38°C) in the summer and as cold as -30 degrees F (approx. -34°C) in the winter.

About 43 percent of the Yellowstone River watershed is covered by grazing land, and agricultural products produced in the watershed help feed people around the world.

There are about 30 active coal mines in the watershed, and the Bakken Oil Field, one of the largest oil reserves in North America, underlies part of the watershed.

North Dakota

See the Yellowstone River Watershed

To see the Yellowstone River watershed, follow these instructions:

1. Use a yellow marker to trace the path of the **main stem** (main channel) of the Yellowstone River through mountains and prairies. Start at the headwaters and follow the arrows to the confluence.

2. All the rivers in the Yellowstone River watershed flow into the Yellowstone River. Find each numbered tributary (smaller river flowing into the larger river) and trace its path using the colors listed:

- ① Shields (red)
- ② Clarks Fork (orange)
- ③ Bighorn (pink)
- ④ Tongue (blue)
- ⑤ Powder (purple)

3. Trace the boundary of the Yellowstone River watershed in black by connecting the black dots labeled with the letters A through GG. All of the land inside the line is part of the Yellowstone River watershed, because all of the rivers within that area flow into the Yellowstone River.

4. Are the following cities IN or OUT of the watershed?

- _____ Helena, MT
- _____ Mammoth, WY
- _____ Cody, WY
- _____ Great Falls, MT
- _____ Bozeman, MT
- _____ Broadus, MT
- _____ Williston, ND
- _____ Your Hometown

Map Key

	town or city
	tributary
	watershed boundary
	headwaters
	confluence
	direction of flow



The Yellowstone River is a tributary of the Missouri River. It flows into the Missouri River, which flows into the Mississippi—and eventually into the Gulf of Mexico.

MEASURE THE YELLOWSTONE



Why Measure the Yellowstone River?

Monitoring the river's **flow** (how much water is in the river) is essential for water managers and elected officials to make informed decisions about how to manage the river.

Where Does River Water Come From?

The water in the river comes from **precipitation** (moisture from rain and snow). This precipitation falls on the land throughout the Yellowstone River watershed and flows into the Yellowstone River through tributary rivers and streams. Mountain **snowpack** (the amount of snow that falls through the winter) has a major impact on the amount of water in the Yellowstone River in the spring and summer months—times of **peak** (highest) river flow. Can you guess why? You might call snowpack nature's storage system. Twelve inches of fresh snow is the same as about one inch of rain.

Is the Yellowstone an Extreme River?

To answer this question, create a **hydrograph**. Hydrographs are used by water managers to show how much water is flowing in the river at a **gauging station** (river measuring location) over time. Hydrographs can be used to show the change in river flow throughout a day, month or year. The more the line on the graph rises and falls, the more extreme the high or low flows were at this place on the river. One use of hydrographs is to measure river flow at one location, such as Livingston, Montana, and then use the information to let people downstream at Reed Point, Billings, Forsyth and Glendive know how much water is moving toward them.



Younts Peak, at 12,156 feet (3,705 m), is at the headwaters of the Yellowstone River.

Make Your Own Hydrograph

- Using the real river flow data provided in the data chart to the right, create hydrographs for 2011, 2004 and an average year in the graph space provided. Each year will have its line on the hydrograph. The first few points for each year have been done for you.
- Use a small triangle ▲ to **plot** (mark) the flow for each month of 2011.
- Connect these triangles with a line to show river flow for 2011.
- Repeat this process with small circles ● for 2004.
- Then repeat this process using small squares ■ for the average year.
- Use the hydrographs you made to answer the questions below.

What year had the highest flow?

What year had the lowest flow?

What month usually has the highest flows?

Which seasons usually have the lowest flows?

What consequences might people experience as a result of extremely high flows?

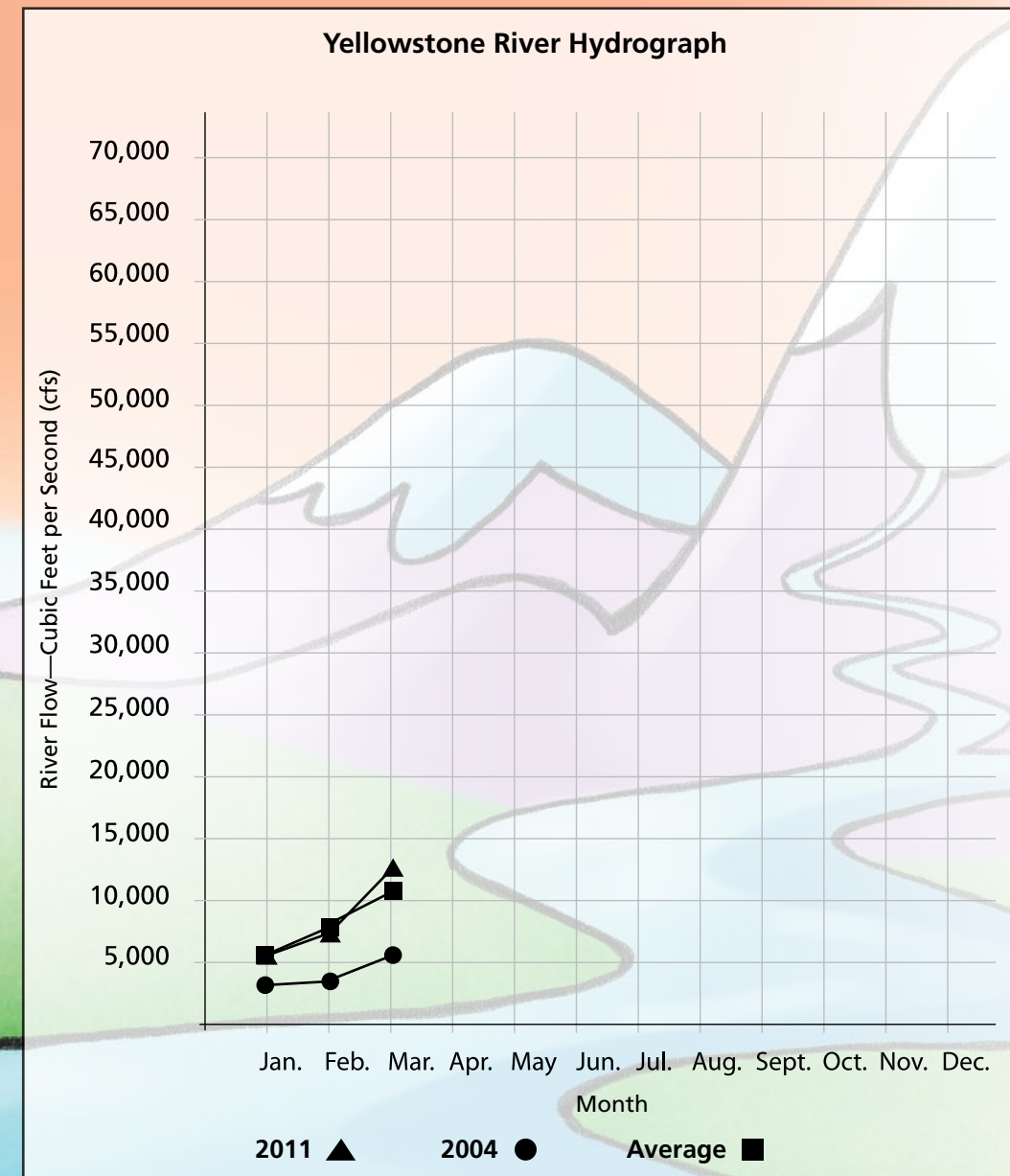
What consequences might people experience as a result of extremely low flows?

Is the Yellowstone an extreme river?

Data Chart

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
2011 ▲	5,900	6,400	13,300	12,000	48,400	69,500	58,500	19,500	10,000	*7,300	*6,900	*5,500
2004 ●	3,900	4,300	5,500	5,300	5,900	13,400	9,300	3,000	4,400	6,100	6,000	5,300
Average ■	5,700	6,700	10,600	10,100	18,400	38,400	22,800	8,500	7,000	8,200	7,200	5,900

* The data in this chart is the monthly mean in cfs from USGS gauging station 06329500 near Sidney, Montana, (numbers have been rounded to the nearest 100). Numbers with * have been estimated because actual data was not yet calculated.



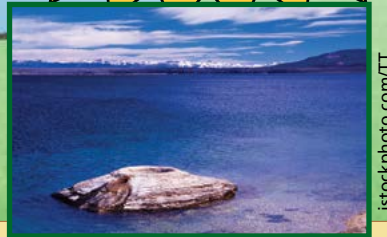
Snow Equals Flow

Different years bring different river flows depending on how the amount of precipitation in the mountain snowpack builds up in winter and how quickly the snow melts off in the spring. For example, very deep mountain snowpack followed by a week of high temperatures could mean that snow melts quickly and causes **floods** (times of high water), like in 2011.

Hydrologists (people who study water) watch water **indicators** (clues) that may predict floods and **droughts** (periods of water shortage). Remember, indicators are signals of things to come, but they are not certainties.

Play the Indicator Game

Go online to www.projectwet.org/discover-the-yellowstone-river to try using indicators like precipitation, snowpack, snowmelt and temperature to predict floods and droughts!



The Yellowstone River flows into and out of Yellowstone Lake, the largest lake in the park. Shrimplike animals, worms and moss have been found in unique hot water vent habitats deep in the lake.

RIVER OF TIME

Find the Time

Use the following words to fill in the blanks. Use the text and the timeline to help you.

Lewis and Clark	Yellowstone National Park	railroad	magma
mammoth	geysers	volcanic	Ice Age
steamboat	miners	fossils	dinosaurs

The Yellowstone River watershed has changed a lot through the ages. The Yellowstone River itself has existed as we know it today since the last Ice Age, about 11,000 years ago. Within the last 200 years, with the development of the land, the Yellowstone River has seen much change.



The Yellowstone River dramatically drops 308 feet (94 m) at the Lower Yellowstone Falls.

Dinosaurs and Volcanoes

Sixty-five million years ago, _____ roamed the land that we now call the Yellowstone River watershed. At that time, the land sat along the shores of an ancient sea. The sea eventually dried up, and the dinosaurs died out, leaving _____ behind.

The area that is now Yellowstone National Park, where the Yellowstone River begins, was formed by three _____ eruptions. Yellowstone Lake now fills the crater from the last eruption. Spectacular water features such as _____, hot springs and steam vents are evidence that superheated _____ still lies just beneath the surface!



Brrr!

During the last _____, frozen water—glaciers and ice sheets up to 3,000 feet (914 m) thick—shaped the landscape of the Yellowstone River watershed. Ice even blocked the Yellowstone River at times, forming natural dams that released huge floods when they broke free.

The first evidence of human settlement in this region is also from about 11,000 years ago. Native American tribes have lived in the area continuously since then. Early nomadic peoples traveled along the Yellowstone River in search of edible plants and animals like _____ and giant bison.



An Expanding Country

_____ explored the West from 1804 to 1806. On their return trip in 1806, a party led by Captain Clark explored the Yellowstone River. During his time on the Yellowstone, Clark saw a prominent rock formation on the river's south bank. He carved his name and the date—both of which can still be seen—into the rock, now called Pompeys Pillar.



After the explorers reported finding abundant wildlife, fur trappers rushed into the region, using the Yellowstone River for navigation. In 1832 the first _____ was used to transport people up the river and goods back down. In the 1860s, gold was discovered in Montana, and the Yellowstone River allowed some _____ to reach their destinations.

Little Homesteads on the Prairie

The Homestead Act of 1862 encouraged settlers to come to the area. Rich, low-lying land along the Yellowstone was in high demand, because living and farming in an area with so little rain was otherwise difficult. The Yellowstone River was **diverted**—meaning water from the river was moved for **irrigation** (watering) purposes—in an attempt to bring water to the arid land.



America's First National Park

More people also meant more attention for the awe-inspiring thermal features all around the headwaters of the Yellowstone River. In 1872, a large part of the Yellowstone River watershed was set aside as _____, the first national park. Shortly after, in 1883, a spur of the _____ was built to bring tourists along the Yellowstone River to visit the park.

Not Enough, Too Much

For thousands of years people have been using the Yellowstone River and the flat land along it for transportation, food and other resources. Issues along the Yellowstone River aren't so different today than they were in the past. Land along the river remains valuable, and tension exists between those who would like to see the river run wild—the Yellowstone is the longest undammed river in the lower 48 United States—and those who have a stake in protecting land from water.



Gardiner, Montana, is located at the North Entrance of Yellowstone Park just inside Montana. The top of the Yellowstone Arch there reads, "For the Benefit and Enjoyment of the People."

RiVER OF CHANGE

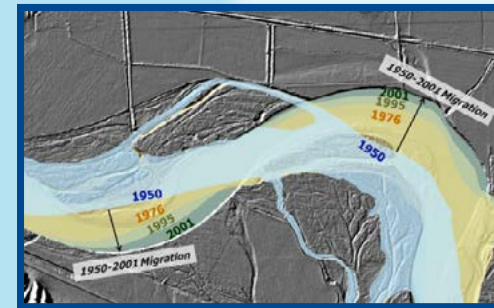
River on the Move!

What do a snake and the Yellowstone River have in common? The way they move! Like a slithering snake, the Yellowstone River moves from side to side across its **floodplain** (flat area next to a river that is likely to flood). That movement pattern changes the river over long periods of time.

The power of water causes the river to move like a snake. Land is **eroded** (broken down or excavated) where water moves fastest—on the outside of curves—and **deposited** (dumped) on the inside of curves, where water slows. The channels of the river find new paths as the water moves sediment through a process of give and take called **channel migration**.

No Barriers

All rivers naturally move across the landscape due to channel migration. However, on many rivers humans have built dams, which can alter the natural migration of the river. The Yellowstone River is the longest undammed river in the lower 48 states, making it particularly active. In the aerial view to the right, you can see how much the river has moved and changed over just 50 years.



Karin Boyd

People and an Active River

The Yellowstone River has been moving back and forth across its floodplain for thousands of years—whether there are people living along its banks or not.

As people did begin to settle and develop the area, they often chose the flat, fertile land next to the river as a prime place to construct homes, plant crops and build highways and railroads.

As the Yellowstone channel has continued to migrate, however, conflicts have erupted between the river's natural processes and the human settlers who call its banks home. The movement of the river can cause banks to collapse, which sometimes threatens the homes, farms, roads and railroads that have been constructed along the river.



Karin Boyd

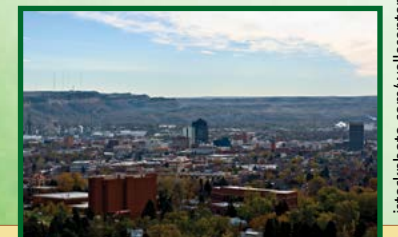
To protect these settlements, people have lined riverbanks with various materials called **riprap**, which prevents riverbank erosion. Today, most riprap is made of rocks and concrete, but in the past people used whatever they had—including old cars!



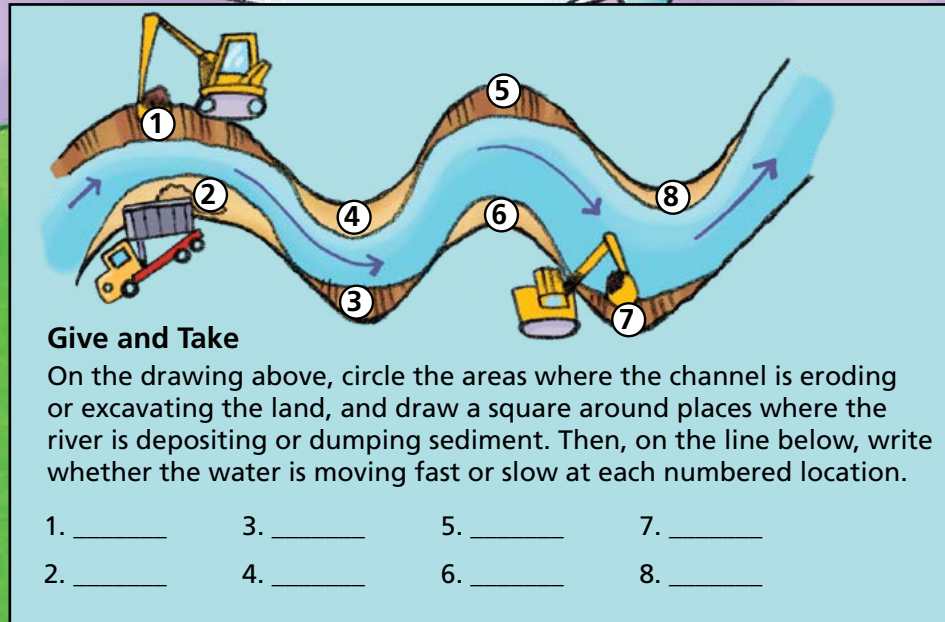
Merle Ann Loman

Sum of the Parts

Stabilizing the riverbank in one place may not seem like a big deal, but when such actions are repeated over and over again down the length of the river, we may start to see **cumulative effects** (changes from actions adding up), and the natural movement and processes of the river may be altered. Land that used to flood may no longer receive the water that the plants growing there desperately need. River waters may flow faster as they are confined to a narrower channel.



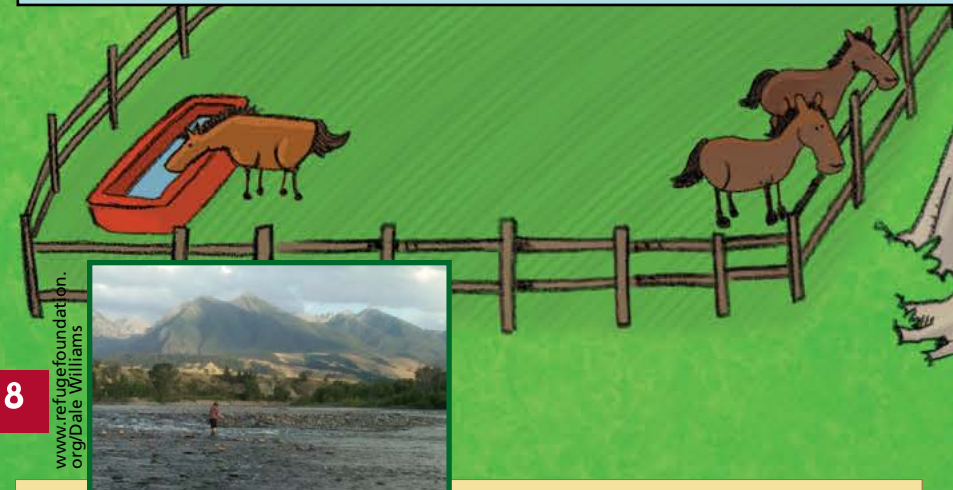
istockphoto.com/wellesenterprises



Give and Take

On the drawing above, circle the areas where the channel is eroding or excavating the land, and draw a square around places where the river is depositing or dumping sediment. Then, on the line below, write whether the water is moving fast or slow at each numbered location.

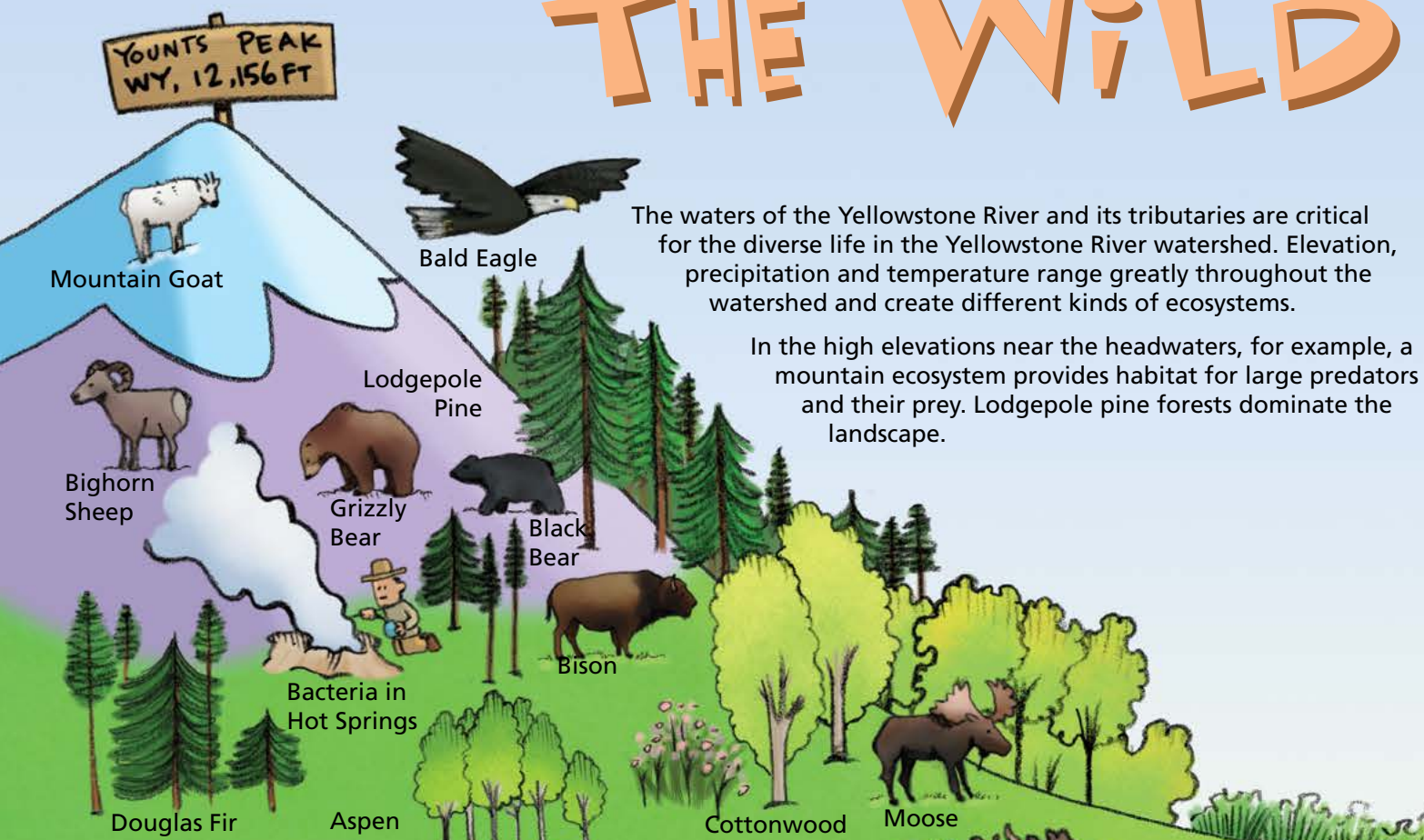
- | | | | |
|----------|----------|----------|----------|
| 1. _____ | 3. _____ | 5. _____ | 7. _____ |
| 2. _____ | 4. _____ | 6. _____ | 8. _____ |



The waters of the Yellowstone River in Paradise Valley south of Livingston, Montana, attract anglers from around the world.

Billings is the largest city in Montana, as well as the largest city along the Yellowstone River, with a population of approximately 104,000 people (2010).

THE WILD YELLOWSTONE



The waters of the Yellowstone River and its tributaries are critical for the diverse life in the Yellowstone River watershed. Elevation, precipitation and temperature range greatly throughout the watershed and create different kinds of ecosystems.

In the high elevations near the headwaters, for example, a mountain ecosystem provides habitat for large predators and their prey. Lodgepole pine forests dominate the landscape.



Canada Geese

About two-thirds of the Yellowstone River's 678 miles winds through prairie ecosystems. These vast grasslands provide wide-open spaces for farms and ranches as well as wild animals.

Uninvited Guests

Non-native species (plants or animals that did not historically live in an area) are found in the Yellowstone River watershed. These "invaders" compete with native species (species historically found in the watershed) and can disrupt ecosystem balance by impacting biodiversity (different kinds of life), food chains and predator/prey relationships. For example, native Yellowstone cutthroat trout in Yellowstone Lake are threatened by non-native lake trout. And along most of the Yellowstone, non-native plants like saltcedar and Russian olive are growing in places where cottonwood and willow trees once stood.

Steve Dewey, Utah State University, Bugwood.org



Saltcedar Russian Olive

David J. Moorhead, University of Georgia, Bugwood.org

are replacing



Cottonwood and Willow

Montana Fish Wildlife and Parks



Lake Trout

are replacing



Yellowstone Cutthroat Trout

istockphoto.com/jmoor17

FishEyeGuy Photography

Something Fishy

In the river's waters, temperature changes create zones where different types of fish can live. Draw a line from each fish to the zone in the river where it would thrive.



Brown Trout
Cold Temperature Zone

Channel Catfish
Transition Zone

UPPER YELLOWSTONE Cold Temperature Zone



Yellowstone Cutthroat Trout

Rainbow Trout

Burbot

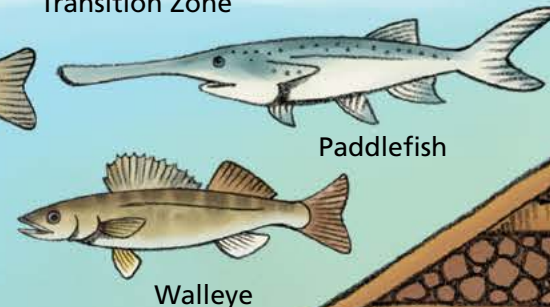
Sauger

Smallmouth Bass

In higher, colder areas, fish such as rainbow and brown trout can be found.

As cold water transitions to warmer water in the Middle Yellowstone, there are fewer trout, and walleye and smallmouth bass are present. Prehistoric-looking paddlefish also can be found here.

MIDDLE YELLOWSTONE Transition Zone



Paddlefish

Walleye

The pallid sturgeon is one distinctive fish that can be found in the warmest waters of the Lower Yellowstone.

Expanding the Range of the Pallid Sturgeon
Although undammed, the Yellowstone does have several **diversions** (structures that divert water, but still allow water to flow over). Diversions provide irrigation water to grow crops but can also cause problems for fish. The pallid sturgeon is one Yellowstone River fish affected by diversions. Pallid sturgeon—which are **endangered** (meaning there aren't many of them left)—can be as large as 60 pounds (27 kg) and may live 100 years! They have difficulty swimming upstream past the Intake Diversion near Glendive, Montana, which limits their **range** (how far they can swim). Watershed managers are working together to modify or replace the diversion to make it work for both people and wildlife and to give the pallid sturgeon more habitat, which would allow them to reproduce more.

LOWER YELLOWSTONE Warm Temperature Zone



Pallid Sturgeon

Much of the Yellowstone River watershed is prairie. Flat grasslands like this provide opportunities to grow crops that can survive dry conditions.

YELLOWSTONE MARKETPLACE

Did you know the Yellowstone River watershed provides jobs and helps feed the world? The watershed covers a large area across three states and a lot of different kinds of landscape. Here are a few examples of people who work in the Yellowstone River watershed: farmers, ranchers, loggers, miners and outdoor guides.

Water and the economy of the Yellowstone River watershed have always been tightly connected. Floods and droughts can have devastating impacts for businesses, while rain in June can give farmers a boost. Now can you see how Yellowstone River waters are key to many families' livelihoods?

Agriculture

The Yellowstone River watershed marketplace contains a huge amount of agricultural lands. Because of this, most of the Yellowstone River watershed runs on snowpack. Water is stored in snow that falls all winter in the mountains. As the snow melts, it feeds the Yellowstone River. Because the weather stays cold in the spring in the mountains, water from the winter snowpack flows to farmers just when their crops need it most—late spring and early summer.

Farms and ranches can be found almost everywhere along the Yellowstone River and its tributaries. Farmers grow crops such as wheat, barley, safflower, corn, dry beans, dry peas, alfalfa hay, grass hay and sugar beets. Ranchers raise beef cattle, milk cows, pigs, sheep, chickens, horses and honeybees. Some of the farmland in the Yellowstone River watershed is too far away from the river to be irrigated. In these areas, farmers practice **dryland farming**—choosing crops that grow well in dry climates with little water and working with the soil to hold what little water falls from the sky.

Tourism and Recreation

The headwaters of the Yellowstone River are near Yellowstone National Park. The park draws over 3.6 million visitors per year. Tourists come to the park to see the hot springs and geysers, watch for wildlife and participate in recreational activities such as hiking. As the river flows out of the park, more recreational activities are available; rafting, kayaking and fly fishing are popular along the Yellowstone River. Farther downriver, dinosaur fossils draw tourists to communities near the river.

Mining

Coal, oil, metals and natural gas are all natural resources mined in the Yellowstone River watershed. There are about 30 coal mines throughout the Yellowstone River watershed, and the Bakken Oil Field (a reserve of oil and natural gas) lies under parts of Montana, North Dakota and Canada. Most of these resources are shipped out of state and sometimes to other countries.

See What You Use

Can you list five products that you or your family use that may have originated in the Yellowstone River watershed?

1. _____
2. _____
3. _____
4. _____
5. _____



Coal is found underground near Forsyth, Montana, and also in parts of Wyoming and North Dakota. Coal is mined here and shipped out to other states and other countries by train along the Yellowstone River.

Badlands (banded rocks eroded by rain and wind over millions of years) near Glendive and Terry, Montana, may contain dinosaur fossils.

YELLOWSTONE WATERSHED

HEALTHY HABITS

What do you do to stay healthy? Do you eat nutritious foods, exercise and drink lots of water? Wash your hands before meals? Get regular check-ups with the doctor and dentist? Practicing healthy habits is a great way to keep from getting sick.

Like you, the health of a watershed depends on the habits of the people who live in it—and everyone plays a role. Watershed management teams include lawmakers, scientists, educators and especially ordinary citizens just like you!

Healthy habits practiced in a watershed are called **Best Management Practices (BMPs)**. There are BMPs that each team member can practice to help keep a watershed healthy. A good watershed management team uses best management practices for “CPR”—Conservation, Protection and Restoration—to keep a watershed healthy. Here are some BMPs you can try:

Conservation: Use Water Wisely! Don't Waste It!

Everyone can use water conservation BMPs to make an impact. Turn off the tap when you brush your teeth. Take brief showers. Sweep driveways and sidewalks with a broom. Make sure the faucet is completely off after you've used it, and report leaks to your parents or teachers.

Protection: Keep Water Clean! Don't Pollute!

You can have an impact on watershed protection, too. Recycle when you can and put the rest of your trash in a trash can to prevent garbage from ending up in waterways. Clean up after your pets so that their waste doesn't pollute the water. Don't dump anything down storm drains.

Restoration: Return Polluted Watersheds to Health!

Sometimes, even when you practice healthy habits, you can get sick and need a doctor.

The same can happen to watersheds. In that case, watershed management professionals—not doctors—can propose solutions, like restoring **riparian areas** (zones next to a river), wetlands or vegetation. You can help by volunteering for projects like waterway clean-up and tree planting.



Best Management Practices

Draw lines to match the description of each water user and the BMPs described to the illustrations to the left.

Everyone can do their part to protect a watershed by participating in river clean-ups and not dumping waste in storm drains.

Ranchers help protect the watershed by creating water gaps that funnel cattle toward less erodable water sites or by using containers for off-stream watering.

Farmers help conserve water by using efficient sprinklers that use less water, scheduling irrigation for cooler morning and evening hours so less water is lost to evaporation and taking care not to water and erode the riverbank.

Business owners reduce stormwater runoff by including porous (sponge-like) surfaces such as grass, trees and mulch in and near parking lots to slow down and catch water in constructed ponds or wetlands.

Elected officials and government agencies play a role in how land is used by making rules and laws. For example, rules about how far back buildings can be built on riverbanks can save a lot of money and trouble when a river floods.

The Yellowstone River and its tributaries draw people from all over the world for rafting, kayaking, fishing and more.

Tourists and other recreationists help by not littering, removing trash and cleaning their boats to prevent the introduction of non-native species.



River Reflections

If you are wondering who is responsible for watershed protection, just look at your reflection in the river! Choose a BMP that you can do to help protect the watershed where you live. In the space below, draw a picture of yourself taking action in your watershed!



The confluence of the Yellowstone River and the Missouri River is just east of the North Dakota border near Fort Buford, North Dakota.



Sidney, Montana, is located above a very large reservoir of oil called the Bakken Formation.

Answer Key and More Activities

can be found at www.projectwet.org/discover-the-yellowstone-river

Scan the code with a smart phone to access the Answer Key online.



Scavenger Hunt

Use the book to help you answer the following questions:

1. Use the following words to fill in the paragraph about watersheds. The first word is done for you.
headwaters confluence tributaries main stem
All water in a watershed flows from higher points to lower points. Water from the headwaters of the river comes together to form the _____. Smaller rivers, called _____, also flow into the main river. The point where the Yellowstone River meets the Missouri River is called the _____.
2. What is one use for a hydrograph? _____
3. Use the timeline on pages 6 and 7 to fill in the dates below:
Lewis and Clark explored the West between _____ and _____.
Yellowstone became a national park in _____.
The most recent diversions on the Yellowstone River were built in _____.



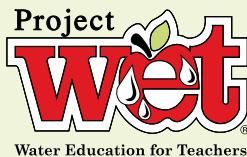
WANT TO LEARN MORE ABOUT WATER?
VISIT WWW.DISCOVERWATER.ORG FOR MORE FUN!

4. On the drawing, choose the number of the location that would be the best place to build a house so that riverbank erosion is least likely to affect it. _____



5. List one animal that you may see in the mountains of the Yellowstone River watershed. _____
List one animal that you may see in the plains of the Yellowstone River watershed. _____
6. What are the three major areas of income for the Yellowstone River watershed marketplace?
1. _____
2. _____
3. _____
7. What is one thing you can do personally to help conserve, protect and/or restore the Yellowstone River? _____

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Project WET Foundation
Vision: Every child understands and values water through action-oriented education, ensuring a sustainable future.
www.projectwet.org



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Yellowstone River
Conservation
District Council

With support from:



Montana Department
of Natural Resources



Montana Fish,
Wildlife and Parks



Natural Resources
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Center for Invasive Plant
Management

*The opinions expressed in this publication do not necessarily reflect those of the National Park Service or other funding entities.

Published by the Project WET Foundation
Dennis L. Nelson, President and CEO

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Field-tested by:

Ms. Gillespie's 5th Grade Class (2011-2012), East Side School, Livingston, Montana
Mrs. Wilson's 5th Grade Class (2011-2012), Anderson School, Bozeman, Montana
Mr. Strachan's 5th Grade Class (2011-2012), Blue Creek Elementary, Billings, Montana
Ms. Riley's 5th Grade Class (2011-2012), Gardiner School, Gardiner, Montana
Mrs. Mathison's 5th Grade Class (2011-2012), Lincoln Elementary School, Miles City, Montana

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PDF ebook edition, April 2015.
ISBN, print edition: 978-1-888631-95-1
ISBN, PDF ebook edition: 978-1-942416-58-6