

River Features & Function

What are the key features and eight characteristics of healthy freshwater rivers in N.W. Montana?

◆ Grade Level(s)

9-12th grade

◆ Subject Areas

Earth Science, Biology, Ecology, and Human Impacts

◆ Key Topics

River features, hydrology, aquatic habitats, floodplain

◆ Duration

Preparation Time: 30 min

Activity Time: 2 x 50 min

◆ Setting

Classroom (Individual)

◆ Skills

Gathering and applying information

◆ Standards

NGSS & MT Science Std.:

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

ESS2.C: Roles of Water in Earth's Surface Processes

ESS3.C: Human Impacts on Earth Systems

CROSSCUTTING CONCEPT(S):

Stability and Change

Cause and Effect

SCIENTIFIC & ENGINEERING

PRACTICE(S):

Constructing Explanations and Designing Solutions

Overview

Freshwater rivers are an amazing erosional force upon the land. As they wind their way from the mountains to the oceans they create unique ecosystems that support a variety of life. Students will be introduced to the key features and characteristics of rivers that help to create complex, healthy habitats for aquatic and terrestrial organisms.

Objectives

Students will be able to:

- identify and describe the basic features of a river.
- explain how the eight key characteristics of a healthy river impact the water quality, water flow, erosion, and availability of diverse aquatic habitats within the river.
- describe one way humans are impacting the natural features of a local river and provide one solution that could help to minimize the impact.

Materials

Warm Up / Activity / Wrap Up

- Computer, projector, and student worksheets
- Colored pencils
- Aerial photo of a local river or Google Earth image
- Computers or tablets with the Google Earth installed

Advanced Preparation

- Copy the student worksheets #1-7 (double-sided).
- Prior to class, pre-load the River Features and Function presentation found on the FLBS website:
<https://flbs.umont.edu/newflbs/k12teachingmaterial>
- To provide relevance to your students, find photographs of local examples of the river features and healthy characteristics explored in this lesson that will allow the students to connect the lesson to the area in which they live.
- Explore how to zoom in and out of your geographical region using the Google Earth Program on your computer and/or tablet.

Background

Freshwater rivers are host to a wide-variety of species. The diversity of species found within a river can be greatly impacted by the quality of the water and by the variety of the aquatic habitats available within the river.

Seasonal and temporal changes in water flow can greatly impact the distribution of river features, such as, **pools, riffles, runs, glides, point bars, and meanders**. Although the location of these features can change as river channels migrate and move throughout the **floodplain**, the proportion of these features throughout the river are relatively stable.

As the water flows downstream it can move through narrow canyons and wide floodplains according to the natural geology through which it flows. The rivers in Northwest Montana are filled with relatively clean, clear, and cold water. The **habitat complexity** in these rivers creates high levels of **biodiversity**. The diversity is greater in rivers that can move freely and access their natural floodplains. As water levels rise from **baseflow** to **bankfull** and finally to **flood** levels each spring, it brings with it sediments that serve as natural fertilizers for the surrounding **riparian** and **upland** areas found along the rivers. As the water recedes in the summer, the nutrients left behind in the riparian zones help to trigger more plant growth and as a result, create diverse habitats along the river corridors for mammals, birds, amphibians, and reptiles. The riparian zones help to stabilize the rivers, prevent erosion, and provide shade along the river boundaries. They also contribute large woody debris that is deposited along the river, which provides natural shelter for adult, juvenile, and baby fish.

The natural scouring that occurs by high flood water, cleans out the pools and spawning sites used by native Westslope Cutthroat trout and Bull Trout. The flood waters also help to replenish the groundwater aquifers. These aquifers release water back into the rivers during the drier summer months and as a result, they help to provide important thermal refuges for the aquatic life.

A river's access to its floodplains can greatly impact the health of the river. If a river does not have access to its floodplain, the river will create deeper channels that hold a larger volume of the water. The higher water flow will destabilize the river banks, increase the amount of erosion, and fill the pools with sediment. In contrast, a river with access to its floodplain will have a decreased water flow, less channel migration, and less erosion. These healthy rivers have more varied aquatic and riparian habitats that support more life.

When humans expand their development into floodplains they often try to control the seasonal flow of water with dams and other man-made structures. Alterations to the natural flood cycles can cause devastating effects to biodiversity and habitat complexity in and around a river.

Humans need to rethink flood management so that the rivers can return to a more natural state. For example, scientists in Montana and Switzerland are working with the dam operators to mimic seasonal flood events by creating artificial floods below the dam. These man-made floods are slowly restoring the river's access to its floodplain, which in turn is scouring the river, redistributing the natural river features, fertilizing the riparian zones, and shifting the river back to a more healthy state.



The flood event along the Middle Fork of the Flathead River (shown above) caused the main river channel to shift from one side of the floodplain to the other in a 24-hour period of time. In doing so, the river features were redistributed and the nutrient-rich sediment was deposited along the riparian and upland zones. This flood event was not as destructive as it could have been since the river had full access to its floodplain.

River Features and Function

Lesson Vocabulary

Aquatic zone – The area covered by water in a river.

Bankfull – The maximum flow of water in a river channel.

Baseflow – The lowest flow of water through a river that typically occurs every summer.

Floodplain Flow – The flow of water through a river that completely covers the riparian zone and floodplain. This type of flow typically occurs every 25-100 years.

Floodplain – Land built of sediment deposited by the river that is regularly covered with water during floods.

Glide – The transition zone between a pool and a riffle, located just below the pool. The water moves slowly with little turbulence over fine gravel, sand, and organic matter.

Hydrology – The study of Earth's water and its movement in relation to the land.

Meander – A bend in a stream or river.

Point bar – A shallow, depositional area along the inner edge of a meander composed of gravel, sand, silt, & clay.

Pool – A deep, cool area of a stream often found along the outer edge of a meander where the stream bottom is more easily eroded.

Riffle – A short, straight section of a stream found midway between two meanders. A riffle is often shallow and characterized by turbulent water flowing over and through gravels, cobbles, and boulders.

Riparian Flow – The flow of water through a river that covers the riparian zone that borders the river or stream. This type of flow typically occurs every few years.

Riparian Zone – The vegetated region that borders the margins of a river or stream and serves as a transitional zone between the aquatic zone and the upland areas.

Run – An area in a stream with deep, fast water with little or no turbulence that typically follows a riffle.

Upland Zone – Region of land along a river or stream at elevations higher than the floodplain, riparian zone, and aquatic zone.

Procedure

◆ Warm Up (10 minutes)

- **ENGAGE:** Display the “River Features and Function” presentation and pass out the students worksheets.
- Slides #1-2: Either display the Google Earth images of the Flathead or Swan River or use Google Earth to display a portion of a river in your local area. Ask the students to predict and record where they might find adult, juvenile, or fry (baby) fish. Discuss what all fish need to survive (e.g. cool water, oxygen, shelter (places to hide), food, etc.). Ask the students where they would expect to find cooler water (deep areas), more oxygen (fast moving areas), and more food (areas the insects like to live and hide in)? Students record their responses on their worksheet.

◆ PART I – River Features and Function (40 minutes)

- Display the “River Features and Function” presentation on the projector.
- Pass out the colored pencils so that each student has their own pack of 12 colors.
- Slides #4-39: As you explain the slides, guide the students as they complete the student worksheets.
- Slide #40: Discuss how healthy rivers with access to the floodplain can shift the path of the water frequently over of time. Different areas of the floodplain get more or less disturbance.
- Slide #41: Discuss how flood events create new habitats over time. The river features/habitats of a healthy river may move in space but remain relatively stable in abundance throughout the floodplain.
- Slide #42: Discuss how variable the river water temperature can be throughout the summer and how the groundwater springs, pools, and woody debris create thermal refuges at this time of the year. Animals living in the shallow areas need a higher tolerance for a wide range of daily temperature change.

◆ Part II – Local River Features (25 minutes)

- **EXPLORE:** (Slide 43) Ask the students to use Google Earth on a computer or tablet to examine a river in the region that they live in.



River Features and Function

- Ask the students to take a screen shot of the river, insert it into a Google Presentation, and then to identify and label the meanders, glides, riffles, runs, pools, point bars, and side channels of the river using text boxes and arrows.
- Students answer the following questions in their Google Presentation:
 - Is there evidence of river channel migration over time?
 - Does the river have access to a flood plain?
 - Does the river have a well-established riparian zone? Why or why not?
 - Where would you expect to find adult fish, juvenile fish, fry, or eggs?
 - Which areas of the river could be potential spawning sites?

◆ Wrap Up (25 minutes)

- **ELABORATE:** (Slide 44) Group the students into pairs or ask them to partner up with their closest neighbor. Ask the students to conduct a quick 3-minute brainstorming session on whether the rivers in the region are in a natural and/or healthy state? Ask the students to record their ideas on their worksheet and to be prepared to share one observation with the class. Student share and discuss their observations.
- **EXPLAIN:** (Slide 45) Ask the students to describe one way humans have impacted the natural features of a local river and one solution that could help minimize the impact.
 - Students record their ideas on their worksheet and share with the class.
- **EVALUATE:** (Slide 46) Ask the students respond to the following writing prompt on their worksheet:
How do the eight characteristics of a healthy river impact the river's water quality, water flow, amount of erosion, and availability of diverse habitats?
Note: Students may complete their response for homework if more class time is needed.

Teacher Resources

Assessment Options

Have students:

- **complete the River Features and Function** activities as described.
- **summarize their understanding** by responding to the writing prompt.
- create a **portrait of understanding or collage** that depicts the key river features and the 8 attributes of a healthy river.

Modifications

- The students can complete the river features portion of the worksheets at home to free up class time.
- The worksheets can be enlarged for students in need of larger text.

Extensions

Students can:

- **go on a scavenger hunt** to find and document the 8 attributes of a healthy river that are found along a local river or stream.
- **use the engineering design process create a solution** to a human impact that helps a local river to restore some of its natural function.

Online Resources

To order an Explore the River DVD go to the following website:

<http://exploretheriver.org/>

Acknowledgements

Content from this lesson was retrieved from the Explore the River DVD created by the Confederated Salish & Kootenai Tribes.



Photo credit: Paul Frederickson
(CC BY-SA 2.5)

Due to the installation and operation of the Seli's Ksanka Qlispe' Dam, sections of the Flathead River south of the dam have become channelized over time and are now unable to fully access the floodplain. Channelization makes the river deepen and causes an increase in volume through that river section. Channelized water does not flow into the floodplain during floods, which in turn causes a decline in riparian plant health and damaging floods downstream.



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Warm Up

Student Worksheet (1 of 7)

Look at the provided image of a local river and answer the following questions:

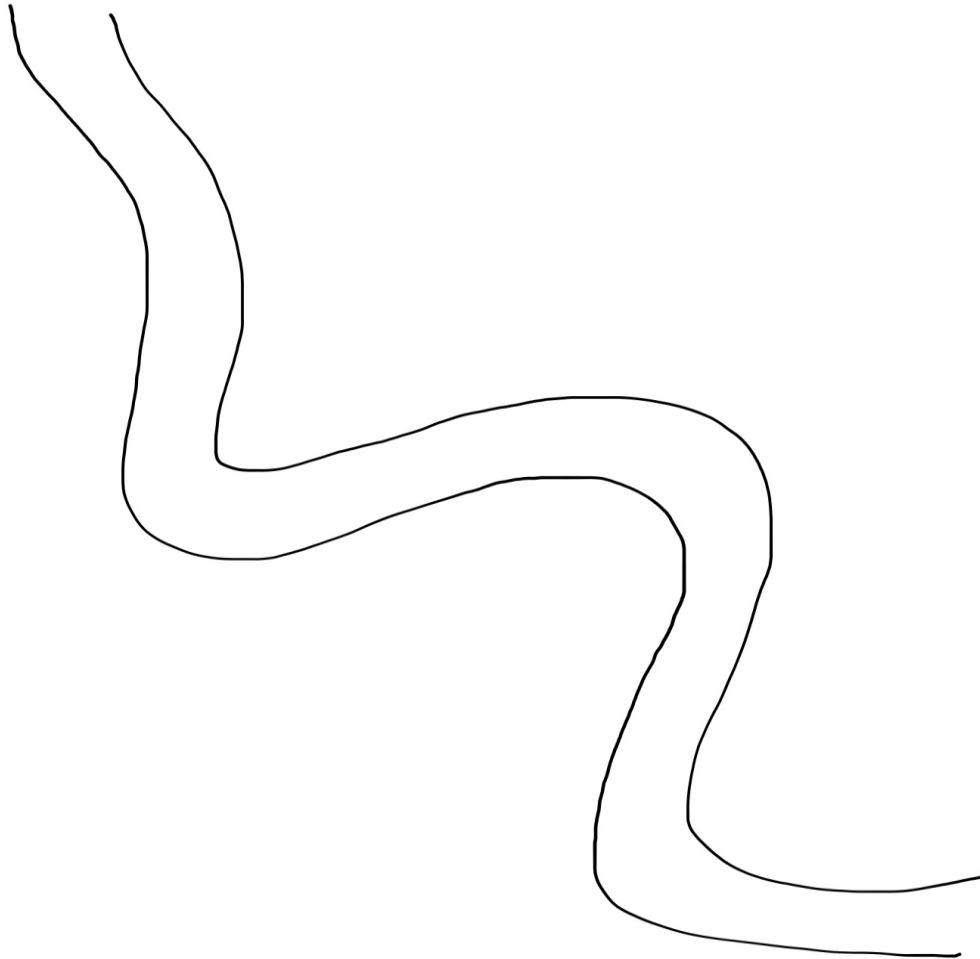
Make a prediction. Where do you think you would find adult, juvenile, or fry (baby) fish?

Brainstorm...What do all fish need to survive?

Part I: River Features and Function

Use the colors in the key below and the provided presentation to identify, label, and describe the features of a river on the diagram below.

- | | | |
|---|--|--|
| <input type="checkbox"/> Aquatic Zone (violet) | <input type="checkbox"/> Meander (black) | <input type="checkbox"/> Pool (sky blue) |
| <input type="checkbox"/> Riparian Zone (yellow green) | <input type="checkbox"/> Riffle (blue) | <input type="checkbox"/> Point bar (brown) |
| <input type="checkbox"/> Upland Zone (forest green) | <input type="checkbox"/> Run (orange) | <input type="checkbox"/> Glide (red) |

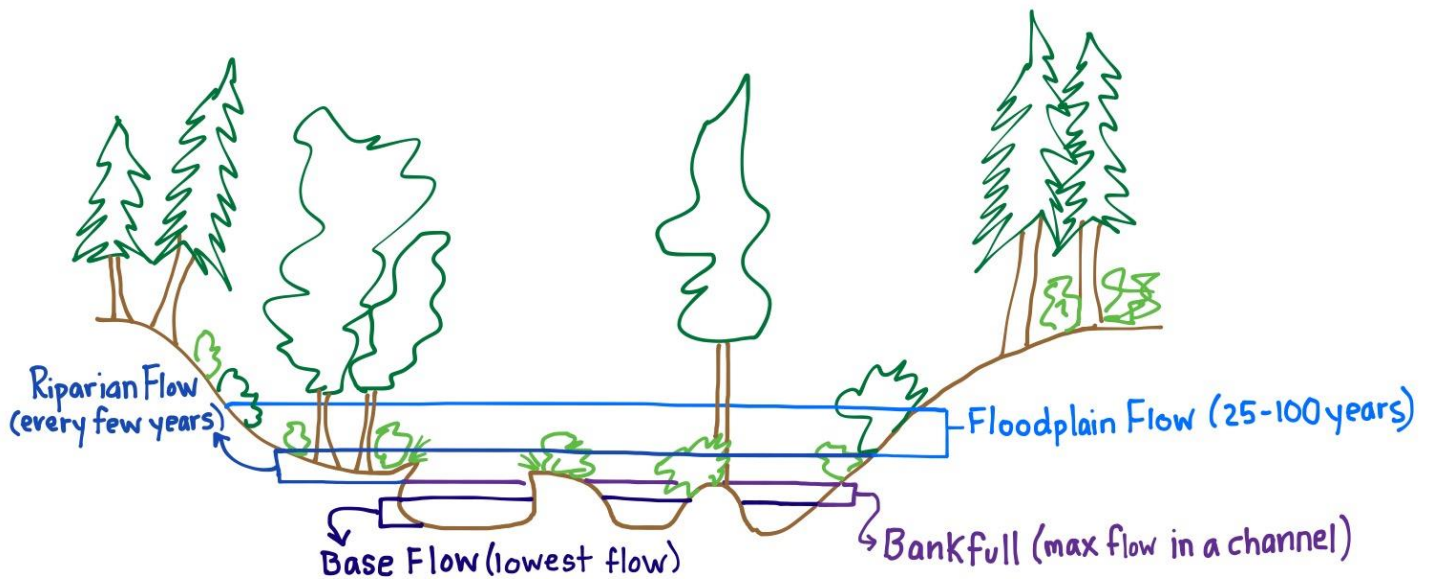


Use the provided presentation to complete the tasks below.

EIGHT CHARACTERISTICS OF A HEALTHY RIVER

1. ALL FLOWS HAVE AN IMPORTANT FUNCTION AND ARE NECESSARY FOR A HEALTHY ECOSYSTEM.

Add color to show the different flows and describe the impacts the flows have upon the river.



2. FLOODS PERIODICALLY SHIFT THE MEANDERS AND REARRANGE THE POINT BARS.

How do shifting meanders impact the riparian communities?

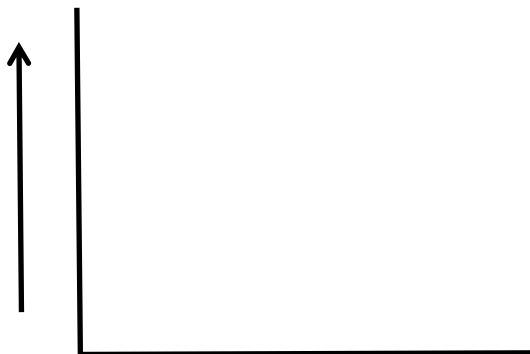
List the habitats that shifting meanders help to create.

How do shifting point bars impact the quality of the aquatic habitat for the fish?



3. A HEALTHY RIVER HAS ACCESS TO ITS FLOODPLAIN.

Complete the graph below showing how the stream power and destructiveness increases when the river does not have access to the floodplain.



Fill in the table below to summarize how the system is impacted by floodplain access.

River Has Access	River Does Not Have Access

4. MATERIALS IN THE RIVERBED NATURALLY MOVE PERIODICALLY.

During what time of year does the amount of stream flow typically peak?

Baseflow	= _____
↓	
30-40% Bankfull	= _____
↓	
75-85% Bankfull	= _____
↓	
Bankfull	= _____
↓	
> Bankfull	= _____

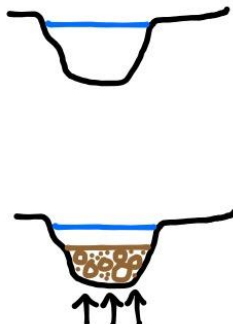


River Features and Function

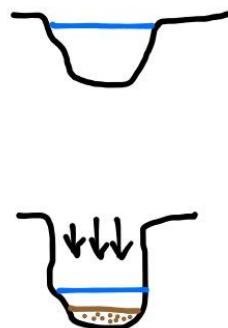
Student Worksheet (4 of 7)

5. THE SEDIMENT ENTERING THE RIVER EQUALS THE SEDIMENT LEAVING THE RIVER.

What happens to the river channel when the sediment size and amount of sediment increases?



What happens to the river channel when the sediment size and amount of sediment decreases?



Why does the river need a balance of sediment flow into and out of the river system?

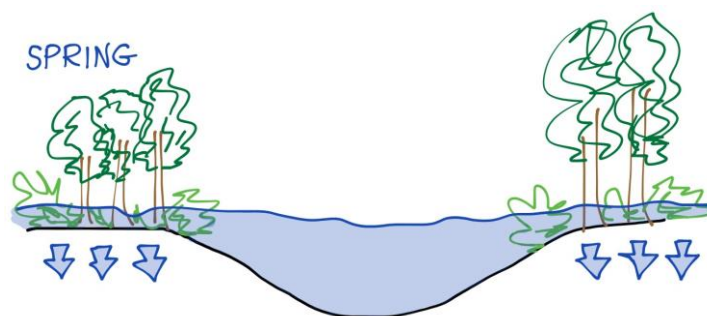
How do periodic floods restore the sediment flow balance?

Is the sediment flow in the rivers in your area out of balance? Explain your answer using a specific example that you have observed locally.

6. HEALTHY (VEGETATED AND UNDEVELOPED) FLOODPLAINS SOAK UP THE WATER, REPLENISH GROUND WATER AQUIFERS, PREVENT DOWN STREAM FLOODING, AND CYCLE NUTRIENTS THROUGH THE RIPARIAN ZONE.

Why is a floodplain describes as a sponge?

How do the riparian plant roots systems impact the rate of water absorption AND soil erosion?



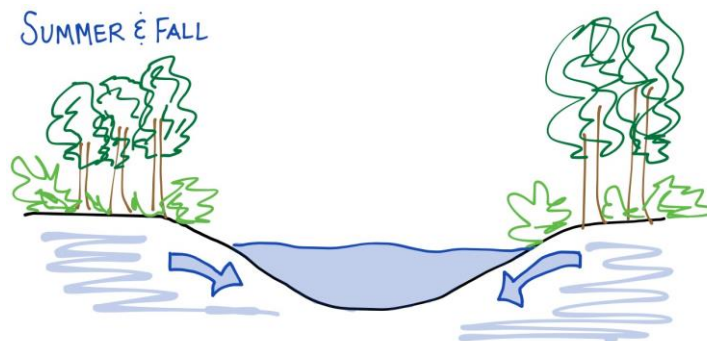
How does slowing the rate of run off help prevent floods downstream and to recharge the ground aquifers?



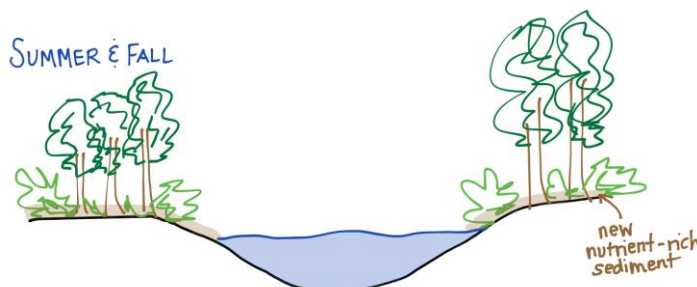
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Why is stored water in the aquifer important for organisms living in the stream during the summer and fall?



Many riparian trees like cottonwoods need large amounts of water to survive. What do you think happens to the cottonwood stands when the river does not flow into the floodplain?



Provide one way in which floods promote new plant growth within the riparian zone.

7. LARGE 10-20 YEAR FLOODS CREATE A COMPLEX RIVER ENVIRONMENT.

List six ways large floods help to create a complex environment.

-
-
-
-
-
-

8. NATURAL FLOWS LEAD TO DIVERSE RIPARIAN COMMUNITIES OF PLANTS AND ANIMALS.

Select TRUE (A) or FALSE (B) for each of the following:

_____ Riparian plants cannot adapt to the constantly changing flows.

_____ Riparian plant communities will be more diverse (contain more species) if base, bankfull, riparian, and flood flows all occur regularly in the river.

_____ When floods scour the floodplains, shift the meanders, and cover the land in water, there are fewer habitats available for the different riparian plant communities.

Fill in the blank using the terms below.

habitat simple complex large wood shade

The riparian zone is _____ in physical structure. Forested riparian areas provide _____ along the river bank, _____ in the stream channel, and varied _____ for mammals, birds, amphibians, fish, and insects.



Explore with Google Earth

Use Google Earth on a computer or tablet to zoom in and examine _____ river. Take a screen shot of the image, insert it into a Google Slides presentation and then identify and label the meanders, glides, riffles, runs, pools, point bars, and side channels of the river. Share the presentation with your teacher.

Answer the following questions:

- Is there evidence of river channel migration over time?
- Does the river have access to a floodplain?
- Does the river have a well-established riparian zone? Why or why not?
- Where would you expect to find adult fish, juvenile fish, eggs or fry?
- Which areas of the river could be potential spawning sites?

Wrap Up

Conduct a quick 3-minute brainstorming session with a partner on whether the rivers in the region are in a natural and/or healthy state? Record your ideas in the space below and select one observation to share.

Describe one way humans have impacted the natural features of a local river.

What is one solution that you could use to minimize or remove the impact described above?



SHOW ME WHAT YOU KNOW!

INDIVIDUALLY respond to the following writing prompt:

How do the eight attributes of a healthy river impact the river's water quality, water flow, amount of erosion, and availability of diverse habitats?

You may write/draw/describe your response in the box below.



River Features and Function

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