Rivers of the World

Objective:

1. Students will investigate and explain how rivers are formed.
2. Students will demonstrate knowledge of the unique ecosystems of specific rivers and make comparisons.
3. Students will analyze data and identify possible solutions to natural disasters that impact the ecosystems, flow and water quality of rivers.
4. Students will demonstrate and understanding of invasive species, floods, droughts, erosion, and destruction of habitats related to rivers.
5. Students will investigate local rivers and form conclusions related to conservation.

Grade: 6-8

Key Vocabulary:

- **Ecosystem**
- **Terrain**
- **Erosion**
- **Mustelidae**

Related Literature:

Every River on Earth
Neil Carpathios

The Grand Adventure
Mark A. Hicks

Tom's River
Dan Fagin

Performance Objectives:

Grade 6: Strand 1: Concept 1 – PO 2-3; Strand 3: Concept 1 – PO 2; Strand 3: Concept 2 – PO 1-4; Strand 4: Concept 3 – PO 1-2
Grade 7: Strand 1: Concept 3 – PO 1-5; Concept 4 – PO 1; Strand 3: Concept 1 – PO 1-3; Strand 4: Concept 3 – PO 4-6
Grade 8: Strand 1: Concept 3 – PO 3-5; Concept 4 – PO 2-5

NGSS: MS-LS2; MSESS3-4; MS-ETS1-1

Background Information:

The rivers of the world provide a source of life to humans, animals, plants, and insects. Habitats for a wide variety of species can be found along the side of rivers and in the river itself. Among the longest rivers in the world are the Amazon, Mississippi, Yangtze, and Nile. These rivers like all others in the world are critically important to the natural environment, **ecosystems**, and habitats in and around them. An ecosystem is a biological community of interacting organisms and their physical environment.

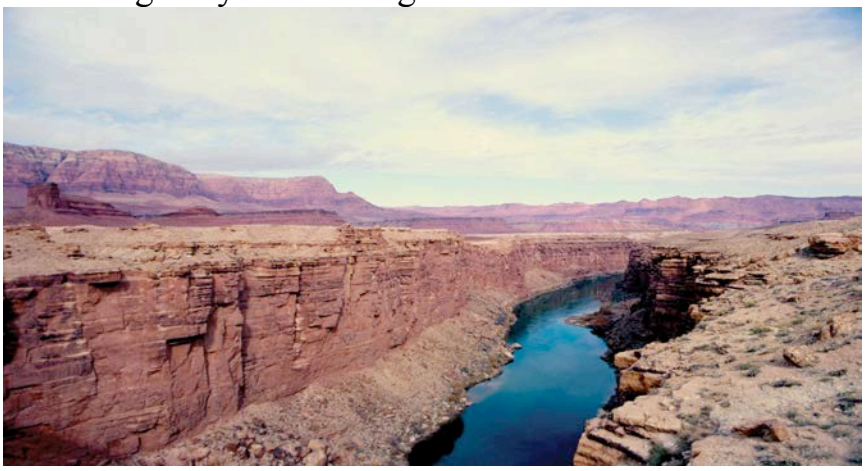
Rivers are naturally flowing streams of water that generally originate high in the mountains where rain fall, melting snow, and even ice contribute to their formation. Rivers exist on every continent in the world. From glacier packed areas to dry deserts, rivers carry an abundance of life-sustaining resources to their surrounding environments. Rivers flow downhill from their source, which can include underground springs, melting snow, and water that evaporated into the atmosphere and then fallen back to earth as rain.

The importance of rivers cannot be underestimated. Rivers carry large amounts of water back to the ocean where sea water constantly evaporates. This water in the atmosphere then forms rain clouds, which supply rain to rivers again. Rivers also carry water to lakes creating unique ecosystems for plants and animals. The mouth of the river, which is the place where the river empties into another body of water, can be a place where silt, soil, sand, clay, and other particulates build up. The combination specific to the area is a gathering spot for local animals to feed, plants to grow and habitats to form. For example, turtles, ducks, dragonflies, and even otters are found along rivers in many regions of the world.

As rivers flow, the movement of water carves out the land in its path. Habitats are formed alongside the flowing river and under the water. Large fish that tolerate the swiftness of flowing water can live in the deepest parts of the river while smaller species may be found along the banks and among the plant life. Freshwater rivers

also support an abundance of insects, birds, and other wildlife that frequent the area. Deer, bobcats, and coyote are among the wildlife that inhabit river banks in Arizona.

Every river is unique due to the speed of its flow of water and **terrain** through which the river travels. While every river is different in location, size, shape, movement of water, and terrain, rivers have some similarities. Regardless of location, the journey taken by a river helps shape the landscape. The energy from flowing water carves out the land as gravity takes the water downward. A perfect example of the power of flowing water is the Grand Canyon in Arizona. Over millions of years, the water has carved out a very deep, wide, and beautiful canyon. From any direction you look, the shape, size, and color of the canyon walls have been shaped and changed by the flowing **Colorado River**.



The Grand Canyon

When water rapidly flows through the landscape taking soil, clay, sand, and particles of rock with it, this process is called erosion. **Erosion** can create valleys and deep grooves in the earth's surface. Over long periods of time these grooves can become part of creating canyon walls.

The Colorado River formed deep grooves and canyons in seven states. Until 1921, the Colorado River was called the Grand River. The river flowed through so much of the land in the western region of the United States that its impact was divided into two parts, the upper basin and lower basin. Life along the Colorado River is as varied as the states through which it flows.

Consider the amount of water flowing in the Colorado River and the impact on wildlife and humans in each location. Water is critical to the survival of life on earth, and the Colorado River is a major contributor. Not only does life in the Grand Canyon depend on the river, but life in each state depends on the river water and its resources. (U.S. Department of Interior map)

The **Mississippi River** is another major river in the United States. Flowing over 3,900 miles from its start, Lake Itasca in Minnesota, to the mouth of the river near New Orleans, Louisiana, the "mighty" Mississippi has been a river of legends and folk tales along with being the home of some very unique freshwater species and wildlife. The National Parks Service estimates that the Mississippi River is home to 260 species of fish and 40 percent of the nation's waterfowl. Numerous species of birds use the river as a pathway for migration. A variety of insects, amphibians, and reptiles inhabit the environment along the river as do many other animals that use the river banks as a source for food and shelter. The banks of the Mississippi display the foliage of the region. Trees, shrubs, and floating water plants are common types of vegetation found there. Areas along the river have formed marshes that house varieties of birds, insects, fish, and in some locations, river otters.

Alligator gar are the largest species in the gar family, and among the largest freshwater fishes found in North America. Mature alligator gar commonly

measures 6 ft in length, and weigh over 100 lbs. However, anecdotal reports suggest they can grow up to 10 ft in length, and weigh as much as 350 lbs.
Diet studies have shown alligator gar to be opportunistic ***piscivores*** (fish eating), and even scavengers depending on the availability of their preferred food source. They occasionally ingest sport fish, but the majority of stomach content studies suggest they feed predominately on forage fishes as well as invertebrates, and water fowl. Diet studies have also revealed fishing tackle and boat engine parts in their stomachs.
Alligator gar inhabit a wide variety of aquatic habitats, but most are found in the Southern United States in reservoirs and lakes, in the backwaters of lowland rivers, and in the brackish waters of estuaries, bayous and bays. They have occasionally been seen in the Gulf of Mexico.
There are now efforts to reintroduce Alligator gar between Tennessee and Illinois as part of an effort to control invasive Asian carp.

These river otters have found a marshy area to rest and hunt for food.

North American river otters have returned to area along the Mississippi where once they were in danger. The National Parks Service continues to monitor these playful animals in hopes that their habitat will be maintained as a safe place for them to survive.
Asian small-clawed otters are native to Southeast Asia from northern India to southeastern China, the Malay Peninsula, and parts of Indonesia. This species of otter weighs between 8-10lb on average and is only about 2 ½ feet long from nose to tail, a significant part of that length being composed of the tail. Asian small-clawed otters are the smallest of the 13 species of otters in the carnivore family **Mustelidae**. Other members of this family include weasels, skunks, and ferrets.

They spend much time on land, unlike other otter species, which makes them semi-aquatic animals rather than marine mammals.
Their paws are a distinctive feature because their fingers and toes are only partially webbed, leaving the end of them free for movement. Because of this, they have a high degree of manual dexterity so they can use their paws rather than their mouths to catch their prey. They will also flip stones and dig in sand for clams, mussels, and crab. This partial webbing is a feature unique to this species of otter.
These otters eat a variety of crustaceans and mollusks, small fishes, amphibians, and insects. They supplement their diet with small rodents and snakes.

The **Amazon River** is another example of how flowing water winds its way through the land from its source to the mouth of the river. Ecosystems that are located in freshwater areas are important to human survival. The Amazon River region is one of those ecosystems. Scientists have discovered that 40 percent of the world's fish species live in freshwater ecosystems.
One of the longest rivers in the world, the Amazon, is home to thousands of living organisms and its life-sustaining ecological feature covering a vast area of South America. The Amazon River is second only to the Nile River in length but carries the world's largest volume of fresh water along its path through several countries. This valuable water source flows through Peru, Bolivia, Venezuela, Colombia, Ecuador and Brazil as it makes its way over 4,000 miles to the Atlantic Ocean. A variety of ecosystems exist along the length of the river, including the largest tropical rainforest in the world and even some dry grasslands. Amazon plants and wildlife range from the most microscopic species to various large aquatic species. The origin of the famous river is high in the Andes Mountains of Peru. There are more than 1,000 tributaries, streams or rivers that flow into the main river and 17 of those are over 1,000 miles long. The Amazon River contributes nearly one-fifth of all of the fresh water that flows on Earth. In addition, the Amazon Basin is so vast that it continues to be the location for exploration and discovery for potential new species. Some scientists believe that the Amazon Basin contains more species

of fish than the Atlantic Ocean. Some interesting examples of these species include electric eels, stingrays, pink dolphins, and manatees.

Amazon River Dolphin

The banks of the Amazon River provide numerous habitats for a wide variety of animal and plant life. Both aquatic and land-loving species populate the river's edge and interact with the humans that thrive on the abundance of the river's resources. The many arteries of the Amazon River are impacted by seasonal changes; for example, annual floods affect the ecology and inhabitants of the region. The enormous volume of water and the rapid speed of its flow expand the width of the river and its tributaries during the flood season. Animals, plants, and humans endure significant changes in their lives as the river goes through this transformation.

In contrast, the dry season causes the river banks to re-emerge and, in some areas, the water flows very slowly. As seasons change, so does the river, and thus the interdependent relationship between river, animals, plants, and humans becomes critical for the survival of each group. The fragile ecosystem of the Amazon River region, which many scientists believe produces much of the Earth's oxygen, is vulnerable to any type of climate change, atmospheric contamination, natural disaster or any disregard for the preservation of the natural environment.

Water is the one common factor between all of the world's rivers. Large or small, rivers provide life sustaining resources to both animal and human life on Earth. These aquatic biomes house millions of species of plants, animals, insects, and microscopic organisms. Without water these life forms would not exist. Variation of temperatures, water currents, and land forms allow for the diversity of life sustained in the ecosystems of a given river area.

Sources: US Department of Natural Resources; World Wildlife Federation; National Parks Service, U.S. Department of Interior, National Geographic; UCMP Berkley; Arizona Game and Fish. Photos: U.S. Department of Interior and public domain.

Procedures and Activities:

1. State the learning objectives. Review previous instruction as it relates to the topic and objectives.
2. Review vocabulary.
3. Read related literature. Follow-up with discussion and open-ended questioning. Ask students to think about the area in which they live and what rivers they can name or have visited.
4. Discuss with students the impact of natural disasters, (floods, strong winds, dust storms, etc.) on the local river environments as compared to other river areas in the world. (A suggested topic for discussion is the Salt River as it travels past Tempe and the flood season in Arizona.)
5. Discuss how natural disasters such as flooding can be managed. Brainstorm ways in which people in flood zones may better manage the impact.
6. Review and discuss the issue of pollution related to rivers and the inhabitants (wildlife, plants, and humans).

 **Indicates 'take along' activity.**

Activity: Pre or post field trip activity. Following the lesson on rainfall, atmospheric temperatures and the impact of rivers, students complete the 'Arizona Rainfall and Rivers' activity. Students create a chart or graph noting the average rainfall in one year. A more advanced chart or graph can include the average high temperatures. Discuss the nature of water conservation in the local community due to limited rainfall and warm temperatures. Ask students to describe the general area with respect to vegetation, desert terrain, dust levels, and animal life. Show students a map of the local area so they can become familiar with the rivers and lakes in Arizona. This activity can be done in groups and presented to the class.

Activity: Students use technology to research water conservation and/or pollution of rivers. Students select either water conservation or stopping pollution as their topic and create a poster to help educate others. Posters are done on poster board and should display an original design and slogan related to the topic. Posters must

include the impact on aquatic life in rivers. Assessment is based on participation and original design.

Activity: "What's in a Name" is an activity to help students identify major rivers in the state of Arizona. Students may research the general area around which the selected river flows to complete the description of the ecosystem. Encourage students to include aquatic life and life along the river bank.

Activity: **Follow-up activity.** Students complete the questions, 'The River Journey.' This activity may be used as a quiz, individual activity or as a class discussion.

Activity: Present the Apache and Gila trout information. Students research the species and create a graph or chart to demonstrate the specific chronology of events leading to the recovery plan, the actions taken, and the end results. Students write a summary of their findings. In addition, students identify another endangered or threatened species in Arizona, research and chart the data, summarize their findings and draw conclusions for the future survival of the species. Students prepare a presentation for the class.

 **Activity:** "OdySea Aquarium Ethogram" is an activity to do at the aquarium. Students observe a river habitat and chose one fish or other animal to observe for two minutes. From the observational data, make an inference about how the animal spends its day.

Activity: 'The Food Chain' activity is in two parts. First, students divide the pyramid and label the sections as primary producers, secondary consumers, and tertiary consumers. Students define and give examples of each. Next, students apply their knowledge to the activity, 'Who is Eating Who?' related to a river. Either may be used as a quiz or activity.

Activity: The biome activity requires students to identify specific characteristics of a desert biome and an aquatic biome. Students research each type and list the specifics. Students compare and contrast the two biomes. This activity can be done in small groups. **Optional:** Students write an essay comparing and contrasting the biomes.

Activity: The 'Arizona Wetlands' activity can be done as a homework or project assignment. The activity is designed to be done at a wetlands location. Possible locations for field notes: Tres Rios Wetlands (Phoenix) and Sweetwater Wetlands Park (Tucson). Students observe the environment noting significant characteristics, sights, sounds, and smells, and complete the field note guide.

Activity: Creating an aquatic biome is a lab activity. This activity can be an individual, group or class project. As an option, the activity could be done as a home-based project with findings presented to the class.

Activity: The 'Life around Rivers' activity draws from students' prior knowledge and application of new knowledge. Students identify and categorize the differences between amphibians, reptiles, and fish. Focused on life along a river, students investigate the local river environments and identify species in each category. In learning about endangered species, students research the IUCN Red List and note how their selected species is labeled. The final part of the activity is to create a plan to protect the selected species from environmental changes and the impact of human contact.

Activity: Writing a ballad is a fun and creative activity. Some students may choose to write a musical ballad, while others may want to draw a picture of the inspiration for their ballad.

Reflections and Assessments: Students are assessed on varied levels depending on the activity. Participation, grade standards, and percentages may be applied to each activity. Activities are designed for flexibility and can be done both pre and post field trips.

Activities meet the **STEM** education guidelines involving problem solving, investigation, gathering data, analysis, using technology, application of math, integration of interdisciplinary instruction and inquiry.

The Apache and Gila Trout

Arizona has long been the home of the Apache and Gila trout, which are the only native trout species in the state. Since the 1800's, Apache and Gila trout swam in the White Mountain rivers and streams and were documented as unique to the region. The Apache trout has an olive-yellow body with black spots across the body, fins, and head. The golden colored belly of the trout offers another identifying characteristic of the species. The Apache trout can grow between 9 and 20 inches in length and average about 5 pounds in weight. The Gila trout's body is an iridescent gold that blends into a darker shade of copper on the gill plates. Small spots on the fish's body extend from the head to the dorsal and caudal fins. The tiny spots and the red/pink lateral band are identifying characteristics as the Gila and Apache are closely related in shape and size. Both types of trout prefer clear, clean water flowing over gravel riverbeds.

Apache Trout

The Arizona Game and Fish Department has reported that historic photos and stories have been told about the hundreds of trout caught in a single visit to the local rivers. Considered to be on the decline by the early 1900's, federal agencies began to stock non-native trout in an effort to replenish the lakes for trout fishing. Believing that stocking the lakes would resolve the concern of over-fishing, species of rainbow, brook, cutthroat, and brown trout were introduced to the local lakes to live alongside the Apache and Gila trout. As time passed, evidence became available that the non-native trout were competing with the Apache and Gila trout for food and shelter and making it difficult for the native species of trout to survive.

The White Mountain Apache Tribe worked diligently to ensure the survival of the trout species by closing fishing in reservation waters. In 1969, the Apache trout became the first species to be listed as endangered. Considered endangered under the Federal Endangered Species Preservation Act, actions were taken to label the Apache trout protected under the law. By 1975, the Apache trout had been down-listed from endangered to threatened, due to conservation efforts. It was clear that these native fish were a part of Arizona's history and the community's relationship with native species. Human intervention would impact the population of both species of trout. A joint effort was undertaken by the White Mountain Apache Tribe, the U.S. Fish and Wildlife Service, and USDA Forest Service to form the Apache Trout Recovery Team. This joint team made plans to bring the species of native trout back from the decline.

Gila Trout Release (Photo in public domain)

Along with diminished food and shelter, the native trout species faced another battle. The natural environment for these fish was deteriorating by livestock grazing near streams and rivers, timber harvesting and other land uses near the trout's habitat. These activities introduced dirt and pollution to the clear water. This increase in the destruction of the trout's natural habitat required intervention. The Arizona Game and Fish Department teamed up with the U.S. Forest Services to develop a habitat improvement plan designed to protect areas of the lakes and streams and improve water quality and riverbeds. The recovery team launched a plan to protect the rivers and streams, restoring the environment by stabilizing banks, adding vegetation and fencing or closing areas to reduce erosion.

An Apache trout recovery stream

The Apache trout is now returning to its natural habitat due to the continuing efforts of the recovery team. Part of Arizona's natural history, the Apache trout continues to survive and is found nowhere else on earth.

Source: Arizona Game and Fish Department.

Arizona Rainfall and Rivers

Rainfall has a tremendous impact on rivers. **Chart** the rainfall data, analyze the amounts, consider the average temperatures, and draw conclusions about the negative or positive impact on the rivers in each scenario.

Average Rainfall in 1 year		Average high temperatures
Month	Inches of rain	Degrees
January	0.83	65
February	0.79	69
March	1.06	74
April	0.24	83
May	0.16	92
June	0.08	102
July	0.98	104
August	0.94	102
September	0.75	97
October	0.79	86
November	0.75	73
December	0.91	65

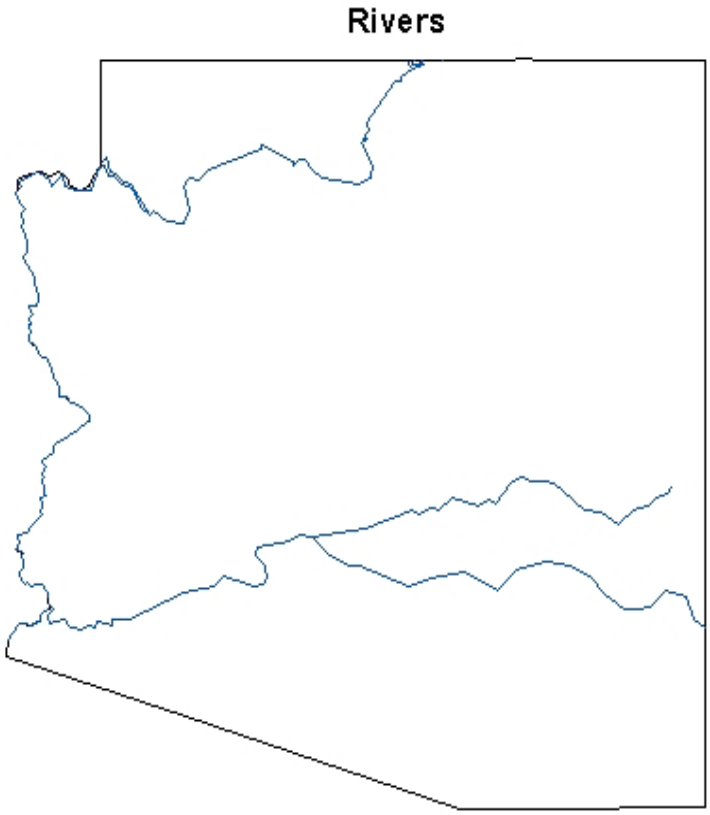
Use a map to help with each scenario.
Scenario 1: It is the month of July. The temperature is slightly above average and the humidity has risen to 40%. A monsoon storm has hit Phoenix dropping 5 inches of rain in just 2 hours. The rain started to pour at 2:00 pm. What impact will this have on the Salt River at the Mill Avenue Bridge area?

Scenario 2: The temperatures in May have been at an all time high of 110 for two weeks straight. No precipitation has been reported since February. Considering the charted data, what conclusion can be drawn about farm fields in the west valley? What would be a possible resolution to the problem?

Scenario 3: The Snow level has been extremely high in the Arizona mountains. Snow is melting and the Verde River has begun to rise. The weather report shows additional rainfall in the area and the river is expected to exceed its banks in several areas.
What can be done to protect the animal habitats along the Verde River?

What's in a Name?

Complete the map of Arizona rivers. **Select** one river and describe the ecosystem based on geographic location, (estimated) average rainfall, atmospheric temperature, and general animal populations of the area.



Describe the chosen river ecosystem: _____

_____

_____

_____

_____

_____

Arizona Rivers-KEY

National Parks Service Map

Students should draw in the rivers and name them. Students select one river and describe the ecosystem along that river.

The River Journey

1. How are rivers formed? _____
   _____
   _____
   _____

2. What is an ecosystem? _____
   _____
   _____
   _____

3. What are the two main areas for river ecosystems?
   _____ _____

4. What is the 'mouth' of a river? _____

5. Explain the term, erosion. _____
   _____

6. Give an example of erosion. _____

7. Name two of the longest rivers in the world.
   _____ _____

8. Give an example of how pollution affects the world's rivers?
   _____

9. Explain how water is considered a renewable resource. _____
   _____

10. What impact do humans have on the quality of water? _____
    _____
    _____

What do you think the greatest concern with water may be for the future?
_____
_____
_____

OdySea Aquarium Ethogram

Practice what it is like to be a behavioral biologist and study one animal at OdySea Aquarium for two minutes.

An Ethogram is a way we can record the behavior of an animal over time in order to make inferences, or assumptions, about how an animal generally spends its time.

Every 15 seconds, mark what behavior the animal is exhibiting.

Species: _____

OdySea Aquarium Ethogram					
	Resting	Moving	Hiding	Eating	Other
0:15					
0:30					
0:45					
1:00					
1:15					
1:30					
1:45					
2:00					

Inference about animal's behavior:

_____

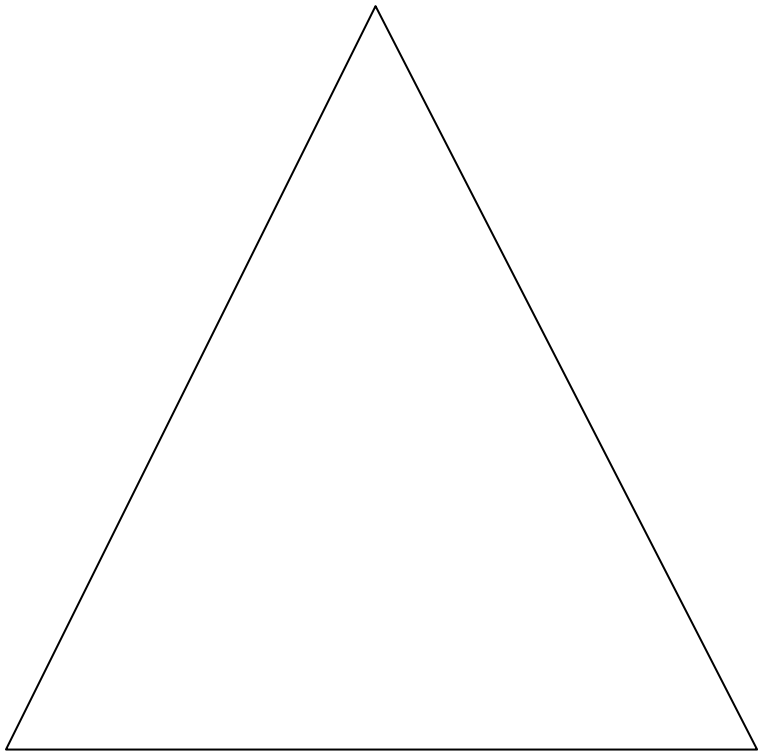
_____

_____

_____

NAME _____

The Food Chain



Divide the pyramid to reflect the food chain: Primary producers, Secondary consumers, and Tertiary consumers. Define the terms:

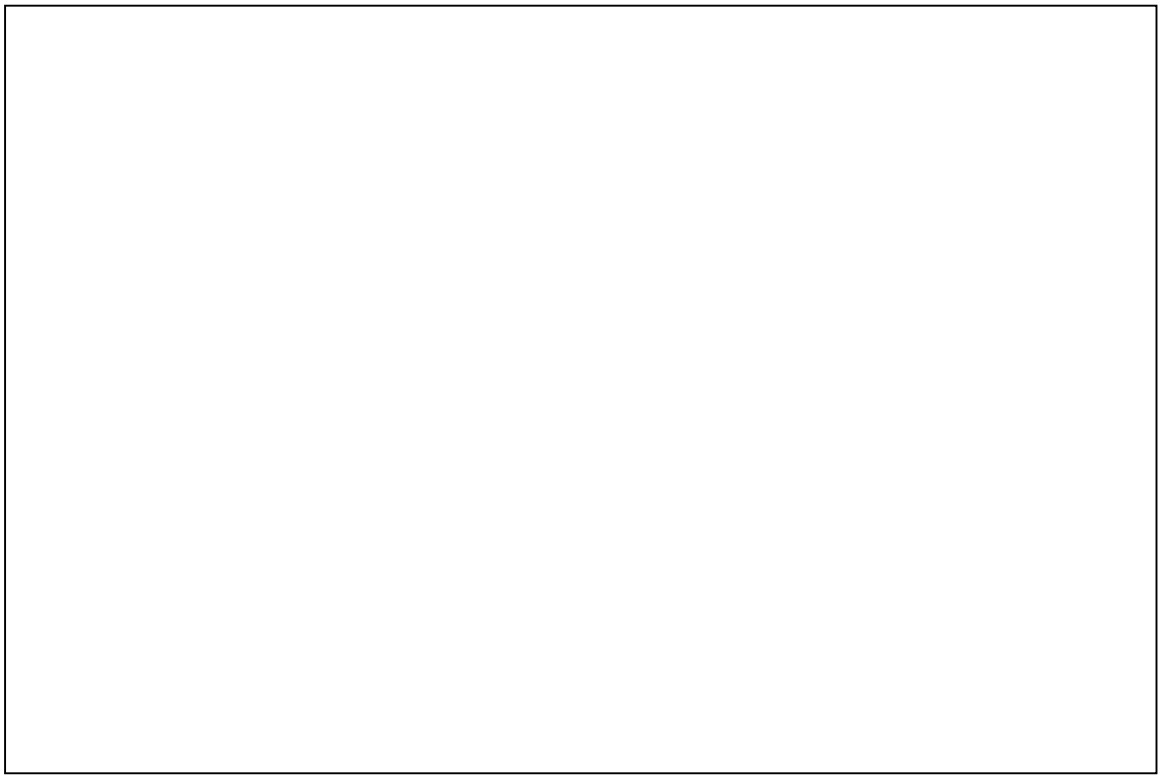
Primary producers: _____

Secondary consumers: _____

Tertiary consumers: _____

Who is Eating Who?

Draw a river life food chain that identifies the primary producers, secondary consumers, and tertiary consumers. Include: plants, minnows, insects, crawfish, large fish, etc. **Explain** the food chain below the drawing.



Biome Activity

Biomes are areas on earth with distinctive weather patterns, plants, and animals. There are 5 major types of biomes on Earth: aquatic, desert, forest, grassland and tundra. Two types of biomes are listed below. Describe the characteristics of each biome. Compare and contrast the Desert Biome and the Aquatic Biome.

Desert Biome

Location:

Weather:

Plants:

Animals:

Insects:

People and their activities:

Aquatic Biome

Location:

Weather:

Plants:

Animals:

Insects:

People and their activities:

Arizona Wetlands
Field Notes

Wetland Name and location: _____

Date of observation: _____ Time: _____

General observations: (Spend 5 minutes quietly observing. What do you see, smell, hear and feel?)

_____
_____
_____
_____
_____

Weather
Temperature: _____ Wind: _____
Sun or clouds: _____ Other: _____

Habitat Description	Animals: List ones in each category. Describe what you see.	Evidence of animals. (Tracks, burrows, nests)	Plants List the types you see.
	Birds: Mammals:		

	Reptiles Fish		

Water in the wetland: (Describe what you see in the water – insects, plants, tiny fish, etc. How do they interact?) **Draw a picture of the wetland.**

Create an Aquatic Biome

An aquatic biome can be created in a clean, clear glass container that is stable enough to hold water, rocks, and a few plants. Observe the biome as the environment changes over time.

Materials:

- Clean, clear glass container (large mason jars work well)
- Clean water (water should be 50-75% of the area of the container)
- Rock, pebbles, or sand (small rock or pebbles are best and should take up 10-25% of the container)
- Aquatic plants (small aquatic plants can be purchased at an aquarium store; limit one or two.)
- Air (the top of the container must be 10-25% air)

Optional: Small snails or fish can be added to the biome. Be sure to get food for them.

Directions: Put the rock or pebbles in the bottom of the glass container first. Add plants next. Slowly add water. Place the container in a sunny, indoor area.

Begin your observation by creating an observation chart. List each date of the observation, what you see taking place in the biome. Watch for the plants (and animals) to stay healthy. If the water begins to smell the biome location may need to be adjusted.

Life around Rivers

The following species have very specific characteristics to help identify them. Name a few of the following that live in your area.

Amphibians

- Have a backbone – Vertebrates
- Cold-blooded – cannot regulate their body temperature
- Spend part of their life in water and on land
- Do not have scales
- Have gills for at least part of their lives (or all their life)
- Most go through metamorphosis

Reptiles

- Have a backbone – Vertebrates
- Covered with scales
- Breathe with lungs
- Most lay eggs (some give have live birth)
- Most are cold-blooded (exception is leatherback sea turtle)

Fish

- Live in water
- Have a backbone – Vertebrates
- Breathe with gills
- Most are cold-blooded (except tuna and Pacific salmon shark)
- Some fish have scales

The International Union Conservation of Nature (IUCN) reports that amphibians, reptiles, and fish are in danger due to pollution in the water, warming temperatures and diseases. Significant numbers of these species will be facing the label of 'endangered' and potentially 'extinct' in the future.

Identify a species in each category, amphibians, reptiles, and fish that live in your state. Next, **find** the location in which the species lives. If the species lives near a river, name the river. **Complete** the species chart for your selection.

Species Chart

Amphibian: _____
Classification Order: _____ Family: _____
Characteristics: _____
Location: _____

Reptile: _____
Classification Order: _____ Family: _____
Characteristics: _____
Location: _____

Fish: _____
Classification Order: _____Family: _____
Characteristics: _____
Location: _____

Select one of the species above and find out how that species is labeled on the IUCN Red List.

Species selected: _____

IUCN Red List Label: _____

Create a plan to protect the species you selected. Consider the impact that could be made on the species by climate changes, flooding, draught, pollution, changes in the land or rivers and human contact.

Write a Ballad

Ballads come from traditions and stories handed down over time. The characteristics of a ballad consist of supernatural events, sensational or tragic stories, simple details, and a rhyming pattern.

Choose a story to tell that involves action, tension and a resolution.

Decide on a rhyming scheme: “abab” or “abcb” then use 6 or 8 syllables. Marlowe’s example: “Come LIVE with ME and BE my LOVE”

Your ballad can be a funny or serious story. Listen to musical ballads such as John Lennon’s, “Imagine” for inspiration. Your ballad can be set to music too!

A picture can inspire a ballad.