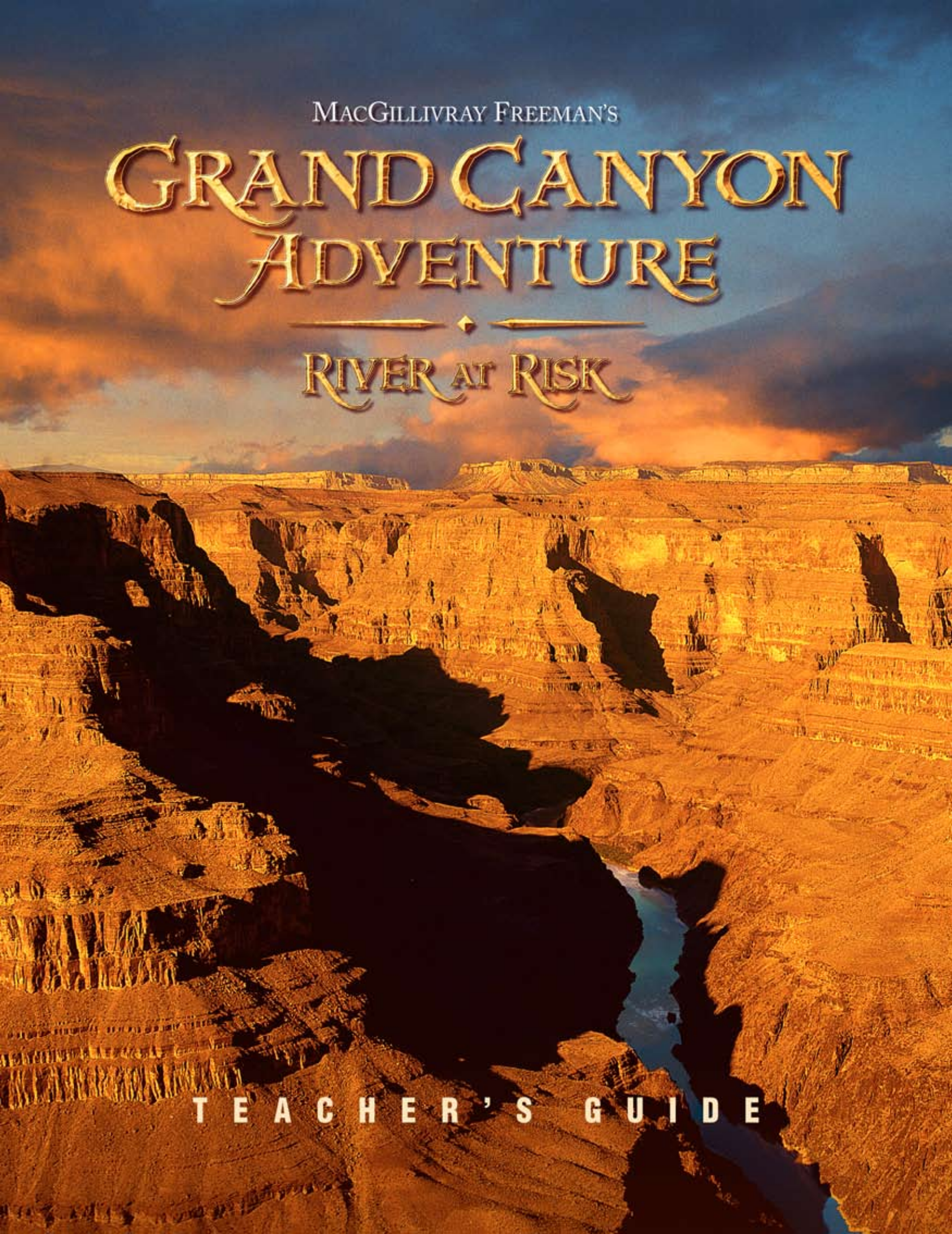

MacGillivray Freeman's
Grand Canyon Adventure
River at Risk
TEACHER'S GUIDE

In the film, anthropologist/writer Wade Davis re-photographs the same canyon landscapes first photographed by explorer John Wesley Powell's expedition photographer, Jack Hillers, in 1873. By comparing the photographs, Davis will look for changes in the environment over the last 130 years.

TABLE OF CONTENTS

An Educational Resource for Teachers

The giant screen film, *Grand Canyon Adventure: River At Risk*, and this Teacher's Guide are appropriate for all intermediate grades (4-8). This guide will be most useful when accompanying the film, but is a valuable resource on its own. Teachers are strongly encouraged to adapt activities included in this guide to meet the specific needs of the grades they teach and their students. Activities developed for this guide support National Education Standards for Science, Art, Social Studies, Math, and English.

For information about how the activities in this guide align withU.S. National Education Standards, visit:
www.grandcanyonadventurefilm.com/PDFs/GCA_ED_Alignment.pdf

An Educational Resource for Teachers

MacGillivray Freeman's

Grand Canyon Adventure

River at Risk

Teacher's Guide created by Wyland Foundation

INTRODUCTION

Grand Canyon Adventure: River at Risk is the captivating story of the worldwide water crisis and the great drought now plaguing the American Southwest. Audiences will join a team of explorers on an exhilarating Colorado River whitewater adventure through the Grand Canyon as they seek important answers about water conservation. From the journey's launch at Lee's Ferry to the world-famous Lava Falls rapids, from the turquoise waters of Havasu Falls to far beyond the great canyon, where the river runs dry, *Grand Canyon Adventure: River at Risk* is a riveting cinematic celebration of water—and what each of us can do to make a difference.

Water: A Limited Resource

I am the lakes and the oceans.
I am the clouds and the rain.
I am a river, and I run through everything.
Touch me and you touch an entire world.

Water makes life possible. It nourishes the plants we eat and the trees we sit under. It provides a habitat for an endless number of living things. Water connects us all. The same drop of water that flows through the Amazon may end up raining on your town someday. The arctic water that a whale swam through could be in your bathtub. Every living thing depends upon water.

About 70 percent of the world is covered with water, yet only a very small portion of that is accessible freshwater. Most of our freshwater is locked up in icecaps and glaciers or hidden underground. Although some scientists speculate that Earth may receive small amounts of new water from meteors, the amount of water on our planet is relatively fixed and gets used over and over again through the water cycle.

Humans, plants, and animals have existed on that set amount of water for a long time, so everything is fine, right? Maybe, or maybe not when you consider the rising world population, a higher demand for water, and the increase in the amount of water that is so polluted it is unsuitable for use. To add to the problem, freshwater isn't spread evenly across the planet. Some places like North America have decent water supplies that replenish (if they aren't overtaxed), but others such as Saudi Arabia and parts of Africa are very dry and face constant water shortages. Even in the United States water is becoming an issue. States are beginning to argue with each other and file lawsuits to determine who owns the rights to water that flows across several state lines.

Watersheds

Because of gravity, water runs downhill from high points like mountains and hills to lower points in lakes, rivers, ponds, and wetlands. Eventually, all water drains into the world's ocean. In every area of Earth, the highest points of land form boundaries from which water runs downhill. Each area the water drains into is called a watershed. You can think of it as a big bowl with the high edges being the boundaries of the watershed. Smaller watersheds are contained in larger watersheds, like a stack of bowls that fit inside each other.

Watersheds, rivers, and the ocean aren't bound by town, state, or even country lines. The Colorado River watershed includes Wyoming, Colorado, Utah, Nevada, New Mexico, Arizona, California, and Mexico and covers about 244,000 square miles. Once the water reaches the ocean, currents drive it to other parts of the world, so water truly does connect us all.

The River's Journey

Rivers are often referred to as the arteries or lifeblood of watersheds because they bring essential water, sediments, and nutrients from one area to the next. Rivers usually begin in the mountains or hills as the result of snow melting or a natural spring bubbling up from the ground. These small amounts of water collect to create streams. When these streams merge to become a river they are called tributaries.

The Colorado River begins its 1,450 mile journey up in the Rocky Mountains of Colorado and Wyoming as snow melt and gains speed as water is added from tributaries and flows downhill. The fast flow of the river causes the water to pick up a large amount of soil, rocks, and pebbles and carry it along. As these rocks and pebbles hit other rocks, they begin to wear away the banks of the river in the process of erosion.

When a river flows swiftly and its water carries a large amount of material, canyons can form. The process can take millions of years. The eroding forces of the Colorado River and a powerful geologic uplift created the Grand Canyon millions of years ago. Erosion of the canyon is still taking place today.

Most rivers eventually flow to the ocean or another large body of water. As the flow of the river slows down, it drops the material it has been carrying on its journey. This mixture of gravel, sand, and silt creates a new landform called a delta. The Colorado River meets the ocean at the Gulf of California in the Sea of Cortez, although much of the time it does not reach the sea anymore.

Formed by the Colorado River as it carved its way through the desert, the canyon's awe-inspiring strata reveal two billion years of geological history and offer one of the most dramatic examples of erosion anywhere in the world.

Human Impacts

Everything that exists in a watershed affects the quality of the water in the watershed. If water runs through a mountain forest, it will pick up leaves, dirt, or pine needles. If it runs through a pasture where cows graze, it will pick up bacteria or pollution from the waste cows create. If it runs through a city or a neighborhood with a lot of people, it will pick up things people use, such as food wrappers, plastic water bottles, or lawn fertilizers. If it runs through factory or farm areas, it will pick up chemicals, pesticides, oil, fertilizers, or other pollutants.

Storm drains and catch basins are the openings along the sides of highways, street gutters by sidewalks, and often the drains you see in parking lots. They are designed to capture the runoff water. They lead directly to rivers, lakes, and the ocean. Most storm drains do not clean or filter the water they carry, so any pollutants the water has collected go straight into water bodies where they can harm plants and wildlife.

This type of water pollution is called non-point pollution as it comes from more than one source and more than one place. It accounts for most water contamination. Because it can affect areas far from the original source, it is difficult to control. From motor oil to fertilizers to pesticides to trash, individual people are responsible for most non-point pollution. This is why every person has a huge responsibility to control non-point pollution.

An Important Role to Play

Rivers play an important role in the Earth's water system. They are a source of food and drinking water and provide homes for many types of fish, reptiles, amphibians, birds, and mammals. People have always depended on rivers. There is evidence to suggest people have been living in the Colorado River watershed as far back as 23,000 years ago. Many different tribes of Native Americans throughout history have used the Colorado for fishing, transportation, spiritual ceremonies, and agriculture.

It is estimated that the Anasazi lived in Chaco Canyon from about 600 to 1150 A.D. By 1200 A.D. the Anasazi disappeared completely from Chaco Canyon. There is evidence to suggest that the disappearance of the Anasazi in this region was due in part to a severe drought. Prior to the drought was a time of wet weather and the Anasazi flourished. When the drought came, there was not enough water to sustain their booming population and farming methods. The drought brought about famine and warfare and led to their abandonment of the Chaco area.

The Anasazi left behind buildings, irrigation channels, and rock art that can still be viewed today. All of these give us glimpses into the past and reveal important knowledge about the people and their culture. As the climate now shifts again to drier times and massive cities spring up in the deserts, perhaps one of the most important things the Anasazi left

One of the Colorado river's man-made lakes, Lake Powell, is now only half full after years of drought. The white, chalky band above the water indicates where the lake's waterline used to be.

behind is their story. Hopefully we can learn from the past and plan now to conserve our water resources.

A River at Risk

Today the Colorado River supplies us with water for drinking, home use, agriculture, entertainment, hydroelectric energy, and industrial use. Dams, canals, pipelines, and aqueducts have been built to change or divert the flow of the river to meet these needs. All of these diversions can create dramatic changes in a river's natural ecosystem.

Changes in water flow and water levels change the properties of the water and can disrupt aquatic ecosystems. Salinity rises when water levels fall. Dams change the velocity of the water flow and the temperature of the water. Dams also prevent sediment from flowing downstream to nourish wetlands and maintain the delta. The Colorado River has some 10 dams and 80 diversions along its path. Water from the river is sent via pipelines to areas without abundant water supplies. Every drop of the Colorado River is owned.

So many cities, farms, and communities use its water that the Colorado sometimes no longer reaches the Gulf of California. Man-made changes have led to the endangered status of many native species all along the Colorado River such as the desert pupfish, Yuma clapper rail, bobcat, vaquita porpoise, squawfish, razorback sucker, humpback chub, bonytail chub, totoaba, yellow-footed gull, Heermann's gull, elegant tern, reddish egret, and peregrin falcon. Other wildlife such as river otters and muskrats have already disappeared from the river.

Plants and animals aren't the only dependents of the Colorado River that are at risk. Scientists suggest that we are shifting to a warmer, drier climate. The snow pack in the Rockies that feeds the Colorado River is growing smaller while demands for water are increasing. Lake Powell alone has lost over half of its volume over the last eight years. The cities and farms that rely on the Colorado River for water are facing some difficult decisions about the way they use water.

What Can You Do?

It is easier to make a difference than you might think. The choices you make about simple actions you do each day add up. Use water wisely, use less electricity, put trash in its place and recycle or re-use everything that you can. Tell others what you know. If we start thinking of water and aquatic habitats as the precious and valuable resources they are, then we can begin to make a difference. Contained within this guide are many specific ways you can help. For more information, visit:

www.wylandcleanwaterchallenge.org

WATER CYCLE ART

ACTIVITY 1

Objective:

Students will observe the different stages of the water cycle to learn why water is a limited, non-renewable resource. They will demonstrate their understanding of the process by creating an artistic representation of the water cycle.

In the Film:

Water levels in the Colorado River and its reservoirs have dramatically dropped over the years due to over-use and a warmer climate. The warmer climate has accelerated the rate at which the water is evaporating. Left behind are white deposits of salts and nutrients that are visible on the Grand Canyon walls.

Materials:

- ❑ Airtight, watertight containers (1 per group of 4-5 students) such as disposable plastic ware containers that hold 6 or 8 cups.
- ❑ Pitcher filled with 2-3 cups hot water (not hot enough to burn) for each group.
- ❑ 1-2 cups of ice for each group
- ❑ 3 pieces of white, construction, or watercolor paper for each student
- ❑ 1 large piece of light colored construction paper for each student
- ❑ Variety of watercolor paints and brushes
- ❑ Containers with water for rinsing brushes
- ❑ Paper towels or rags for blotting brushes
- ❑ Cut up sponges
- ❑ Clean, empty spray bottles (travel size bottles are ideal)
- ❑ Glue sticks
- ❑ Pencils or black felt-tip pens
- ❑ Scissors

Teacher Prep Notes:

This activity can also be done as a demonstration to reduce the amount of materials and time needed. Try this demonstration in advance as you may need to adjust amounts of water and ice needed to work well with your containers.

Some students may feel a little unsure about creating an artistic representation of something rather than a realistic representation. Reassure them that everyone's art is individual and there is no "right" and "wrong" in art. It helps to have a couple of completed samples to show them.

Background:

The water on earth is on a journey that never ends. Each drop is used over and over again! It travels the world by changing form during the water cycle. Here's how the Water Cycle works: Heat from the sun or other sources turns water on the Earth's surface into an invisible gas called water vapor through a process called evaporation. When the water vapor cools it changes back into liquid through a process called condensation and forms clouds. As it cools, the water in clouds becomes heavy and sticks together to form droplets. These droplets then fall back to Earth as rain or snow known as precipitation. Some of the water soaks into the ground and collects into pools underground called aquifers. Some of the water is used by plants and then released through their leaves in a process called transpiration. Some of the water runs off the land through rivers and streams and collects in larger water bodies such as lakes, wetlands, and oceans where it evaporates and starts the cycle all over again.

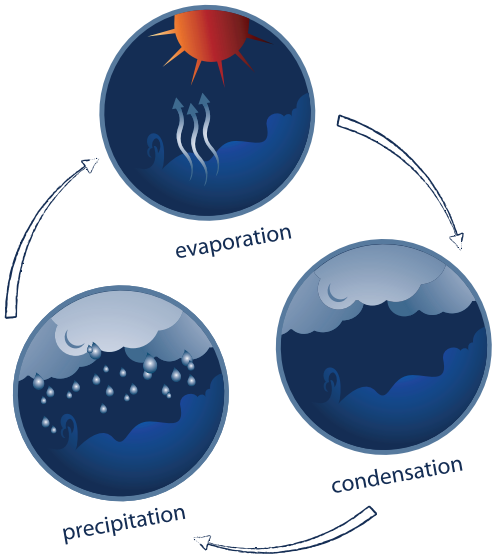
Key Words

Evaporation: Heat from the sun or other sources turns water on the Earth's surface into an invisible gas called water vapor.

Condensation: Water vapor cools and clouds are formed.

Precipitation: The water in clouds cools, clumps together and becomes so heavy that it falls to earth.

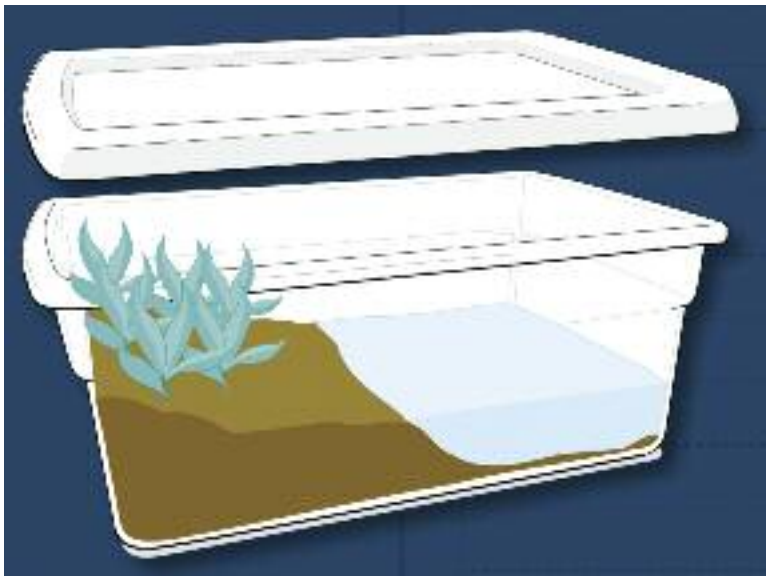
Saturation: When something contains all that it can hold and nothing more can be added.



The three main stages of the water cycle

To Do (part one):

Lead a discussion on water. Ask students what they know about water. Where does it come from? What happens when rain falls? Where does it go? Is there a limit to how much water is on the planet or do we get more somehow? Write answers on the board. Introduce the term Water Cycle and draw the parts of the water cycle on the board as students mention or describe them. Tell students that they will be creating their own miniature water cycles. As the experiment progresses, create notes and a diagram on the board based on the students' observations.



Expand this activity by making the water cycle model into a terrarium.

Students should carefully pour hot water into their container, approximately one or two inches. They should make a mark of the water level on the container with a piece of tape or a permanent marker. When evaporation is observed within the container (when the water level goes down), ask students what has happened to the water. Discuss the process of evaporation as a class and have students give examples of how they have seen this process in their everyday lives.

Students should place ice on the lid of their container. When condensation is observed (water collects on the lid or sides of the container), discuss the process of condensation and the formation of clouds. Ask students if they have seen condensation occur before.

When precipitation has been observed (water droplets begin to fall from the lid), discuss this step of the water cycle.

Ask students to review the steps of the water cycle. Tell students that water is a limited resource. All the water we have on earth now is all the water we will ever have. The water that falls to the bottom of the container as precipitation will evaporate once again and start the cycle over.

To Do (part two):

Pass out watercolor supplies and let students know they will be creating an artistic representation of the water cycle.

Students should fold each of the smaller pieces of paper in half and cut a large circle out of each. The use of circles represents the continuous nature of the water cycle.

Ask students to think about how they would communicate the process of evaporation without words and instruct them to create a watercolor painting on one of their circles to show the process of evaporation.

Students will use sponges dipped in watercolors to paint another circle, this one representing condensation and clouds.

On the third circle have students create an artistic representation of precipitation by using fingers, flicking paintbrushes, and spraying watercolor from squirt bottles.

Have students incorporate their three art circles into one large work of art. They should arrange their three circles to illustrate the flow of water from one stage to the next in the water cycle and label each stage. They could do this by painting arrows, placing them in a painted circle, painting a landscape and placing the circles appropriately or other creative means.

What is going on and why?

The miniature water cycle demonstrates that water is a limited and non-renewable resource that recycles over and over again. The art components reinforce some key messages about the water cycle. The circle shapes used in the art project reflect this cycle that has no beginning and no end. Evaporation is responsible for the drying of watercolor paints. Sponges and clouds have a saturation point where they can't hold any more liquid.

Taking it Further:

Have students turn their water cycle models into terrariums by adding soil and plants. Students can observe and learn about transpiration (when plants release water) in this closed environment. Can they create a small sustainable ecosystem? Have them document what they add and subtract to their ecosystem until it has a perfect balance. How difficult is this task?

Every Drop Counts

ACTIVITY 2

Objective:
Students will compare amounts of saltwater, freshwater, and available freshwater on Earth and will identify ways that water is important to the planet and their daily lives. They will log their household's indoor water usage and commit to make one change to help save water.

In the Film:
Availability of water is a global crisis. Worldwide one in five people lack access to clean drinking water. It is every person's responsibility to use water more wisely and protect this precious resource. There are many simple actions that can be taken to help save water. Some great ideas are suggested at the end of the film.

Materials:
- ❑ Water usage tally chart for each student
- ❑ Large map or globe
- ❑ Pencils and erasers
- ❑ Empty gallon container
- ❑ Colored pencils, markers, or crayons
- ❑ A round object that can be cut for demonstration (paper plate, apple, etc.)

Teacher Prep Notes:
This activity must be conducted in two parts as students will need to take home their water usage tally sheet overnight. Make enough copies of the tally sheet for each student. During the activity, display a world map in the classroom for students to refer to. Discuss ways to save water. As a resource, go to www.grandcanyonadventurefilm.com. The education section of the website features water conservation tips and two interactive programs from Hamline University's Center for Global Environmental Education. For more conservation ideas, visit www.kohler.com/savewater

To Do (part one):
Lead a discussion about the importance of water. Ask students what water does for the planet (grows plants, creates habitats, creates weather, etc.). Then ask students why it is necessary that people have freshwater (drink, shower, laundry, etc.). Brainstorm these needs with the class and write them on the board.

Ask for a volunteer to identify some bodies of water (oceans, lakes, rivers) on the map at the front of the classroom. Students can come up and point to these areas. Ask students what the body of water is and whether or not it is made up of salt or fresh water. Is there more freshwater or salt water covering our planet ? Is water a limited resource or does our planet get more of it somehow?

Demonstration:
Show students the limited amount of available freshwater by using a visual aid: Choose something round and easy to cut such as an apple, pie, paper plate, etc. to represent all the water on earth. Cut out a section to represent 3%—just a small sliver. This sliver represents all the freshwater on earth. The rest is saltwater in the ocean and not useful to us in terms of our survival.

Key Words

Aquifer: An underground bed or layer of earth, gravel, or stone that water can move through.

Take the small section you just cut and cut out about 70% to represent water trapped in glaciers and ice caps—also water we cannot use. Put that section aside. The tiny piece that is left is 1% of the object you started with. This is the remaining water we have in lakes, rivers and ground water and aquifers that is available for us to use.

Ask students if we can use all the water in our lakes? Is all the water underground accessible to us? We have a very tiny portion of our planet's water to use—about 1% of all the water on the planet!

Hold up a gallon/liter container and ask students how many gallons/liters of water do they think their household uses in a day? Log each student's guess. Hand out the water usage tally chart on page 8 for them to take home and complete.

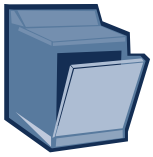
To Do (part two):
When students bring back their completed water usage tally sheets, divide them into groups of 4-5 students.

Students should calculate their water usage and discuss what (if anything) surprised them about their household's water use.

Water is a limited resource

Ask for volunteers to share their collected data and what they learned. Have students brainstorm ways to save water and think about what commitments they could make to save water.

Water Usage Tally Chart

	Daily Frequency	x	Usage	=	Consumption
 **Shower or Bath:** 10-minute shower or half-full Bath		x	**30 Gallons/ 114 liters**	=	
 **Toilet:** 1 toilet flush		x	**5 Gallons/ 19 liters**	=	+
 **Faucet:** 1 minute running faucet		x	**3 Gallons/ 11 liters**	=	+
 **Laundry:** 1 load		x	**41 Gallons/ 155 liters**	=	+
 **Dishwasher:** 1 load		x	**15 Gallons/ 57 liters**	=	+

Calculate your water usage at home by using this tally sheet. The gallons/liters indicated in the "usage" column are meant to be used as a guide and are based on average number in a range from EPA WaterSense, h2oconserve and other reliable sources. These estimates are based on more inefficient appliances. Your actual water usage may be different.

=

Total_____

Have students log on to www.wylandcleanwater-challenge.org and click on "take the challenge." They can make a personal pledge right on the website to help save water. Record how many gallons/liters of water the class saved as a whole.

Taking it further:

Have students do tally sheets over a week and graph their usage. The class can calculate average daily home usage based on the data they collected. Figure an average yearly water use. Students can compare that number to the gallons/liters of water they pledged to save and calculate the percentage of water saved. How many people live in your town? Have students figure out how much water could be saved if everyone made the same pledges as your classroom.

Water's Extreme Journey

ACTIVITY 3

Objective:
Students will learn what a watershed is and how water flows through it. They will investigate non-point pollution, how it enters a watershed, and the resulting impacts.

In the Film:
The Colorado River begins high in the Rockies and travels over 1400 miles to its outlet in the Gulf of California. Seven states and Mexico are part of the Colorado River watershed and they all affect the quality of the water in the river.

Materials:
- ❑ Colored pencils or markers in blue, red, brown, and green
- ❑ Colorado River watershed map *(see page 10)* or watershed map of your own region which you can find at www.epa.gov/surf or www.usgs.gov
- ❑ Plastic spray bottles (clean and filled with water)
- ❑ Foil turkey pans or paint tray liner for each group of 3-5 students
- ❑ Various objects to build the landscape of the model such as newspaper, brown paper bags, cardboard, cups, toilet paper rolls, foam pieces, mesh wire, balloons, etc.
- ❑ 1 bowl or tray for every 3–4 students (at least 3" deep and 6" wide)
- ❑ Lots of newspaper
- ❑ Masking tape
- ❑ Scissors
- ❑ Flour
- ❑ Water
- ❑ White glue
- ❑ Acrylic paints
- ❑ Sponges
- ❑ Paint trays
- ❑ (egg cartons, ice cube trays, small cups, etc.)
- ❑ Containers with clean water to rinse brushes

Teacher Prep Notes:
Your students can create the Colorado River watershed, a watershed near you, or an imaginary watershed for this activity. Decide ahead of time what you'd like them to do and collect a variety of maps and images for students to use as references. If you choose to have students create a large watershed, such as that of the Colorado River, you may want to have each group of students create a different section and put the sections together before applying the paper maché. You may wish to set a scale for the creation of the model. Check the scale on the maps you collect for ideas to see what might work well in the space you'll have available.

A great resource for you or students to view during this activitiy is Hamline's video "Journey of a Raindrop." Look for it on the *Grand Canyon Adventure* filmsite.

Background:
Point pollution is pollution that comes from one source that is easily identified, such as an oil spill. Though point pollution can be devastating, non-point pollution is actually a bigger problem and on a daily basis accounts for more pollution in watersheds. Below is a list of some types of non-point pollution and where they may come from.

Key Words

Watershed: An area of land that water travels through from the highest spots to the lowest collection spot.
Non-point pollution: Harmful substances that enter the watershed through rain runoff from many different places and many different sources.
Point pollution: Harmful substance(s) that enter the watershed by one source that can be easily identified, such as an oil spill from a ship.

Trash/Plastics: There are so many types of trash we dump into our waterways. Animals eat some and fall ill. Some release toxic chemicals into the environment as they break down. Some, such as plastics, never go away. Plastics break down into tiny polymers that can't completely decompose.

Sediments: When soil or sediments are washed into bodies of water they clog the water and make breathing hard for aquatic animals and plants. Sediments can come from a variety of sources such as construction sites, clear cutting of forests, or people's yards.

Fertilizers/waste/sewage: Sewage and fertilizers contain nutrients such as nitrates and phosphates that cause extreme growth of plants like algae that live in waterways. When overfed plants "bloom" like this, they use up dissolved oxygen as they decompose leaving no oxygen for sealife.

Recipe for Paper Maché
Blend 2 parts flour to 1 part water and add a couple of drops of white glue. Adjust as needed until the consistency is similar to pancake batter.

Organic Pathogens: Living organisms such as bacteria or viruses that can cause illnesses ranging from typhoid to dysentery to respiratory diseases. These pathogens enter waterways from untreated sewage, storm drains, septic tanks, farms, and boats that dump untreated sewage in lakes or the ocean.

Chemicals: Many types of chemicals get into watersheds such as industrial chemicals, household cleaners, pesticides, antifreeze from cars, and more.

Petroleum/Oil: Runoff from streets, roads, and parking lots can carry these substances through the watershed.

To Do:
Introduce the term "Watershed" as an area of land that water travels through from the highest spot to the lowest spot, which is usually the sea. The water "sheds" from the high elevations down to the low elevations. Small

The Colorado River watershed

watersheds exist inside much larger ones, like bowls that fit inside one another. Everyone lives in a watershed.

Pass out copies of the Colorado River watershed map to the students and place one map on the overhead projector. Ask the students to trace the Colorado River with a blue color. Are there other rivers on the map that empty into the Colorado? Color them blue as well. Point out the mountains and other high elevations to students. Have the students trace the dotted line around the high boundaries of the watershed with green.

Tell the students they will be working in groups to build 3D models of a watershed and will see how human-introduced items get into watersheds.

Organize the students into groups and have them create a simple sketch of the watershed they are going to build. They should decide which materials they will use and who will be responsible for each part. Give each group of students a pan and the materials needed to create the landscape of their watersheds. They can crumple newspaper, stack items, build a framework out of cardboard, use mesh wire (chicken wire) or balloons for support, etc.

Once they have their foundation ready, they will cover the entire project with a few layers of paper maché. Allow models to dry.

Once models are dry, have students paint them and allow drying again. Make sure to use paint that is not water-soluble. Acrylic paints work well. The entire project should be mostly covered with paint to prevent the model from falling apart.

Ask the students to spray their models with the spray bottles to make it "rain" and observe what happens.

Introduce the different types of man-made pollution that can affect a watershed. Ask students to brainstorm about what the sources might be for each type of pollution.

Have students add items or symbols to their watershed models to represent some human elements such as cities, farms, construction sites, and industry. Students may create these elements out of paper or clay. If time is short, you can use labels.

Ask students to consider the human elements that they added and the pollutants they might bring. What if it rained on their watershed now? What would happen? (pollutants run into the waterways and drain to the sea). You can have students sprinkle sugar free chocolate drink mix on the model in places where pollution would be. Have them spray water on the model again to see the path pollutants take in the watershed they created.

LEGENDARY LAYERS

ACTIVITY 4

Objective:
Students will learn about the rocks and sedimentary layers of the Grand Canyon. They will explore the layers through time to learn the geologic history of the Canyon and recreate that history in a giant watercolor painting of a wall of the Grand Canyon.

In the film:
Dramatic scenery throughout the Grand Canyon is due to the sedimentary layers of rock formed over billions of years. The various minerals present in the rocks form these inspirational layers of color.

Materials:
- ❑ Geologic cross section of the Grand Canyon
- ❑ Samples or images of the different types of rocks found in the Grand Canyon (see below)
- ❑ Watercolors and paint brushes
- ❑ Containers of water to rinse brushes
- ❑ Large roll of art paper or white butcher paper
- ❑ Project an image of the Grand Canyon or post images around the room for inspiration

Background:
The Grand Canyon has been an inspirational landmark for people throughout the ages. Naturalists, artists, historians, adventurers, and writers have been inspired by the dramatic landscape and natural beauty of the canyon. The Grand Canyon has formed slowly over time, etched away by the Colorado River exposing the colorful layers that we see today. Each layer leaves behind clues painting a picture of life in the past. Traces of ancient coral reefs, coastal wetlands, ancient rivers, and even fossils from humans can be found in the layers.

Geologists have identified at least 21 distinct rock layers along the Grand Canyon. Sedimentary, metamorphic, and igneous rock can all be found in the Grand Canyon with the oldest layers at the bottom of the cliffs dating over a billion years old and the youngest on the top of the cliffs only several million years old.

Geologists record rock types on maps by using symbols that correlate to specific rock types. The provided cross section of the Grand Canyon catalogs the various rock types that form each sedimentary layer.

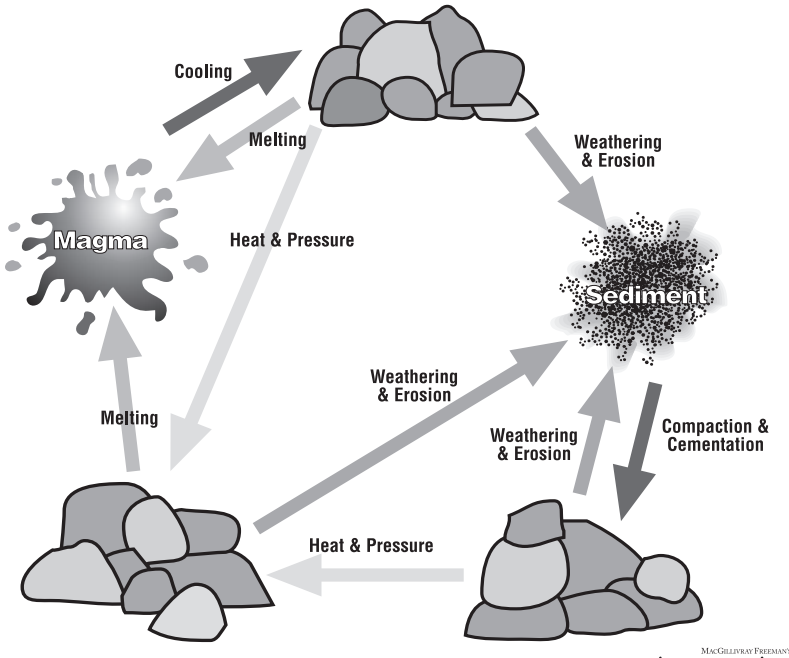
Most of the Grand Canyon's visible layers are sedimentary rock layers. One way sedimentary rock forms is by the deposit of sediments (sand, silt, clay) compressing over time. Limestone, sandstone, shale, dolomite, conglomerate, chert, and siltstone are examples of sedimentary rocks. Metamorphic rock layers form when rock has been subjected to extreme temperatures and/or pressure. Schist, quartzite, marble and slate are types of metamorphic rocks. Igneous rocks are formed when rocks melt, become magma, cool and crystallize. Examples of igneous rocks include granite, basalt, obsidian and pumice.

Teacher Prep Notes:
Copy the rock cycle onto an overhead projector sheet. Make copies of the geologic cross section for students to reference. When creating the watercolor wall, you may wish to establish a scale for the layers to more accurately represent the Grand Canyon and fit the space available in your classroom. You may wish to expand this activity by having students identify rock samples and their lithologic symbols by using a rock key or field guide. You can purchase a rock key and guide or download one of the many available online. If you don't have space to build a giant Grand Canyon watercolor wall, students can do individual paintings.

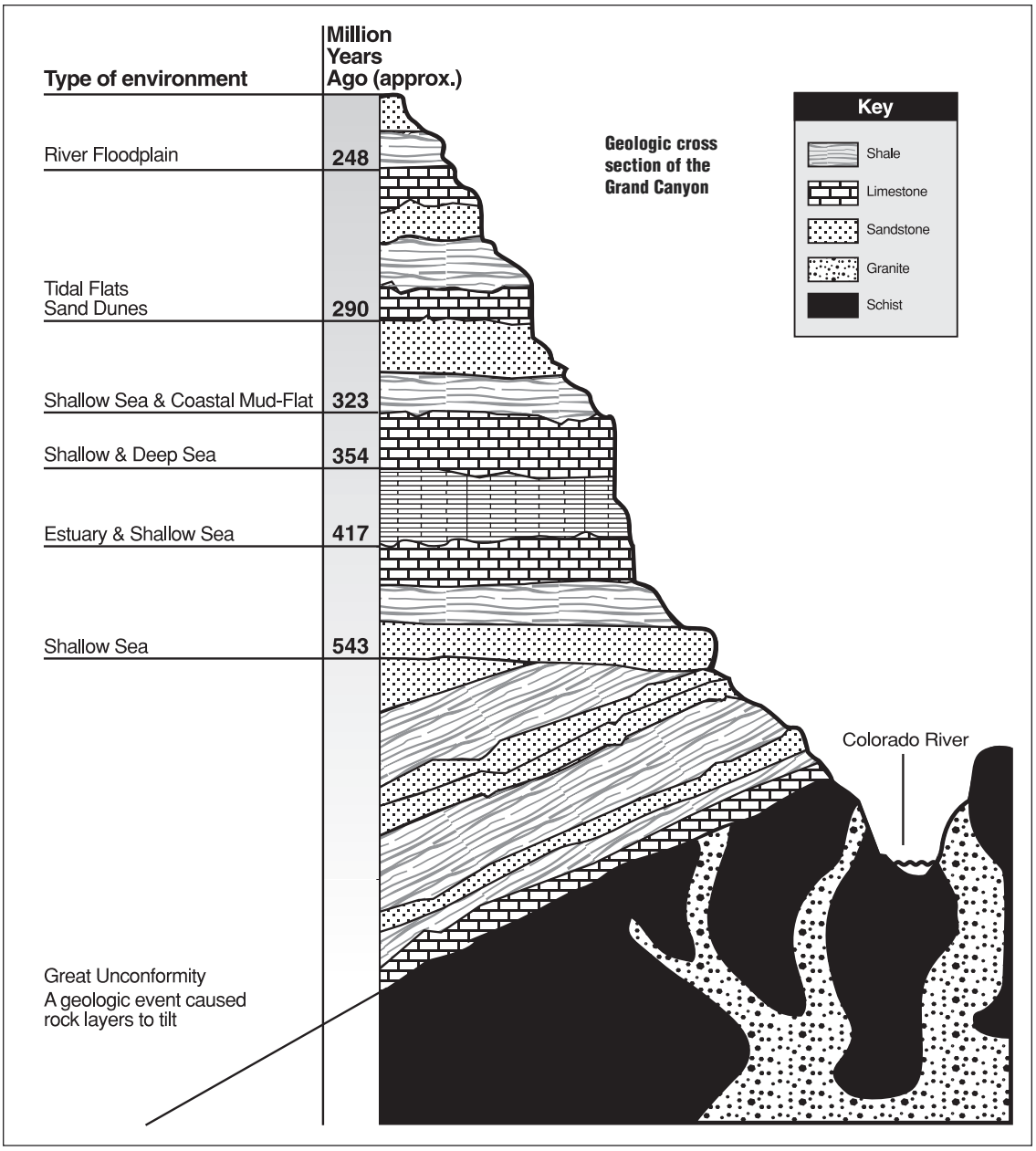
Key Words

Sedimentary rock: Rock formed by the deposition of sediment over time.
Metamorphic rock: Sedimentary rock exposed to extreme pressure and/or temperature.
Igneous rock: Rock that melted, became magma, then cooled and crystallized.
Lithologic symbols: Standard symbols used to depict different types of rocks. Lithology is the study of rocks.

To Do:
Display images of the Grand Canyon cliffs on a projector or post around the room. Ask students to take note of



The rock cycle



the colors and number of layers they see in the images.

Explain the three different types of rock layers and how they form by showing the rock cycle diagram. Share with students samples/photos of the types of rock found in the Grand Canyon.

Pass out the geologic cross section. Discuss how the layers are aged from the oldest at the bottom to the youngest at the top. The deep canyon that we see today has been slowly carved away by the Colorado River, leaving a history behind in its layers for us to see. The geologic cross section uses the lithologic symbols for the types of rocks.

Discuss the different layers and what composes them. Are students surprised to learn that the area used to be an ocean? What else about the makeup of the layers surprised them?

Split students into groups and assign them a certain time period. Using watercolors, they will paint the geologic cross section from that time period and on a separate piece of paper create a key. Students can choose color, textures, and patterns they like to represent each sedimentary layer based on the images of the Grand Canyon walls and sample rocks that you provide.

When paintings are dry, hang them in chronological order on a tall wall to simulate a giant wall from the Grand Canyon. Display the keys next to the painting.

Rollin' Down The River

ACTIVITY 5

Objective:
Students will learn about the different human uses of water and how difficult apportioning a water resource can be. They will become water trying to make it to the end of the river in a game filled with water usage scenarios.

In the Film:
The life force of the Southwestern United States is the Colorado River. It is estimated that thirty million people rely on the Colorado River and that number is growing. The water supply, however, is shrinking.

Materials:
- ❑ Dice (one per stop along the river)
- ❑ Large room or playing field
- ❑ Highlighters
- ❑ Chalk or rope
- ❑ Map of your local watershed or the Colorado River *(see page 10)*

Teacher Prep Notes:
Make a copy of the watershed map you'll be using for the activity. If you are short on time or have younger students, you may wish to create the scenarios for the river sites yourself instead of having the students create them in class.

Background:
Freshwater is consumed by plants, animals and humans. The water that we are drinking today is the same water that the dinosaurs drank! The water that exists on this planet today is all we have. Less than 1% of all the water on the planet is freshwater that we can access for human consumption.

With populations increasing, demands on our water supply are growing. More people mean more agriculture and farming to feed everyone, more homes and landscaped yards, more industry to make the products we consume, more reservoirs to hold drinking water and more golf courses, theme parks, and giant fountains to entertain us. Is there a point at which a region can't sustain any more population growth because it doesn't have the water supply?

Some regions, including the Colorado River Basin, are facing these types of issues today. Who has the rights to the water? If there is a shortage, what types of water use should be cut first? Can a region really close its doors to new development? These are questions cities, states, and the courts are struggling to answer.

To Do:
Look at a map of your local watershed or the Colorado River and pick one major river for this activity. On the map identify and highlight the headwaters, outlet or mouth, and several places along the river to be sites in the activity that will be stopovers such as towns, agricultural fields, industrial sites, dams, and major cities. Choose 6-8 sites along the river to use in this activity. You can also create your own sites if information is not readily available.

As a class, generate six scenarios for each site (one for each number on the die—see examples in box). Make sure some of the scenarios advance players. Write each site's scenarios on a piece of paper to be referenced during the game.

Scenario examples—Agriculture/Farming site

- = new water saving equipment mandated for farmers—move to next site
- = huge storm causes a flood—take one friend to the next site
- = heat wave causes water to evaporate—return to the headwaters
- = broken irrigation system—wait one roll
- = due to drought Governor orders water diverted to city for drinking water—flow to nearest city and wait three rolls
- = farmers implement mixed crop practices that save water—move to next site.

Once the parts of the river are identified, lay out the wavy line of the river on the floor with chalk or rope. Designate the headwaters at one end of the line and the outlet at the opposite end. Along the line, designate the various sites that you generated and label with chalk or a piece of paper. Each site on the river will have one die.

Each student will role a die and become water on a journey from the headwaters of the river down to the outlet at the river mouth. Students will encounter various scenarios that detour or accelerate their journey downstream. Students are challenged to make it to the river mouth and reflect on ways to conserve water in their own lives. How many students actually make it to the outlet?

Taking it Further:
Split students into small groups and have them research the different users of water for the Colorado River. Each group should choose a user that they will represent in a water negotiation meeting. Establish a set amount of water available from the Colorado River and give each group an amount of water they need to function. The total of needed water should exceed the amount of water available. Students can have a meeting and try to negotiate a plan for fair water usage for all.

ROCK ART

ACTIVITY 6

Objective: Students will learn about petroglyphs by creating their own symbolic representation. Students will interpret each other's work and discuss how ancient cultures may have used this form of communication.

In the film:
Glimpses of the past are seen in the Anasazi ruins at Chaco Canyon. Their buildings, kivas, and petroglyphs can still be viewed today. Petroglyphs are images carved into stone often left behind by ancient peoples. They can tell a story, contain practical everyday information, or have spiritual meanings.

Key Words

Petroglyph: images carved into stone

Pictograph: images painted onto stone

Geoglyph or Intaglio: large scale image made by carving away the top layer of rock to reveal lighter colored areas that form an image

Materials:
- ❑ Plaster of Paris
- ❑ Paper plates
- ❑ Tools to scrape plaster with such as sharp rocks or clay tools
- ❑ Newspaper
- ❑ Earth tone paints
- ❑ Paint brushes
- ❑ Cups of water for rinsing brushes
- ❑ Images of southwest petroglyphs. pictographs, and geoglyphs (intaglio)

Teacher Prep Notes:
Find petroglyphs, pictographs, and geoglyphs (intaglio) examples to share with students. Many examples are available online or there are a variety of books that display vivid images. At least 24 hours before activity prepare plaster of Paris according to the directions on packaging and pour onto a plate for each student and make sure it is dry before starting activity.

Petroglyph from the Grand Canyon

Background:
Petroglyphs are images or symbols carved into rocks. Pictographs are images painted onto rock. Geoglyphs, also called intaglio, are large scale images where a layer of stone is removed from the ground, leaving a lighter layer of earth exposed. Intaglios are usually so large scale they can only be recognized when viewed from the sky.

The Colorado River region, with its rich Native American history, has all three types of rock art. These types of images are also found worldwide. While similarities among the images and symbols exist, the meaning of each symbol may vary by culture, the specific site, and the arrangement of the images in relation to others. The exact meaning of these symbols is still a mystery. Archaeologists, anthropologists, researchers, and native informants have made educated guesses about the meaning of these images that vary from abstract geometric shapes such as spirals, to animal or human like figures.

To Do:
Display images of southwest rock art on a projector or provide images for students to view. Break students into small groups and assign them an image or set of images to interpret together. Students will present the image to the class and share their thoughts about the meaning of the images.

Next, students will design their own symbol to inscribe on the plaster of Paris. Ask students to think of a symbol that represents something special or meaningful to them and sketch it on a piece of paper. (Keep in mind that rock carving can be time consuming and challenging.)

Give each student a plate of prepared and dried plaster. Students will carve their symbol into the plaster of Paris using clay tools. After carving their symbols, students can paint their carvings to resemble stone by dipping newspaper into their choice of paint colors and dappling the surface of the plaster to create a mottled appearance. Allow to dry.

Display the artwork around the room and place a blank piece of paper next to each student's work. Students will walk around the room and look at each other's images jotting down words that come to mind on the paper next to the artwork when they look at the image. When everyone is finished, students will read what others wrote about their symbol.

Discuss how the interpretation of symbols can be based on people's life experiences. Living artists can answer questions about the image and it's meaning, but the artists from the past are long gone and we only have these symbols as a clue to their lives.

Trash to Treasure

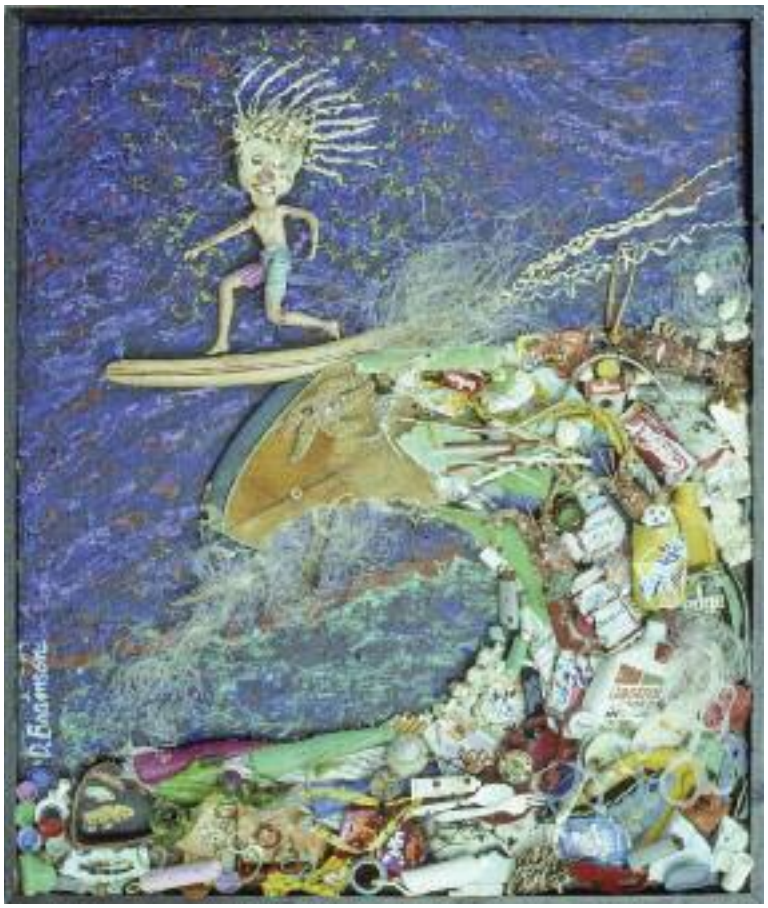
ACTIVITY 7

Objective:
Students will learn about threats that litter poses to aquatic ecosystems by organizing and participating in a community clean-up. Students will collect and evaluate data on what they find. A school-wide exhibit will feature art created from "found objects" and posters that show the students' scientific research results and suggestions for helping reduce litter.

In the Film:
Every action we take as an individual makes a difference on this planet. By taking action and removing litter, we can reduce the amount of pollution that ends up in our waterways.

Materials:
- ❑ Pencils, erasers, and a variety of markers
- ❑ Clipboards
- ❑ Trash tally cards
- ❑ Garbage bags
- ❑ Plastic gloves (check with students about latex allergies)
- ❑ Bins to separate materials that can be cleaned and used for sculpture
- ❑ Dish soap, water, and towels for cleaning items
- ❑ Large piece of heavy cardboard or plywood for base of art
- ❑ Hot glue guns (for adult use) and cartridges or another strong adhesive from a home improvement store. (Be careful with these products and make sure to wear rubber gloves).
- ❑ String, variety of tape, zip ties, rubber bands, clamps, clothes pins or other things for attaching and holding pieces while glue dries or for additional reinforcement.
- ❑ Scissors
- ❑ Poster board
- ❑ Clear contact paper
- ❑ Glue—we suggest wood glue, tacky glue, white glue, and glue sticks
- ❑ Any additional media you would like students to use in artwork such as plaster of Paris, clay, etc.

Teacher Prep Notes:
This activity will take several class sessions to complete. First decide where to do the clean-up and get the appropriate permissions for the date you'd like, then schedule your classroom activities. Go to www.wylandcleanwaterchallenge.org and click on the "Teacher Resources" section and "Beach Clean-ups" to find and read tips for organizing a clean up and to download the trash tally card.



It's amazing what you discover while collecting trash in or along a watershed. Artwork was created from items found during a 20-minute walk along a California beach. ©David Bramsen

To Do (part one):
Let the students know that the class will be doing a clean-up to collect the trash and data. Ask students what information would be useful. How should they collect it? Discuss how scientists might tackle the situation—for example, assigning teams with a tally card to clean certain areas or assigning teams certain categories of items to clean and gather across the whole area. Have the class vote for their preferred method. Hold the clean-up event. When students are done collecting, sort the trash into three categories: items to be used for art, recyclables, and trash.

Before leaving the area, have students take notes on anything they observe that might be contributing to the litter problem (overflowing trash cans, no recycle bins, nearby road traffic, storm drain outlet, etc.) and discuss as a group.

To Do (part two):
Back in the classroom, have students tally all the data and create a bar graph showing the numbers of different

types of litter found. Put students back in their groups and assign each group one or two litter items to research and discuss.

You or the students can wash and dry items to be used in the artwork, then begin the process of creating the collaborative art. You may opt to create a sculpture of an animal, place, figure, or an abstract sculpture. Discuss with the class a plan for how to achieve this, and make a sketch before starting the project. Have one group at a time work on the art while other groups are working on their posters for the exhibit. The idea is to cover the plywood with items found during the clean-up and/or with representative items brought in. There are no rules for this project, except to keep it safe.

For the posters, have groups research the impact of their litter items on the quality of water, the plants, and the animals that live in the ecosystem. Have them also discuss why they think that particular item got there and how. Each group will create a poster on the litter items that they have been assigned, explaining how the items are harmful and persuading people to help in some way. They can use markers directly on the poster or use a computer to create text and graphics and glue them to the board. Have them cover the board with clear contact paper when they are finished if the display will be outside.

Set up the artwork and posters in a place where students from other classrooms, administrators, and parents can visit them. Students can conduct guided tours of the exhibit.

Once the activity is over, ask students the following questions:

- What are some ways trash hurts the ecosystem?
- Did you discover any of the contributing factors to the trash problem?
- What could be done to help limit the amount of trash?
- How does your "trash to treasure art" help convey a message?

Key Words

Exhibit: To present something such as art or information for the public to view.
Ecosystem: Living things, the physical environment they live in and how they function together.
Data: Facts or pieces of information.

Taking it Further:

Have students design a study to determine the source of the litter problems. They should present the conclusions of their study and suggestions to the governing agency responsible for the area where the clean-up was held. And they can learn more about protecting water quality in their area at www.waterkeeper.org

Resources

Water, Earth, and Sky: The Colorado River Basin
Michael Collier, The University of Utah Press, Salt Lake City, UT, 1999

An Introduction to Grand Canyon Geology Michael Collier, Grand Canyon Association, AZ, 1980

A Field Guide to the Grand Canyon
Stephen R. Whitney, The Mountaineers, Seattle, WA, 1996

Downcanyon
Ann Haymond Zwinger, The University of Arizona Press, Tucson, AZ, 1995

Discover a Watershed: the Colorado
Project Wet International Foundation, 2005
www.projectwet.org

Life in a River
Valerie Rapp, Lerner Publications Company, Minneapolis, MN, 2003

Freshwater Ecoregions of North America: A Conservation Assessment
Robin Abell, et al., Island Press, Washington, D.C. 2000

Troubled Water: Saints, Sinners, Truths and Lies about the Global Water Crisis
Anita Roddick, Anita Roddick Books, United Kingdom, 2004

The Water Atlas: A Unique Visual Analysis of the World's Most Critical Resource
Robin Clarke and Jannet King, The New Press, New York, NY, 2004

Websites

www.grandcanyonadventurefilm.com
Film background, media, water conservation tips

www.teva.com/water
Test the health of your local waterway.

www.wylandcleanwaterchallenge.org
Art and science activities relating to clean water

www.kohler.com/savewater
Ideas for water conservation at home

www.waterkeeper.org
Get involved with local Waterkeepers—citizen advocates who patrol and protect their waterways in 172 communities around the world.

www.hamline.edu/gse/cgee_site
K-12 classroom projects and media products

www.usc.edu/org/cosee-west/quikscience
Lesson plans, information, and science contest

www.americanrivers.org
River facts and ways to get involved

www.epa.gov/teachers/water.htm
A collection of lesson plans and background on a variety of water topics

www.usgs.gov
Downloadable maps, geological information, lesson plans, and other resources

www.respectthebeach.org
A collection of lesson plans from the Surfrider Foundation as well as a watershed education video called "Sea to Summit."

www.projectwet.org
Lesson plans, maps, books and student supplements on a variety of water topics and waterbodies

www.un.org/waterforlifedecade
The United Nations Water for Life site has fact sheets, detailed information on worldwide water crisis and a kids corner.

www.ryanswell.ca
Empowers children and adults to share Ryan's vision of a world where everyone has clean water.

Acknowledgements

The material in this guide was developed by the Wyland Foundation in support of the Wyland Clean Water Challenge and MacGillivray Freeman Films Educational Foundation. The Clean Water Challenge is designed to instruct and inspire young people everywhere about marine science and the conservation of water quality on our planet. Through a unique range of continually updated art and science activities, students are offered a global view of our planet's ocean, lakes, rivers, streams, and wetlands. For more activities and information visit: **www.wylandcleanwaterchallenge.org**

MacGillivray Freeman Films Educational Foundation funded the educational outreach materials for *Grand Canyon Adventure: River At Risk* thanks to the generosity of organizations and individuals across the United States who are committed to water conservation. The MFF Educational Foundation, a non-profit organization, seeks to develop films and ancillary programs and materials that focus on the importance of our environmental heritage.
Visit: **www.mffeducation.org** to learn more

The Foundation engaged three U.S. teachers who received the prestigious 2006 Presidential Awards for Excellence in Mathematics and Science Teaching to help evaluate this Teacher's Guide and outreach materials. We thank Debra Las, Rhonda Spidell and John Madden for their review.

Writers and contributors:

Writers: Sue Ann Balogh, Crystal DeSoto, Dawn Dickerson, Courtney Hughes-Browne, Sarah Trueblood, Erika Reeves, Peter Landry, Emily Coyne

Project Manager: Alice Casbara-Leek, MacGillivray Freeman Films

Designers: Jeff Girard, Ken Harris

Illustrations pages 5 & 6: Tracy Potter, for theWyland Foundation; *page 15:* David Bramsen

MacGillivray Freeman's

Grand Canyon Adventure

River at Risk

Presented by Teva

Proudly Supported by KOHLER

Narrated by Robert Redford

Featuring Songs and Music by Dave Matthews Band

Produced by MacGillivray Freeman Films Educational Foundation

in association with Waterkeeper Alliance

and Museum Film Network

MacGillivray Freeman Films Educational Foundation

Wyland Foundation

OARS

Soundtrack available on RCA BMG

Waterkeeper Alliance

Outside magazine

Companion Photo Book available from Earth Aware Editions

Distributed by

MacGillivray Freeman Films Distribution Company

P.O. Box 205, Laguna Beach, California U.S.A. 92652 Telephone (949) 494-1055 Fax (949) 376-4147

www.grandcanyonadventurefilm.com