



Desert Waters

A one-hour Green STEM program for students in grades 3-5.

To the Teacher:

Thank you for making the “*Desert Waters*” Green STEM Program a part of your curriculum. During this exciting educational program, students will visit different activity stations and complete a worksheet to understand our region’s water story. They will meet live desert animals, manipulate watershed and aquifer models, complete a map of Arizona’s rivers, and consider ways that they can conserve water at home.

The following information contains pre- and post- program background and activity ideas along with a vocabulary list and suggested resources. These activities and the program content are aligned with Arizona Academic Standards in Science and Math and support Next Generation Science Standards (<http://www.nextgenscience.org/next-generation-science-standards>) as detailed below. The following materials were gathered to help you extend this class topic with both introductory and follow-up lessons. The pre-visit information will introduce students to some of the basic concepts presented in *Desert Waters* and help prepare them for the program. The post-visit activities pursue water conservation questions through applied mathematics and provide work sheets designed to meet the standards for each grade. We hope you’ll find this information useful and easy to incorporate into your science and math curriculum. For more information about the Desert Museum and the Sonoran Desert, visit our website at www.desertmuseum.org.

Sincerely,

ASDM Department of Conservation Education and Science

DESERT WATERS

Where is water more precious than in the desert? Students will visit activity stations that tell our region's water story and meet live animals to discover where our water comes from and where it goes, how surface water supports a diversity of life in our region, how these waters have changed, and what can we do to protect the vital desert waters that remain.

Program Objectives:

Through the examination and manipulation of materials and models at activity stations and interaction with live animals students will:

- Review the water cycle.
- Describe Tucson’s watershed and how it is connected to other watersheds.

- Understand the relationship between groundwater and surface water.
- Reveal and explain human-caused changes that have occurred in Arizona’s surface waters over the last one hundred years.
- Develop an appreciation for the diverse organisms that depend on these water resources.
- Describe different aquatic and riparian habitats found in the desert and how animals depend on these water resources.
- Identify some ways humans can conserve and protect limited water resources to ensure that they remain to meet the needs of humans and other living things.

Arizona Academic Standards Correlation:

Science Standards:

GRADE 3:

Strand 1: Inquiry Process

Concept 1: Observations, Questions, and Hypotheses

PO 1. Formulate relevant questions about the properties of objects, organisms, and events of the environment using observations and prior knowledge.

Strand 2: History and Nature of Science

Concept 2: Nature of Scientific Knowledge

PO 1. Describe how, in a system (e.g., terrarium, house) with many components, the components usually influence one another.

Strand 3: Science in Personal and Social Perspectives

Concept 1: Changes in Environments

PO 2. Describe the beneficial and harmful impacts of natural events and human activities on the environment (e.g., forest fires, flooding, pesticides).

Concept 2: Science and Technology in Society

PO 1. Identify ways that people use tools and techniques to solve problems.

Strand 4: Life Science

Concept 3: Organisms and Environments

PO 4. Describe how plants and animals cause change in their environment.

PO 5. Describe how environmental factors (e.g., soil composition, range of temperature, quantity and quality of light or water) in the ecosystem may affect a member organism’s ability to grow, reproduce, and thrive.

Concept 4: Diversity, Adaptation and Behavior

PO 1. Identify adaptations of plants and animals that allow them to live in specific environments.

PO 3. Cite examples of how a species’ inability to adapt to changing conditions in the ecosystem led to the extinction of that species.

GRADE 4:

Strand 3: Science in Personal and Social Perspectives

Concept 1: Changes in Environments

PO 1. Describe how natural events and human activities have positive and negative impacts on environments (e.g., fire, floods, pollution, dams).

Concept 2: Science and Technology in Society

PO 2. Describe benefits (e.g., easy communications, rapid transportation) and risks (e.g., pollution, destruction of natural resources) related to the use of technology.

Strand 4: Life Science

Concept 3: Organisms and Environments

PO 3. Analyze the effect that limited resources (e.g., natural gas, minerals) may have on an environment.

PO 4. Describe ways in which resources can be conserved (e.g., by reducing, reusing, recycling, finding substitutes).

Strand 6: Earth and Space Science

Concept 3: Changes in the Earth and Sky

PO 1. Identify the sources of water within an environment (e.g., ground water, surface water, atmospheric water, glaciers).

GRADE 5:

Strand 1: Inquiry Process

Concept 3: Analysis and Conclusions

PO 1. Analyze data obtained in a scientific investigation to identify trends and form conclusions.

Strand 3: Science in Personal and Social Perspectives

Concept 1: Changes in Environments

PO 2. Propose a solution, resource, or product that addresses a specific human, animal, or habitat need.

Arizona's College and Career Ready Standards – Mathematics:

GRADE 3:

Operations and Algebraic Thinking - Represent and solve problems involving multiplication and division.

3.OA.A.3. Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.

Number and Operations – Fractions - Develop understanding of fractions as numbers.

3.NF.A.1. Understand a fraction $1/b$ as the quantity formed by 1 part when a whole is partitioned into b equal parts; understand a fraction a/b as the quantity formed by a parts of size $1/b$.

3.NF.A.3. Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.

Recognize and generate simple equivalent fractions, e.g., $1/2 = 2/4$, $4/6 = 2/3$).

Express whole numbers as fractions, and recognize fractions that are equivalent to whole numbers.

Geometric measurement: understand concepts of area and relate area to multiplication and to addition.

3.MD.C.5: Recognize area as an attribute of plane figures and understand concepts of area measurement.

- a. A square with side length 1 unit, called “a unit square,” is said to have “one square unit” of area, and can be used to measure area.
- b. A plane figure which can be covered without gaps or overlaps by n unit squares is said to have an area of n square units.

3.MD.C.6: Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).

3.MD.C.6: Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).

3.MD.C.7: Relate area to the operations of multiplication and addition.

- a. Find the area of a rectangle with whole-number side lengths by tiling it, and show that the area is the same as would be found by multiplying the side lengths.
- b. Multiply side lengths to find areas of rectangles with whole-number side lengths in the context of solving real world and mathematical problems, and represent whole-number products as rectangular areas in mathematical reasoning.
- c. Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths a and $b + c$ is the sum of $a \times b$ and $a \times c$. Use area models to represent the distributive property in mathematical reasoning.

GRADE 4:

Number and Operations in Base Ten - Note: *Grade 4 expectations in this domain are limited to whole numbers less than or equal to 1,000,000.*

Use place value understanding and properties of operations to perform multi-digit arithmetic.

4.NBT.B.5: Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.

Number and Operations – Fractions - Note: Grade 4 expectations in this domain are limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12, & 100.

- d. Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.

Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.

- 4.NF.B.3: Understand a fraction a/b with $a > 1$ as a sum of fractions $1/b$.
- 4.NF.B.4: Apply and extend previous understandings of multiplication to multiply a fraction by a whole number.
- c. Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. *For example, if each person at a party will eat $3/8$ of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?*

Measurement and Data - Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.

- 4.MD.A.2: Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

GRADE 5:

Number and Operations in Base Ten - Understand the place value system.

Perform operations with multi-digit whole numbers and with decimals to hundredths.

- 5.NBT.B.5: Fluently multiply multi-digit whole numbers using the standard algorithm.
- 5.NBT.B.6: Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.
- 5.NBT.B.7: Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

Next Generation Science Standards:

3-LS4 Biological Evolution: Unity and Diversity

Science and Engineering Practices:

Constructing Explanations and Designing Solutions

Use evidence (e.g., observations, patterns) to support an explanation. (3-LS3-2)

Disciplinary Core Ideas:

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (*secondary to 3-LS4-4*)

LS4.C: Adaptation

For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

LS4.D: Biodiversity and Humans

Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)

Crosscutting Concepts:

Systems and System Models

A system can be described in terms of its components and their interactions. (3-LS4-4)

5-ESS2 Earth's Systems

Science and Engineering Practices:

Obtaining, Evaluating, and Communicating Information

Obtain and combine information from books and other reliable media to explain phenomena. (3-ESS2-2)

Disciplinary Core Ideas:

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

Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)

Crosscutting Concepts:

Cause and Effect

Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2)

5-ESS3 Earth and Human Activity

Science and Engineering Practices:

Obtaining, Evaluating, and Communicating Information

Obtain and combine information from books and other reliable media to explain phenomena. (3-ESS2-2)

Disciplinary Core Ideas:

ESS3.C: Human Impacts on Earth Systems

Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)

Crosscutting Concepts:

Systems and System Models

A system can be described in terms of its components and their interactions. (5-ESS3-1)

5-ESS2 Earth's Systems

Science and Engineering Practices:

Using Mathematics and Computational Thinking

Describe and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)

Disciplinary Core Ideas:

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

Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)

Crosscutting Concepts:

Scale, Proportion, and Quantity

Standard units are used to measure and describe physical quantities such as weight and volume. (5-ESS2-2)

Patterns

Patterns of change can be used to make predictions. (3-ESS2-1),(3-ESS2-2)

Recommended Teacher Resources:

Arizona Project WET: Arizona Project WET (APW) offers teacher-tested, water-related curriculum at no cost to teachers via hands-on, motivating workshops. www.cals.arizona.edu/arizonawet/index.html

CAP Educational Materials (H2O4U) at www.caph2o4u.com. Grades middle through high school. Can also request free elementary level activities.

Environmental Education Exchange water programs for **Tucson Water:** Da Drops, Our Water, Our Future, and Tucson Toolkit. Teachers can schedule these programs to be taught at their schools through <http://www.eeexchange.org/outreach>, and curriculum materials can be found at www.cms3.tucsonaz.gov/water/education. They also have a middle school activity book called *Stormwater in the Desert* with a teachers' guide at <http://www.tucsonstormwater.com/teachers/>.

Environmental Protection Agency has a variety of resources including Water Education teachers' guides, <http://water.epa.gov/learn/resources/index.cfm> and Water Sense kids' guides with conservation activities and games, <http://www.epa.gov/watersense/kids/index.html>.

Jeremy Jackrabbit Harvests the Rain is a whimsical story for lower elementary audiences about Jeremy, who lives in the desert and learns from his friends about the importance of reusing water in easy and fun ways. The story and curriculum ideas are at <http://www.jeremyjackrabbit.com/stories/>

National Geographic's website has lots of information about water issues:

<http://environment.nationalgeographic.com/environment/freshwater>, a water footprint calculator: <http://environment.nationalgeographic.com/environment/freshwater/water-footprint-calculator/> and quizzes to test yourself and students about freshwater, drinking water and sanitation, and more: <http://environment.nationalgeographic.com/environment/freshwater/drinking-water-and-sanitation-quiz/>

Teachers' Guide to Water Related Lesson Plans and Materials has an extensive inventory of water related activities and links, primarily for elementary school teachers and students.

<http://www.seametrics.com/water-lesson-plans>

U of A Water Resources Research Center (WRRC) promotes understanding of critical state and regional water management and policy issues through research, community outreach and public education and is the site of Arizona Project WET as well as several other water related resources.

<http://wrrc.arizona.edu/>. Their **Conserve to Enhance Program** promotes water conservation and ties the savings directly into habitat restoration projects: <http://wrrc.arizona.edu/c2e>.

USGS Water Science School offers a vast array of water science resources for teachers and students:

<http://water.usgs.gov/edu/>.

Water Footprint Calculator: <http://www.h2oconserve.org/home.php?pd=index>

Water – Use it Wisely is a smart water use campaign based in the greater Phoenix Metropolitan area which has many links to teacher resources at <http://wateruseitwisely.com/kids/#resources>

Watershed Management Group (WMG) is a Tucson-based not-for-profit organization focusing on stakeholder based soil and water conservation including rainwater harvesting, greywater, and erosion control. WMG works with schools to promote water conservation and develop wildlife habitat through water harvesting and native gardening activities. They also partner with WRRC above for the Conserve to Enhance Program.

Other:

Arizona Water Resources and Riparian Habitat Conservation:

Pima County Natural Resources, Parks, and Recreation: Protects a variety of important ecosystems throughout Pima County including riparian ecosystems and provides educational and recreational opportunities for the public within these properties. <http://www.pima.gov/nrpr/>

River of the Month: for interesting profiles of Arizona's rivers and their unique issues:

<http://www.edf.org/ecosystems/celebrating-arizonas-rivers>

Santa Cruz Valley Heritage Alliance: website contains a wealth of cultural/historical background of the region to better understand the impact of the river on the community. www.santacruzheritage.org/.

Sonoran Desert Conservation Plan: <http://www.pima.gov/cmo/sdcp/>

Sweetwater Wetlands: <http://cms3.tucsonaz.gov/water/sweetwater>

Tucson Audubon Society: www.tucsonaudubon.org has a Habitat Restoration Program to restore riparian habitat for preservation of bird diversity and has a variety of projects throughout the Tucson area.

Tucson Water Open Space and Riparian Contribution/Conserve to Enhance Programs:
<http://cms3.tucsonaz.gov/water/checkbox>

Colorado River:

Down the Colorado: Follows two expeditions by kayak, foot, and raft over 2500 miles on the Colorado River system, from two sources to the sea. Through photographs, articles, and a web-video series, it depicts the whole watershed, from snowcapped peaks to wilderness canyons to a devastated delta.
<http://downthecolorado.org/>

National Geographic's The American Nile: This multi-media essay on the Colorado River gives a great overview of the issues facing the river and its conservation, including then-and-now historical photographs from various locations along its watershed.
<http://www.nationalgeographic.com/americanile/>

Raise the River: A group effort to help reconnect the Colorado River to the Gulf of California and restore life to the Colorado River Delta. <http://raisetheriver.org/>

Renewal –A Reborn Colorado River Once Again Finds Her Path to the Sea: Narrated by Robert Redford, Renewal captures the breathtaking and historic surge of water that was released into the Colorado River in the Spring of 2014. The new water created, once again, a river to the sea.
<https://www.youtube.com/watch?v=TODV7FW746s> or
http://www.sonoraninstitute.org/?utm_source=New+Western+Dispatch+2014&utm_campaign=July+2014+Western+Dispatch++Essentials+for+Success&utm_medium=email

Water Release Study: The Spring 2014 “pulse” of water into the Colorado River Delta resulted in several hydrological and ecological studies, including some by UA researchers.
http://azstarnet.com/news/local/education/college/ua-scientists-among-many-studying-colorado-river-water-release/article_9a53b90d-9d03-5f55-b7ab-78d5025f74ae.html

Watershed: Executive Produced and Narrated by Robert Redford and Directed by award-winning filmmaker, Mark Decena, the movie WATERSHED tells the story of the threats to the once-mighty Colorado River and offers solutions for the future of the American West. <http://watershedmovie.com/>

Rainwater Harvesting:

Brad Lancaster is a Tucson water expert specializing in rainwater harvesting and sustainability issues. His books *Rainwater Harvesting for Drylands and Beyond* are award-winning go-to guides for how to harvest the rain. <http://www.harvestingrainwater.com/>

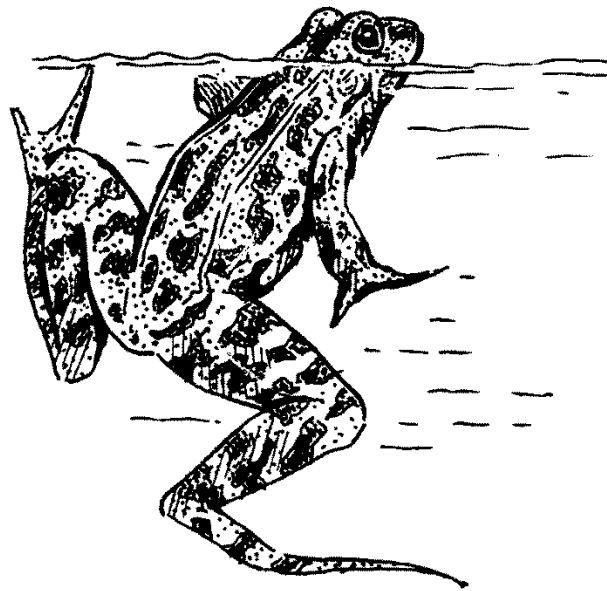
Water Conservation:

American Water Works Association has short, informative videos for kids on various water conservation issues. <http://www.drinktap.org/kids.aspx>

Tucson Water: <http://cms3.tucsonaz.gov/water> and
<http://www.tucsonaz.gov/files/water/docs/homeowner.pdf>

Tucson Water Conservation Programs: <http://cms3.tucsonaz.gov/water/conservation>

Tucson's Water Story: For a great overview of Tucson's current state of water, wastewater, and reclaimed water systems, as well as interesting historical information.
www.tucsonpimawaterstudy.com/Reports/NewChapter_1.pdf



Water Vocabulary:

Aquifer: underground layers of rocks, sand, and clay that hold groundwater.

Central Arizona Project: a 336-mile long canal that carries Colorado River water across Arizona for use by Maricopa, Pinal, and Pima Counties.

Cienega: Marshy riparian habitat near springs or along streams where groundwater is at the surface. Water is shallow and slow moving. Aquatic plants grow in the water, and trees grow along its edge.

Condensation: the change of water vapor into a liquid, i.e. when water vapor forms into clouds.

Conservation: careful preservation and protection of something, especially planned management of a natural resource to prevent exploitation, destruction, or neglect.

Ephemeral stream: a stream that has water flowing in it immediately following a precipitation event.

Evaporation: the process of water changing from a liquid into a gas (water vapor.)

Gray water: water draining from showers, bathroom sinks, washing machines, etc. that can be used to water landscape plants.

Groundwater: water found under the surface of the ground in the spaces between sand, gravel, or silt particles, or cracks in rocks.

Habitat: a place where an animal or plant lives and reproduces that provides food, water, and shelter.

Intermittent stream: a stream that has water flowing in it for at least part of the year.

Native: plants, animals, and people that are original inhabitants of a particular place by birth or origin. Native organisms are adapted to the environment in which they are found.

Percolation: slow movement of water through the pores in soil and permeable rock.

Perennial stream: a stream that flows continuously all year.

Precipitation: water that falls from clouds as rain, snow, sleet, hail, etc.

Rainwater harvesting: the capture, diversion, and storage of rainwater for plant irrigation and other uses.

Reclaimed water: treated, filtered, disinfected wastewater that can be used for irrigation and other non-drinking applications.

Recharge: water percolating down through the soil to replenish underground aquifers.

Restoration: renewing or restoring damaged or destroyed ecosystems and habitats.

Riparian: habitat type associated with surface water (streams and lakes), washes, or near-surface groundwater that supports vegetation communities and ecosystems that require this water for survival.

Riparian woodlands: lush trees and other plants found alongside cienegas, rivers, streams, and washes. These plants do not grow in the dry lands beyond the riparian areas.

Riparian corridors: narrow bands of cooler, wetter habitats found along riparian areas that pass through drier surrounding habitat types and provide habitat and passage for animals that require their moisture.

River: A natural stream of water fed by rain and snowmelt flowing in a definite course or channel. The water flow and temperature change with the seasons.

Runoff: water that flows across the land in streets or washes after a storm.

Santa Cruz River: Tucson's largest river which flows north through the city and is fed by tributary washes and streams

Stream: a body of water with a current contained within a bed and stream banks.

Surface water: water above ground found in washes, streams, rivers, puddles, lakes, etc .

Transpiration: the evaporation of water from plants, mostly through their leaves

Water cycle: the phases through which water moves throughout the environment passing from a gas to a liquid and back again.

Water table: the top level of the groundwater, below which the ground is saturated with water.

Watershed: area of land where all the water that is under it or drains off of it goes into the same place.

Well: a hole dug into groundwater for collecting water.

ACTIVITY OVERVIEW:

The Desert Waters program can serve as a stand-alone introduction to water issues, or it can tie together several concepts taught within a lengthier unit on water. The pre-visit background reading sheet is written at the fourth grade level but will introduce the topic for all grades in the program range. The post-visit math activity is designed to meet the specific needs of either third, fourth, or fifth grades.

Teacher Background Information: Desert Waters

This reading provides an overview of water issues in the desert, with an in-depth history of water use in Tucson and the Colorado River Basin, as well as conservation efforts that help ensure water for future generations.

PRE-VISIT ACTIVITY

Desert Waters

Introduces students to the topics covered in the Desert Waters program through a video, reading, and worksheet.

POST-VISIT ACTIVITY

Water Savers Math: Shower Power and Harvest the Rain

Provides students with math problems that calculate water savings in the home (using low-flow shower heads) and outside the home (collecting rainwater for watering landscape plants.)

