

# SUSTAINABLE BIOECONOMY

FOR ARID REGIONS



# BIOTIC RESILIENCE IN THE DESERT

## OVERVIEW

This lesson explores the concept of resilience in several biotic organisms in a desert ecosystem. Lesson activities including creating lists of resilience strategies, many of which have long been practices of Native American communities, for human resilience facing water scarcity in arid ecosystems.

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## BIOTIC RESILIENCE IN THE DESERT

### STUDENT LEARNING OBJECTIVES:

After completing this lesson, students will be able to:

1. Define resilience and give examples of resilience in biotic members of arid ecosystems.
2. Identify one major factor affecting water scarcity in arid regions.
3. Identify human strategies for resilience in the face of water scarcity.
4. Identify at least two water scarcity strategies already employed by Native American communities in arid lands.

### TIME REQUIRED:

40-60 minutes depending on optional activities

15 minutes teacher preparation

### RESOURCES:

1. Biotic Resilience in the Desert Lesson Plan
2. Biotic Resilience in the Desert PowerPoint Presentation
3. Biotic Resilience in the Desert Resilience Strategy Cards

### EQUIPMENT AND SUPPLIES NEEDED:

1. Resilience Strategy Cards photocopied and cut into cards for each student group in the classroom
2. Ziploc bags to hold card sets
3. Paper and pen/pencil for students to write brainstorm activities
4. Device with internet access for optional virtual field trip:
  - [https://serc.carleton.edu/trex/students/labs/lab4\\_1.html](https://serc.carleton.edu/trex/students/labs/lab4_1.html)
5. Device with internet access for optional article review:
  - <https://www.sciencenews.org/article/climate-change-made-southwestern-u-s-drought-worst-1200-years>
  - <https://www.phoenix.gov/waterservices/resourcesconservation/drought-information>

### THIS LESSON WOULD WORK WELL AS PART OF:

- Earth Science curriculum
- Environmental Science curriculum
- Biology curriculum

THIS LESSON IS ALIGNED TO AFNR, COMMON CORE, FFA AND NGSS STANDARDS.

Expanded standards listed on page 6.



LESSON PLAN:

**1. Part 1: Introduction to Biotic Resilience (20 to 50 minutes depending on optional activities)**

In this lesson, students will define resilience in an ecosystem and use examples to create a list of strategies, many of which have long been practices of Native American communities, for how humans can adapt to arid (desert) ecosystems. Set up Biotic Resilience in the Desert PowerPoint presentation with slide 2 on the screen.

**Slide 2 (5 minutes):** Biotic (living) organisms in an ecosystem demonstrate resilience by adapting to changing conditions. Can you think of an example?

Engage students by reviewing definitions and asking for examples of how organisms adapt to conditions in arid ecosystems. Examples are: *cacti saving water by having spines, bats and other organisms that come out at night, spadefoot toads who lie dormant underground until the monsoons, palo verde's green bark conducting photosynthesis, and more.*

**Slide 3 (1 minute):** Review the objective for the lesson as a way to introduce students to the topic.

**Slides 4-7 (5-8 minutes):** Review three examples of organisms demonstrating resilience through their adaptations. Ask students why it is important to include names in other languages (*the names are included in multiple languages to emphasize the many and varied groups who live in arid lands.*) Ask and discuss with students what factor ties all these adaptations together. Availability of water should be the response emphasized.

**Slide 8 (4 minutes, optional activity 15 minutes):** Explain to students that many of the current human settlements in the southwest depend on water diversion with the Colorado river being the biggest example. The graph shows the states that depend on this water diversion. The states together contain approximately 40 million people.

Optional activity: [https://serc.carleton.edu/trex/students/labs/lab4\\_1.html](https://serc.carleton.edu/trex/students/labs/lab4_1.html)

This is a lesson about water in the Colorado River from Tree-Ring Expeditions. Scroll down for the video: **Colorado River: Running Nearly Empty** (13 minutes). It is listed under "Instructions".

**Slide 9 (2 minutes, optional articles 5-20 minutes):** The continued drought in the southwest is threatening human settlement all over the southwest. Two optional article links are included. Teachers may quickly summarize these articles for students or have students read through the articles and summarize.

The first article is a summary of 2020 drought conditions:

<https://www.sciencenews.org/article/climate-change-made-southwestern-u-s-drought-worst-1200-years>

The second article is a link to the city of Phoenix drought information site. The first two paragraphs are a good summary of current drought conditions.

<https://www.phoenix.gov/waterservices/resourcesconservation/drought-information>



## 2. PART 2: Resilience Brainstorm (20 minutes)

**Slide 10 – 13 (5 minutes):** Pose the question to students: Can we learn from other organisms and their strategies for resilience? A follow up question could be: are there communities in the southwest who already have adopted strategies that are inspired by other organisms? Native American cultures in the southwest region have a long tradition of such strategies. Explain to students that the three examples of resilience can be broadly fit into three categories: technology and innovation, capturing and storage, and efficiency and reuse. Emphasize that these are broad categories that are meant to get students thinking about how humans may better adapt to arid lands.

**Slide 14 (10-15 minutes):** Go over the directions with students. Students can work in pairs or small groups for this activity.

1. Use one paper per group/pair to create a simple chart with 3 columns.
2. Label the columns: Movement and Innovation, Capturing and Storage, Efficiency and Reuse
3. In pairs or small groups, have students list any actions humans in arid lands may take that are related to that category.
4. After 10 minutes, tell students to add up the number of ideas they had for each column and put that number at the top of the column.

A possible option for this activity is to let students use internet search engines to help them with ideas. Possible search terms could be “water saving techniques” or “how cities are saving water”.

## 3. Part 3: Resilience Strategies Card Sort and Wrap Up (15 minutes)

**Slide 15 (5 minutes):** Have students use the cut Resilience Strategy Cards and sort the cards into the three categories given for the brainstorm. Some cards may work in more than one category, and students can demonstrate their understanding by explaining why they chose a category for the card.

**Slide 16 (5-8 minutes):** The three closure questions increase in difficulty. You may choose to ask one or two of the questions as opposed to all three.

**1. What are two examples of strategies that involve modern technology?** *Answers: use water recycling technology at sewage treatment plants, develop appliances that use less water, desalinate (remove salt) seawater and transport it to arid lands, rainwater harvesting, and pave roads with materials like permeable/pervious concrete that allows water to get to the soil underneath.*

**2. What are two examples of strategies involving a practice that may have already been used for a long time?** *Answers: Dig mounds around plant crops to trap rainwater, use more efficient irrigation, migrate to follow seasonal water sources, plant native vegetation that uses less water, grow food crops that thrive in the desert environment.*

**3. What strategies would be difficult to get people to try?** *Possible answers: strategies that cost more money, are expensive to invest in (new technology), things that take extra time, doing things they are not used to doing.*

**4. What strategies would be easier to convince people to try?** *Possible answers: strategies that save money like water saving appliances, rebates to people to add water harvesting.*



**Slide 17 (3-5 minutes):** Ask students to evaluate what a successful strategy could look like. Answers will vary, but more water available in ecosystems for other organisms may be a common response, lower water usage by a large community, more affordable water saving appliances.

## DEFINITIONS:

**Abiotic:** The non-living parts of an ecosystem.

**Adaptation:** The process of change by which an organism or species becomes better suited to its environment.

**Biotic:** The living parts of an ecosystem.

**Contamination:** The introduction of pollution into a formerly pure natural system.

**Desalinate:** To take the salt out of a substance. Desalinization is used to remove salt from seawater or ground water to make it safe to drink.

**Diversion of water:** Human built systems to move water from places it naturally occurs (such as the Colorado River) to areas where it does not occur.

**Irrigation:** The application of water by moving it from a source to crops.

**Native plants:** A plant that occurs naturally in a particular place and has adapted to conditions in that place.

**Permeable/Pervious concrete:** A new type of concrete that allows water to move through the surface instead of blocking water.

**Resilience:** The capacity to recover quickly from difficulties and challenges.



## STANDARDS DETAILS:

### **Common Core – Speaking and Listening**

CCSS.ELA-Literacy. SL.9-10.1: Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

### **NGSS**

Disciplinary Core Ideas:

LS1.B: Growth and Development of Organisms

LS2.A: Interdependent Relationships in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4.C: Adaptation

E S S2.D: Weather and Climate

E T S1.B: Developing Possible Solutions

MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms

MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

### **AFNR**

CRP.02: Apply appropriate academic and technical skills. Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive.

CRP.02.01. Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.

CRP.02.02. Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.

CRP.04: Communicate clearly, effectively, and with reason. Career-ready individuals communicate thoughts, ideas and action plans with clarity, whether using written, verbal and/or visual methods.

CRP.07: Employ valid and reliable research strategies. Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies.

CRP.08: Utilize critical thinking to make sense of problems and persevere in solving them.

CS.06. Analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources.



**FFA Precept**

FFA.PL-A. Action: Assume responsibility and take the necessary steps to achieve the desired results, no matter what the goal or task at hand.

FFA.PL-E. Awareness: Understand personal vision, mission and goals.

FFA.PL-F. Continuous Improvement: Accept responsibility for learning and personal growth.

FFA.PG-J. Mental Growth: Embrace cognitive and intellectual development relative to reasoning, thinking, and coping.

FFA.CS-M. Communication: Effectively interact with others in personal and professional settings.

FFA.CS-N. Decision Making: Analyze a situation and execute an appropriate course of action.

FFA.CS-O. Flexibility/Adaptability: Be flexible in various situations and adapt to change.



## AUTHOR BIOGRAPHY

Matt Swanson is a lifelong Arizona resident and an educator with experience teaching science at the middle school and high school levels. He is now working for the Arizona State 4-H office as a curriculum specialist, where he continues to enjoy bringing learning experiences to youth. He received both his undergraduate degree in philosophy and his graduate degree in science education at the University of Arizona.

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