Desert Shrimp:
Using Science to Protect Playa Shrimp and their Habitats

Overview: Students learn how rainwater collects in playas, creating temporary wetland habitats for many desert organisms. They set up a mini playa in the classroom and observe the changes as several shrimp species hatch and grow. Students learn that runoff carries pollution and litter towards playas. They then use engineering design steps to create a poster that convinces people to reduce pollution to protect desert shrimp.
Optional: Students can observe the food web relationships in the mini playa and construct a playa food web.

Grade level: 3rd- 5th

Phenomenon: A playa is a temporary lake that forms after heavy rainfall and supports unique species like tadpole shrimp and spadefoot toads. Preventing water pollution protects these species.

Next Generation Science Standards
3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing explanations and designing solutions Asking questions and defining problems	ETS1.B: Developing possible solutions	Cause and effect Influence of engineering, technology, and science on society and the natural world

If you include the food web activity, you will also cover:

- 5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers and the environment
- 5-PS3-1: Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.

Common Core State Standards
ELA-LITERACY.W. 3.2, 4.2, and 5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
ELA-LITERACY.SL. 3.1, 4.1, and 5.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade level topics and texts*, building on others' ideas and expressing their own clearly.
ELA-LITERACY.SL.3.4, 4.4, and 5.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

ELA-LITERACY.SL. 3.5, 4.5, and 5.5: Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

Time

Preparation – (10 minutes) - Two or more days before the lesson begins, put approximately one gallon of tap water in a pitcher or bucket and let it sit out with no lid. This helps eliminate chlorine in the water that may be detrimental to the playa ecosystem.
Part 1 – (30 minutes) Modeling the playa watershed and setting up mini playa
(30 minutes) Optional playa food web activity
Part 2 – (10 minutes per day for 5-10 days) Recording data
Part 3 – (60 minutes) Watershed modeling and engineering pollution solutions.

Materials

- 1 watershed model (3-D printed plastic in large aluminum pan)
- 1 spray bottle with a couple of drops of blue food coloring
- Slide presentation
- 1 aquarium thermometer
- 1 plastic bin
- 1 desk lamp with 60-watt bulb
- 1 Playa Shrimp Identification Guide
- 1 small fish net
- 1 plastic container with playa soil
- 1 petri dish
- 1 magnifying glass
- Mini Playa Data Collection worksheet(s)
- Several model pollutants: chocolate jimmy sprinkles, food coloring, paper shreds
- Engineering project supplies (poster paper, markers, craft supplies)
- If doing Food Web activity, students need food web worksheets, pencils, scissors, glue or tape, and colored pencils.

Preparation:

Part 1:

- Prepare the slide presentation to show.
- Fill spray bottle with water and blue food coloring.

Part 2:

- Prepare the slide presentation to show.

Background

A playa is a shallow, undrained basin that can become temporarily filled with water after a rainstorm. Water may last in a playa for a few days to a few weeks. In this short amount of time, many amazing desert organisms hatch, find food, reproduce, and die.

Some playa organisms such as tadpole shrimp, fairy shrimp, and clam shrimp exist in an egg stage in the dry soil. These animals are not actually shrimp, but another group of crustaceans.

When water is added, the playa shrimp species rapidly become active and play out their life cycles in the brief time allowed by their temporary water supply. Algae, cyanobacteria, and detritus (decaying plant parts, animal remains, and waste) in the soil provide a constant food source for some of the organisms, while some eat other organisms in the soil and water. The shrimp also provide a food source for many other animals, including tadpoles, toads, and birds.

Many species of shrimp that live in playas have been identified by the state of New Mexico as Species of Greatest Conservation Need because they are in decline or vulnerable to habitat loss. As development paves over playas or changes the flow of rainwater in the desert, a playa's size, duration, and ability to sustain diverse organisms changes. Sediment and pollution carried to playas by runoff also threaten playa creatures. In agricultural and urban areas, chemical pollution, litter, and bacteria in dog poop lower water quality. In rangelands, increased cattle and off-road vehicle activity leads to more sediment movement, which can fill in playas or change the soil texture.

PART 1 PROCEDURES

1. Playa Introduction (15 minutes)

A. Slide 2: Show students the watershed model.
- This a 3-D printed model of the landscape just north of Las Cruces; the tall mountains on the eastern side are the San Andres Mountains, and the shorter ones on the west are the Doña Ana Mountains.
- The lowest point in this area is called Isaac's Lake, which can fill with water after heavy rainstorms.
- Most of this area is unpopulated. It is just outside Las Cruces, and very few people live here.
- This model represents an area about 10 miles wide.

B. Demonstrate how water collects in low areas of the model after a rainstorm by using the spray bottle to model a rainstorm. Add a few drops of blue food coloring to the water in the spray bottle to make it easier for students to see the water moving. Explain that when we get a lot of rain, these low wet areas can become playas, or temporary lakes. Have students circle around a table or on the floor for this. Using a document camera might be helpful with large groups.

C. Slide 3: Show students the photos of a local desert playa before and after rains. Ask students if they think there are organisms that live in the playa.

D. Slide 4: Ask students to think about other temporary water they have seen, like puddles. Have they ever seen anything living in a big puddle?

E. Slide 5: Share the pictures of animals that live in the playas and depend on them for survival.
- Tadpole shrimp and clam shrimp are small crustaceans with very fast life cycles. Their eggs can remain dormant in dry soil for years. When playas form, the eggs rehydrate and hatch. The shrimp grow quickly, eat algae and other small organisms, then lay eggs in the mud before the playa dries again.
- Spadefoot toads stay dormant underground until they hear the sound of thunderstorms. Then they dig their way to the surface, mate, and lay eggs in playas. The eggs hatch, and the tadpoles grow and go through metamorphosis before the playa dries. Then the adult toads bury themselves until the next rainy season.

- Algae is an organism that grows on the surface of the playa and photosynthesizes, supporting the rest of the playa food web.
- Water birds like killdeer are adapted to feed in shallow water. They find plenty of food in the playa.

F. Slide 6: We will set up a mini playa in the classroom, and we hope some of these playa shrimp will grow. We'll keep track of what is living in our mini playa each day on a data sheet.

G. Slide 7: There are many species of shrimp that live in the playas of New Mexico. The three species we see most often are tadpole shrimp, Texas clam shrimp, and fairy shrimp.
- The shrimp eat many small organisms in the playa, including algae, cyanobacteria, and other shrimp. Some species are also decomposers and eat detritus in the soil.
- All playa shrimp species have a short life span, as they must hatch, grow, and reproduce before the playa dries. They can live for just a few weeks or up to about three months. However, the eggs can survive dormant in the dry soil for decades.
- Shrimp eggs lay dormant and dehydrated in the soil until a playa forms. Water and hot summer temperatures can trigger them to rehydrate and hatch. The shrimp grow and mature quickly in the playa. Before the playa dries, they must mate and leave their eggs in the mud, where they will be protected until the next playa forms. Adult shrimp die as the playa dries.
- One hypothesis for how shrimp first arrive in a playa is that eggs are carried on the muddy feet of animals, particularly birds, from one playa to another.

H. **If not studying food webs, skip to the Mini Playa in the Classroom Set Up**.

2. Playa Food Web (30 minutes)

A. Slide 8: Remind students what a food web is and show them the simple desert food web.
- Energy enters the food web through photosynthesis. Then energy and matter are passed through the food web as organisms eat other organisms.
- This is a simplified food web. There are many other plants and animals in the desert.

B. Give each student a copy of the playa organism cards and the food web worksheet. Show students how to use the table on the student worksheet showing trophic level, prey, and predators for each species.

C. Instruct students to cut out the playa organism cards and use the information on the table to place them on the Playa Food Web worksheet.

D. Slide 9: When students are done, you can show them the completed playa food web.

E. Have students answer the Analysis and Discussion questions.

3. Mini Playa in the Classroom Set Up (10 minutes)

A. Add playa soil to the bottom of the plastic pan to a depth of approximately ½ inch.

B. Using water that sat out for at least two days to dissipate the chlorine, add water to the plastic pan. Fill the pan to approximately 1 inch from the top.

C. Place the bin under the lamp with a 60-watt bulb. Insert the thermometer sensor in the water and leave the display outside the bin so you can monitor the water temperature. Adjust the distance from the lamp to the basin so the temperature is between 25°C and 28°C. You may turn out the light each night, if necessary, although in a cold classroom, this may affect the development of the mini playa.

D. Fill the pitcher with tap water and let it sit out again. After two or more days, add water as needed.

PART 2 PROCEDURES

1. Monitoring and Recording Data on your Playa Critters (10 minutes daily)

A. Aquatic animals may appear a few days to a week after you start your playa. Once they appear, have students collect data on their Data Sheet.
   - Using careful observation and the Playa Shrimp Identification Guide, have students estimate the number of each species.
   - Use the aquarium thermometer to record the water temperature each day.

B. Playa organisms can be moved to the petri dish for closer observation.
   - Place a small amount of water from the pan into the petri dish.
   - Using the small fish net, carefully transfer an animal to the petri dish.
   - Use a magnifying glass to look at these amazing creatures.

C. **IMPORTANT**: At the end of the experiment, you may either save the contents of the bin for future use or dump it outside. To save the soil, let the water evaporate from the bin and let the soil dry completely before storing. You should be able to follow the set-up instructions to grow another generation. Let students know that in nature, playas dry up after a short time and the adult shrimp die.

PART 3 PROCEDURES

1. Understanding Playa Pollution (10 minutes)

A. Slide 10: Now that we know about some of the animals that live in and around playas, we are going to learn how to help protect these special places.

B. Slide 11: Tell students that many species of playa shrimp have been identified by New Mexican scientists as Species of Greatest Conservation Need (example: Beavertail Fairy Shrimp in Doña Ana County are listed as declining, disjunct, and vulnerable), either because their numbers are decreasing or their habitats are disappearing. Reasons include:
   - Human development/construction in areas that were once desert playas
   - ATVs and other off road vehicles destroying habitats
   - Changes in rainfall amount and timing, resulting in not enough water at the right time
   - Pollution in runoff from urban and agricultural areas (litter, dog poop, chemicals, pesticides, etc.)
   - We will focus on pollution, as this is one thing ordinary people can help control.

C. Slide 12: Remind students how water reaches the playa by spraying water over the playa watershed model again. Add a few drops of blue food coloring to the water in the spray bottle to make it easier for students to see the water moving. Have students circle around a table or on the floor for this. Using a document camera might be helpful with large groups.
   - Remind students that this is a 3-D printed model of the landscape just north of Las Cruces; the tall mountains on the eastern side are the San Andres Mountains, and the shorter ones on the west are the Doña Ana Mountains. The lowest point in this area is called Isaac's Lake, which can fill with water after heavy rainstorms. Most of this

area is unpopulated. It is just outside Las Cruces, and very few people live here. This model represents an area about 10 miles wide.

D. Reset your playa watershed model by dumping the water into the pan. Next, place things on the model to represent pollution and discuss what each item represents:
   - Paper bits = litter
   - Different colors of food coloring = chemical sources like oil from cars, pesticides from a farm field or park
   - Jimmy sprinkles = dog poop

E. Spray rain over the model and have students observe where the pollution ends up. Discuss the potential impacts of the water pollution on the playa animals. Remind students that this model represents a very large area, and pollution can travel far distances.

F. Slide 13: Some of the things that pollute playas include litter, chemicals like pesticides and oils from cars, animal poop like dog and cow poop that contain bacteria, and dust, which can increase when there is more off-road activity in the desert. All of these things are carried into the playa when it rains as we just saw in our model.

2. Engineering Solutions to Playa Pollution (30 minutes)

A. Slide 14: As scientists and engineers, we follow an engineering design process to identify problems, brainstorm, and evaluate solutions. We will be using these steps to consider ways to protect playa habitats and the animals that live in them.
   - Students will work in groups to come up with a plan to address the problem of water pollution and reduce one type of pollution.

B. Slide 15: The first step is to identify the problem we want to solve and the challenges to solving it. Remind students that the problem they are trying to fix is water pollution in playas. Discuss the challenges of this problem. Answers might include:
   - People don't like to change their ways.
   - You need to reach a lot of people because the problem is caused by lots of people doing small actions that build up.
   - People don't know about playas.

C. Slide 16: Give students the instructions for how they will address this problem.
   - Students will create a poster that informs people how they can prevent water pollution to protect playa shrimp.
     a. You can give students the option of working in small groups.
     b. You can give students other options besides posters, like skits or slide presentations if you would like, but remind them they must inform people about why and how they can prevent water pollution in playas.
   - In the engineering design process, engineers are always working under constraints or limitations. We do not have unlimited time and money to solve this problem. Give students constraints that make sense for your class, including but not limited to:
     a. How much time do they have? We suggest a minimum of 20 minutes for posters and longer if using other forms of communication.
     b. What materials they can use? Paper, markers, computers, etc.
     c. Who is the audience they are trying to reach? Some students may want to speak to authority figures like the Mayor or President, others may

want to convince fellow students, and others may want to reach the broader community.

D. Slide 17: The next step in the engineering design process is brainstorming possible solutions. You may do this as a class or have students work in their groups or individually. Whatever solution students choose, their in-class project should be a poster (or other informational presentation) informing or convincing people to carry out the solution. Solutions might include:
   - Asking people not to litter.
   - Teaching people about playas and the cool animals that live there.
   - Cleaning the playa water.
   - Asking people to clean up after their pets.
   - Asking people to drive on roads only to protect habitats.

E. Slide 18: After brainstorming, give students time to create their poster (or other informational presentation). Let students know at the end of this work time, they will be sharing what they have created with the class.

3. Sharing and Evaluating Solutions (10 minutes)

A. Once projects are complete, have students share their project with the class. You could do this through a gallery walk (everyone moves around the room looking at projects), or if you have more time, you can do formal presentations or pair groups to present to each other.

B. Slide 19: Let students know that the final step of the engineering design process is to evaluate your solution and look for areas of improvement.
   - Ask students which projects they think do the best job of preventing water pollution in playas. Why did they think those projects were effective?
   - Students might note that others used humor, bright colors, or other attention grabbers or were very informative, knowledgeable, and convincing.
   - Ask students what they saw others doing that they liked and what ideas could they borrow to improve their own project.