

Plant Protectors: Enriching Elementary Plant Biology Education by Integrating Outdoor Science

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Summary: We worked with Texas State University students and Texas Master Naturalists to develop a five-day lesson, *Plant Protectors*, for elementary school students about plant adaptations as mechanisms of natural selection to reduce plant blindness. This lesson highlights plant adaptations that help native Texas species thrive in drought conditions. At the end of the unit, students can plant their own garden of water-wise plants (either as a paper garden decorating the classroom wall or in an outdoor raised garden bed on campus grounds) to showcase what they have learned.

This project aligns with the following Principles for Teaching Plant Biology:

Evolution: Species Biodiversity, Natural Selection, & Environmental Response

Targeted Age/Grade: 3rd-5th Grade

Estimated Length of Activity: The included lesson is a 5-day unit. Each day's curriculum takes about 45-60 minutes with less than 20 minutes of preparation time per day. (3hr 45min – 5hrs total)

List of Supplies:

[Plant Protectors Research Rangers Nature Exploration activity books](#) (one per student)

[Plant Protectors Ranger Reflections Worksheet](#) (one per student)

Pencils/Pens/Markers/Crayons/Colored Pencils

Paper

Either example plants to explore and later plant or [images of example plants](#)

Access to digital plant information website (<https://www.wildflower.org/plants-main>) (or native flower field guides)

Garden Supplies for either a paper garden or an outdoor raised garden bed

Optional Supplies:

Clipboards

Magnifying Glasses

Rulers

Laminator & Laminating Pouches

Plant-related Read Aloud Books

Estimated Costs: \$0 - \$450 per class, pending options selected

Student Guides and Handouts

Plant Protectors




Go outside and explore nature with Scout and Binx!

What is Research Rangers?

Research Rangers is about inspiring people to spend more time exploring the natural world around them, like water to encourage and support people of all ages, abilities, and backgrounds to enjoy and study wildlife in their local area, and to observe and record information about the local environment. Find out more at [researchrangers.org](https://www.researchrangers.org)

What You Get to Do!

In this activity, you will:

- Explore the functions of different plant structures
- Find and identify plant adaptations in your area
- Read about how adaptations help plants survive

This activity takes about 30-45 minutes to complete. Have Fun!

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Know Before You Go

Materials You Will Need:

- Your Research Rangers Activity Book
- Pencil or Pen
- Camera or Phone
- Optional items: Clipboard, iNaturalist App

Location Suggestions:

- Local Park
- Nature or Hiking Trail
- Backyard
- Schoolyard
- Garden
- Anywhere in Nature!

Safe Science

- Give animals space. Keep a safe distance from wildlife.
- Stay calm and quiet around wildlife. Respect their habitat.
- Do not touch wildlife or their habitats.
- Do not eat anything that you find unless you are sure it is safe.

Remember, Safety First!



Engage With Nature

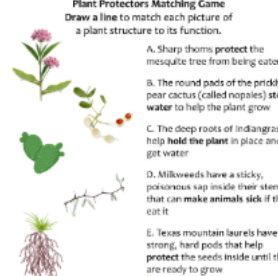
Words to Know

Structure: how something is built or what it looks like (shape, size, and parts).
Example: An oak tree has a thick trunk covered in brown bark.

Function: what each part does.
Example: The function of an oak tree's trunk is to support the tree and move water and food between the roots and leaves.

Plant Protectors Matching Game

Draw a line to match each picture of a plant structure to its function.



- Sharp thorns **protect** the mesquite tree from being eaten.
- The round pads of the prickly pear cactus (called **nopales**) **store water** to help the plant grow.
- The deep roots of indiangrass help **hold the plant** in place and get water.
- Milkweeds have a sticky, poisonous sap inside their stems that can **make animals sick** if they eat it.
- Texas mountain laurels have strong, hard pods that help **protect the seeds** inside until they are ready to grow.

Engage With Nature

Look at this example of a dandelion plant. Circle the structure that you think will help this plant thrive best in a drought when there is little water available on the ground surface.



Did You Know?

- Cacti grow spines instead of leaves to stop water loss and to protect themselves!
- Some plants, like mesquite trees, have roots that can grow over 200 feet down to reach deep water!
- Some trees drop all their leaves during droughts to stop water loss, just like they do in winter!

Special plant structures help them thrive in nature!

Write down a question about this idea that you might be able to answer after exploring nature.



Field Guide

Plant Structure Adaptations

Adapted for Droughts	Not Adapted for Droughts
Little Bluestem Long, deep roots allow this plant to collect more water from deep below the soil, where more water is available. These roots allow this grass to thrive in dry conditions.	Ryegrass Short, shallow roots get water from the soil surface, which dries out when there is not enough rain.
Texas Mountain Laurel Leaves that are coated with a waxy layer help the plant keep water from evaporating (water running to go).	Banana Plant Leaves that are larger without any coatings make them lose more of a chance for more water to evaporate and the plant will dry out.
Prickly Pear Cactus These spiny stems store water in their special thick, fleshy stems (called stems) so they have water to use when the environment is dry. That's a natural water bottle.	Ferns Ferns have soft stems and leaves (called fronds) that are thin and easily dry out in the hot Texas sun.

Field Guide

Plant Structure Adaptations

Adapted for Droughts	Not Adapted for Droughts
Texas Sage Some plants, like Texas sage, only flower when there is enough rainfall to make water available to them and enter a dormant state (the sleeping) during dry periods.	Hibiscus Some plants, like hibiscus, produce flowers all the time and require lots of water to keep healthy.
Fig The fig fruit has a thick, leathery skin that protects the seeds inside from drying out.	Grapes The fruits from a grape vine are juicy when they get full of water. But if the weather gets too dry, the grapes will shrivel because their skin is thin.
 tumbleweed tumbleweeds are designed in a this protective skin and they are meant for a long time. They will only begin to grow when there is enough water and the weather is warm.	Sunflower Sunflower seeds have an special coating and need to be planted in moist soil. If a sunflower seed is planted and there isn't enough water, it will die.

Ranger Records

Explorer's Information

Name: _____

Today's Date: _____ Time: _____ AM/PM (Circle one)

Who are you doing this activity with today (select all that apply):

☐ Myself ☐ Family ☐ Friends ☐ Classmates ☐ Ranger Guide

Where are you? (City, State) _____

What is the current temperature?

_____ °F

Cold Cool Warm Hot

What is the current weather like? (Circle all that apply)

Sunny Partly Cloudy Cloudy Windy Rainy

Nature Observation Site Details

Describe the Type of Location: (select all that apply)

☐ Local Park ☐ Schoolyard

☐ Nature or Hiking Trail ☐ Garden

☐ Backyard ☐ Other (Please describe) _____



Explore Nature

Go on a nature walk and look for three different plants. Draw each of the 3 plants you observe. Then, select a plant structure that you notice about that plant that makes it different or more interesting than other plants you may have seen, and describe what you think is the function of each plant structure.

Draw what you found	Structure observed	Describe the function
Example Rain Lilies	☐ Root ☐ Leaf ☐ Green ☒ Flower ☐ Fruit ☐ Seed	The flowers of the rain lily only bloom after rain, so they don't use much water at other times.
Plant #1	☐ Root ☐ Leaf ☐ Stem ☐ Flower ☐ Fruit ☐ Seed	
Plant #2	☐ Root ☐ Leaf ☐ Stem ☐ Flower ☐ Fruit ☐ Seed	
Plant #3	☐ Root ☐ Leaf ☐ Stem ☐ Flower ☐ Fruit ☐ Seed	

Take photos of your observations!

(Optional) iNaturalist Resource

Contribute to science by sharing your data with others!

The iNaturalist app is an optional resource that can help you identify plants, insects, and animals for your Research Rangers explorations. It is easy to use once you get it set up on your phone or other mobile device.

- Download the iNaturalist app from the Google Play Store or Apple Store onto your mobile device.
- Sign up for an account (with the help of an adult). Then, click on the Projects button at the bottom of the app, search for the Research Rangers Project, and join!
- Open iNaturalist and click "Add Observations" or tap the camera icon labeled "Observe." Take a photo or upload a picture of what you found.
- Need help identifying what you found? Click "What did you see?" to view possible identification suggestions.
- Add your observation to the Research Rangers project to get more information and help scientists collect data! This can be done by clicking Projects and selecting the Research Rangers project before clicking Save or Submit.

For more information and to download this free app, visit: www.inaturalist.org

Scientist Spotlight

Dr. Carmen Catalá studies tomatoes and how they grow.

Meet Dr. Carmen Catalá, a scientist at Cornell University who studies tomato plants and how they grow. We call scientists who study plants, **botanists**.

For her research, Dr. Catalá studies adaptations of tomatoes. With the help of her team around the world, Dr. Catalá experiments on how different types of tomatoes respond to challenges in their environment such as diseases and droughts.

Plants need water to grow, but some plants can go longer without water than others. Dr. Catalá looks at how scientists can change the plant's DNA (microscopic building blocks that tell living things how to grow and survive) so that they can live longer without water. This can help farmers and gardeners to feed more people in areas that experience more droughts, like in Central Texas.

The next time you eat a tomato, you can thank a scientist!

Build Your Knowledge

What is an adaptation?
Plants are **organisms** (living things) that need air, water, and sunlight to survive. Different types of plants can be found in different **environments**, like deserts, prairies, and forests. To live in those environments, plants must have special adaptations. An **adaptation** is a body part or behavior that helps organisms to **thrive** (do well) in an area.

How do adaptations help plants survive?
Plants face different types of challenges, like heat, wildfires, freezing temperatures, too little sunlight, too much water covering a place (**flooding**), or long periods of time without water (**droughts**). Adaptations can help plants adjust to their environment so they can get the resources they need to thrive.

Some plants (like cacti) have structures that help them thrive in droughts but not thrive in floods. While other plants (like Texas Wild Rice) have structures that help them thrive in floods but not thrive in droughts.

Build Your Knowledge

How do adaptations happen?
Adaptations can take a long time to appear. Sometimes, plants can grow in new ways due to random changes to their DNA. These new changes may harm the plant and cause them to die. Other times, these new changes can help a plant thrive better in certain environments. For example, plants with seeds that float will thrive in wet environments. And plants with seeds that need heat to grow will thrive after wildfires. When new changes help a plant reproduce (have offspring), the offspring will likely also grow in the same way, and we call that an adaptation.

Plant Protectors Maze Challenge
Draw a line helping the yucca plant grow deep roots to reach the groundwater.

Cultural Connections

Yucca plants, like those in the Texas Hill Country, grow in dry places. The objects and the Texas Hill Country people have found many smart ways to use the different structures of yucca plants!

Leaves for Weaving and Making Rope
The leaves of the yucca plant are strong and full of long, thin, tough fibers. Indigenous people in the Mexican Desert use these leaves to make mats, baskets, and sandals. Pueblo people use the fibers inside by twisting them into rope to help make blankets with turkey feathers.

Leaf Tips as Tools
The pointy tip of a yucca leaf is very sharp and can be used like a sewing needle to help stitch things together.

Making Paintbrushes and Containers
Pueblo people use the end of the leaf to make a small paintbrush. The tall, hollow stalk of the plant can be used to hold arrows, this type of container is called a quiver.

Roots for Soap and Medicine
The Concho and Mescalero people use yucca roots to make soap, especially for special ceremonies. This soap can also be used to help with some joints and to clean wounds.

Yucca as Food Around the World
People in many countries eat yucca (also called cactus). It can be made into chips, bread, dough, and even a sweet cake with coconut!

Above and Beyond

Build a Waterwise Garden!
Raised gardens are a fun way to see plant adaptations in action and reduce water use at the same time! With careful planning, you can design your own waterwise garden. By picking plants that are adapted for droughts, they won't need as much water as other plants, and your garden will thrive in Central Texas.

To help you get started, look up information about some plants to choose which would be best to plant in a waterwise garden:

Blackfoot Daisy	Fremont	Pringle	Gray's Milkweed
Mealy Blue Sage	Prairie Verbena	Purple Coneflower	Texas Blazing Star

Pick one plant!
Investigate what that plant needs to thrive in your garden.

Plant name	Plant color	Flower color	Plant size	Water use	Light needs	Conditions necessary to help plant thrive in water use

Make a sign for your plant that teaches others about its adaptations and how its special structures will help it thrive in your garden!

You may want to pick a variety of plants to grow in your garden! Remember, plants need space around them to grow, so don't pack too many plants in too tight!

Look up information about plants on the U.S. Wildflower website: <https://www.wildflower.org/plants/index>

Extra Activities & Information

Discover Research Rangers activity topics and upcoming events!

Learn more about how living things change through adaptation!

Watch a video to learn more about plant adaptations!

Apply plant adaptations through games and games!

Little Green Thumbs: A plant is green if it's alive!

CRASH COURSE: Learn more about how living things change through adaptation!

Discover a Native Scapegoat by searching a hidden in Texas desert scene contest!

The Desert Biology Education Resource is located at Texas State University teaching people how to become a Ranger Guide!

TEXAS STATE UNIVERSITY Department of Biology

Join a team about the American Society of New Biologists!

Complete Ranger Reflections Online!

Instructor Guides

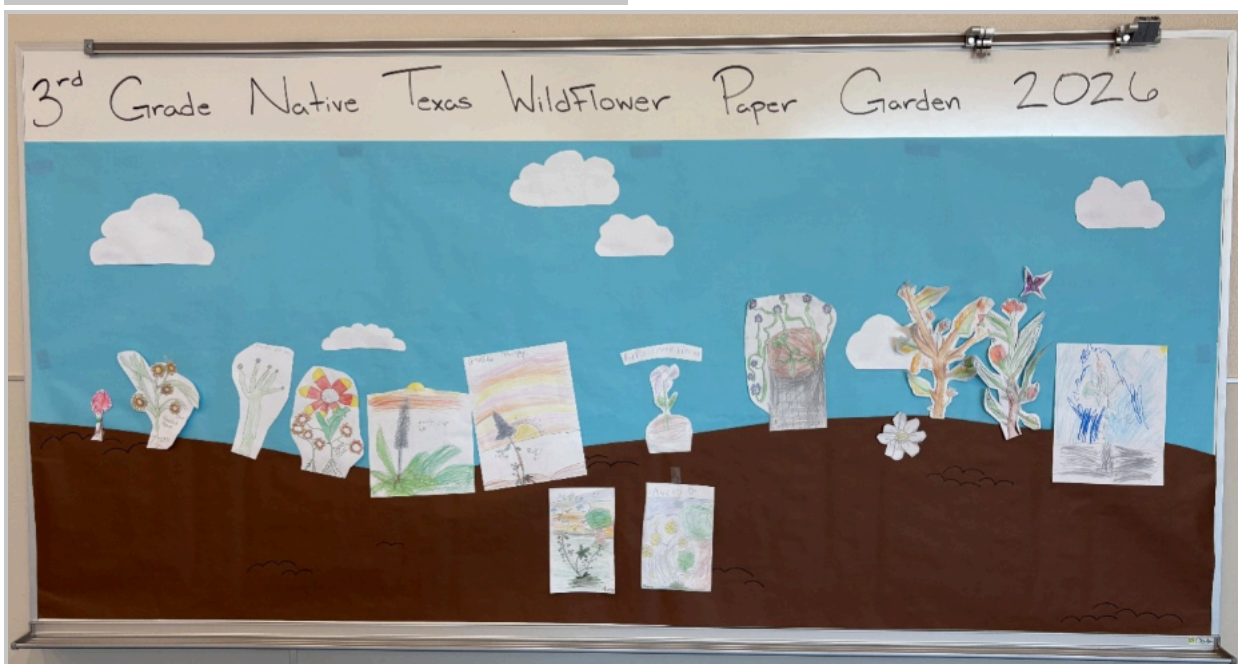
Instructor Background Primer:

Despite plants' ecological and economic importance, animals often receive more attention in education. Additionally, limited plant biology curricula also contributes toward *plant blindness*, the unwillingness or inability to perceive plants within an environment, particularly for students. Unfortunately, such viewing of plants as passive background objects can lead to incorrect assumptions, such as all plants require identical amounts of sunlight, space, and water. Many students also believe that non-adapted plants can simply choose to change or adapt in real time to avoid perishing, or that humans exist entirely outside of natural ecosystems. Rather, adaptations occur at the population level over extended time spans, rather than during an individual plant's lifespan.

A foundational principle in biology is that an organism's structures impact its functions. Natural genetic variation can lead to new structures that help some plants survive environmental pressures while others die, driving biological change over time. Plant adaptations are specialized, inherited traits that arise over generations through such advantageous natural genetic variation from random mutations, enabling species to obtain essential resources (e.g., light, water, nutrients, carbon dioxide) and endure local human-influenced and natural environmental stresses like severe droughts, intense heat, or herbivory. While animals can move to escape harsh conditions, stationary plants rely entirely on structural and physiological adaptations. Common structural adaptations in terrestrial plants that increase resiliency in extreme environments include deep taproots to reach

underground water tables, thick waxy leaves (i.e., cuticles) to minimize water loss through transpiration, fleshy stems to store moisture, or protective thorns and chemical compounds to deter herbivores. Understanding these form-and-function relationships is an educational model that facilitates analyzing how variations in physical traits determine an organism's ability to survive in a specific habitat.

Educators can strengthen evolutionary biology, plant behavior, and ecology knowledge by teaching young students about plant adaptations. The *Plant Protectors* lesson operationalizes these core concepts for upper elementary classrooms through active inquiry, outdoor observations, and place-based learning. Over five structured phases, students transition from investigating example plants indoors to observing localized adaptations in their schoolyard ecosystem. By comparing drought-adapted native species against non-adapted species, students build an understanding of how specific structures fulfill crucial survival functions. This curriculum integrates cross-disciplinary connections by exploring cultural uses of native plants, like Yucca, and culminates in an application activity where students design and plant a native, waterwise garden. The *Plant Protectors* lesson plan addresses alternative conceptions often held by students, reinforces evidence-based arguments surrounding organism survivability, and offers potential solutions to local environmental changes.



Detailed list of required supplies:

[Plant Protectors Research Rangers Nature Exploration activity books](#) (one per student – free for download/printing)

[Plant Protectors Ranger Reflections Worksheet](#) (one per student – free for download/printing)

Pencils/Pens/Markers/Crayons/Colored Pencils (any materials available will work)

Paper (can use printer paper, cardstock, construction paper, tissue paper, or any other options available)

Either example plants to explore and later plant or [images of example plants](#) (*plants tend to cost about \$4-15 each, and we recommend purchasing two each of 8 plant examples per classroom if teachers chose the outdoor raised garden bed option, many nurseries, tractor supply, and lumbar stores may give teachers free or discounted plants upon request*)

Suggested Texas native water-wise plant examples:

Blackfoot Daisy (*Melampodium leucanthum*)

Firewheel (*Gaillardia pulchella*)

Frogfruit (*Phyla nodiflora*)

Gregg's Mistflower (*Conoclinium dissectum*)

Mealy Blue Sage (*Salvia farinacea*)

Prairie Verbena (*Glandularia bipinnatifida*)

Purple Coneflower (*Echinacea purpurea*)

Texas Blazing Star (*Liatris mucronata*)

Alternatives if any of the above plants are not available: Turk's cap (*Malvaviscus arboreus* var. *drummondii*), Rock rose (*Pavonia lasiopetala*), or Straggler's Daisy (Horseherb) (*Calyptocarpus vialis*)

Access to digital plant information website (<https://www.wildflower.org/plants-main>) (or native flower field guides, any with information about the plants are suitable)

Clipboards (*optional, for supporting booklets if working outside*)

Magnifying glasses (*optional, for exploring plant examples*)

Rulers (*optional, for exploring plant examples*)

Read aloud books (*optional, for literacy integration into lesson plan*), recommendations:

[Queen of Leaves by Stephen Briseño](#)

[A Weed is a Flower: The Life of George Washington Carver by Alik](#)

[Gregor Mendel: The Friar Who Grew Peas by Cheryl Bardoe](#)

[The Legend of the Bluebonnet by Tomie dePaola](#)

[Plant Adaptations by Andi Diehn](#)

[How Do Seeds Grow into Gardens? By Clayton Tobias Grider](#)

Laminator & Laminating pouches (*optional, for water-proofing garden signs*)

Garden Supplies (select option – paper garden or raised garden, either option works!)

Paper Garden supplies: construction paper, glue, tape, scissors, coloring utensils (e.g., markers, colored pencils, pens), wall space to “plant” flowers

Raised Garden supplies: 8 – six-foot-long 2”x6” lumber boards, 4 – two-foot-long 3/8” steel rebar stakes, 8 – 7.5”x7.5” concrete planter wall blocks, cardboard to use as a ground/weed barrier, and 1.3 cubic yards of soil/compost, spades, gloves (*this supplies list includes materials needed to build one 6’ sq raised garden bed*)

Homework/Assessment

Plant Protectors

Name: _____

1. For each of the sentences below, choose whether the sentence is true (T) or false (F). (Circle one for each sentence)

T or F Plants need air, water, and sunlight to survive.

T or F Droughts happen when there is too much water.

T or F Adaptations are caused by random changes to DNA.

2. Dante just moved into a new house and wants to put new grass in his yard. The area where he lives does not get much rain, so the soil is often dry. Which grass should he plant?

Dante should plant Little Bluestem / Ryegrass (Circle one) because _____

3. Imagine a plant. It can be your favorite plant, a plant you think is beautiful, or a random plant that just came to your mind. Use the space in the box to **draw that plant** from memory. Remember: Not all scientists see themselves as artists, but biologists use drawing as a way to capture their observations!

4. Which of the following safety rules did you follow while observing plants? (Check all that apply)

☐ Did not eat plants ☐ Did not touch mystery plants

☐ Stayed on the trail ☐ Left flowers for others to enjoy

☐ Respected wildlife ☐ Left berries and fruits for animals

5. Wildfires change the environment. Which of the following answer choices is an example of how plants thrive after a wildfire? (Circle one)

A. Fires burn and damage bark which can cause a tree to stop growing

B. Heat from the fire can cause water in the plant to evaporate

C. Fires burn older plants and give more space for new wildflowers to grow

D. Ash from a fire can cover the soil and stops young plants from getting sunlight

6. Which of the following is **NOT** an example of a plant thriving during a flood? (Circle one)

A. Deep roots help a plant stay in place

B. Some plants have seeds that float and travel to new habitats

C. Some plants enter dormancy until the flood is over

D. Flood waters wash away plants with shallow roots

More Ranger Reflections!



Plant 1



Plant 2



Plant 3

7. Pretend that you observed the three plants pictured to the right. Which plant do you think would best thrive in a garden that **did not** receive a lot of water? (Circle one)

8. Why do you think that plant you picked in question 7 above will thrive the best in a dry garden?

I think the plant I selected above will thrive in a dry garden because _____

9. Plants have different structures that help them survive changes to their environment. The table below describes four different plants.

Plant 1	Sharp thorns protect this plant from being eaten
Plant 2	Thick stems store extra water for this plant to use
Plant 3	Sticky leaves help this plant trap insects
Plant 4	Broad, thin leaves help this plant capture more light from the sun

Which plant will thrive best in a drought? (Circle one)

Plant 1 Plant 2 Plant 3 Plant 4

10. Mark (x) how much you agree with each statement below.

	Yes!	Mostly	A little	NO!
I enjoy caring for plants.				
I care about the plants I see.				
Plants are important for nature.				
Plants are important for providing food.				
Plants are as interesting to explore as animals.				
I am interested in learning about protecting endangered species.				
I am interested in learning about patterns in leaves and flowers.				
Plants are useful to learn about.				
It is important to learn about how plants grow and reproduce.				
I like plants.				
When I take a walk outside, I notice the plants around me.				
Being around plants makes me happy.				
I would like to study plants when I grow up.				

Ranger Reflections Answers

1. T, F, T
2. Little Bluestem, because [answers vary, but may include: this grass is adapted to dry conditions, Little bluestem has long roots to reach deep ground water]
3. [images vary]
4. [answers vary, but hopefully students will follow all of the listed safety rules]
5. C
6. D
7. Plant 3
8. [answers vary, but may include: this plant is adapted to dry conditions, cactus can store water in their stems to use when it is dry, cactus have thick skin to reduce water loss]
9. Plant 2
10. [answers vary, but ideally students will lean toward Yes! for all prompts]