



## Teacher's Guide

Waco Mammoth National Monument is a proud partnership:



Baylor University



# Welcome to Waco Mammoth

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Inside this guide, you will find helpful resources for your group’s visit to Waco Mammoth National Monument. Waco Mammoth is home to the nation’s first and only discovery of a nursery herd of Pleistocene mammoths. As you explore this site, you will notice recurring themes:

- Fossils are clues that tell compelling stories.
- These stories inspire us to
  - continue learning.
  - share what we learn.
  - protect special places for future generations.

We hope these resources help you create the next generation of park stewards!

## Table of Contents

I.	Park Information	
	Includes contact information and a map of the grounds.....	Pg. 1
II.	Dig Shelter Guide	
	Includes a helpful script as well as critical thinking questions .....	Pg. 2
III.	Appendix A: Enrichment Activities	
	Additional ways to experience the park and its history.....	Pg. 13
IV.	Appendix B: Texas Educational Standards Alignment	
	K-12 standards to help educators choose the best activities.....	Pg. 23

## Virtual Tour and Distance Learning



Is your class unable to visit the park? Use the QR code or click the link to take a [virtual tour](#). You can also request an interactive, [distance learning](#) experience with one of our rangers. Consult the resources in this guide to find ways to enrich and enhance your digital experience.

# Park Information

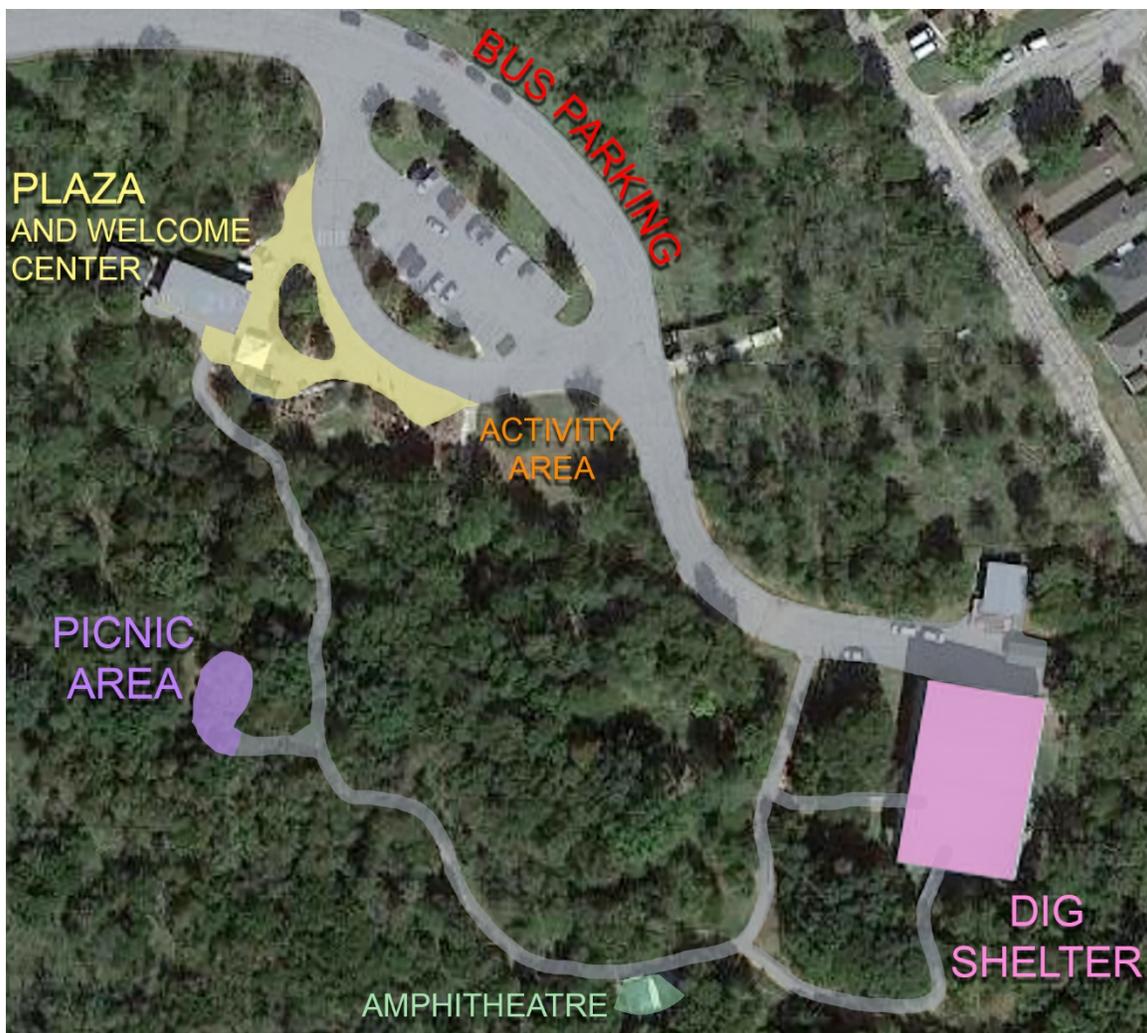
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Address: 6220 Steinbeck Bend Drive  
Waco, Texas 76708

Front Office: 254-299-2663

Unload buses at the ●PLAZA and then use the ●BUS PARKING.  
Bathrooms are in the ●WELCOME CENTER.

The walk from the ●PLAZA to the ●DIG SHELTER is 300 yards.  
No food or drink is allowed in the ●DIG SHELTER.



Map data ©Google, 2021. All photos and illustrations in this guide, unless otherwise stated, have been provided by the City of Waco.

# Dig Shelter Guide

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Begin at the entrance bridge, shown in the image below.



The following pages provide a helpful script as well as critical thinking questions for your students.

# I. Sharing the Story of the Site

All the fossils you will see today are from the **Pleistocene Epoch**, or the Ice Age. The Ice Age started 2.6 million years ago and ended just 12,000 years ago.

**SAY IT TOGETHER: PLY-stuh-SEEN EP-uck**

This bridge crosses over the first dig site.

**ASK: Do you ever go exploring? How would you feel if you found something special? (Excited? Happy?)**

In 1978, two young men named Paul Barron and Eddie Bufkin were exploring this creek. They found a **very** large bone near the embankment you see by the bridge.

They didn't know what the bone was, so they took it to Baylor University here in Waco. There, David Lintz identified the fossil as a mammoth femur, or thigh bone. Teams from Baylor University dug here using tools like trowels and brushes.



*The southern half of the site, before bones were removed.  
Photo by Nick Cirincione, 1990. Used with permission.*

They found 16 different mammoths, which were all adult females and young calves, or a nursery herd. **The Waco Mammoth herd is the only known nursery herd of Columbian mammoths in the world.**

If Paul and Eddie had not told an expert about their discovery, no one would know about this special place. **ASK: If you discover something amazing, what should you do? (Tell an expert! Share your story!)**

Scientists are still learning this site's story. Scientists have found evidence that several groups of animals were buried at this site over time. They know that these animals died and were buried by natural events. As scientists find more clues, they can learn more of the story.



*Fossils being prepared for removal.  
Photo by Nick Cirincione, 1990. Used with permission.*

This site was under a tent for many years, and sometimes it would flood during rainstorms. The water could do a lot of damage to the fossils. For this reason, the fossils were wrapped in plaster and removed in 1990.

After removing the fossils, scientists found more! They began digging a second site, and the people of Waco worked together to build the Dig Shelter, which protects the second site from the weather.



PLEASE READ  
BEFORE YOU  
ENTER THE DIG  
SHELTER



Help us protect the fossils!

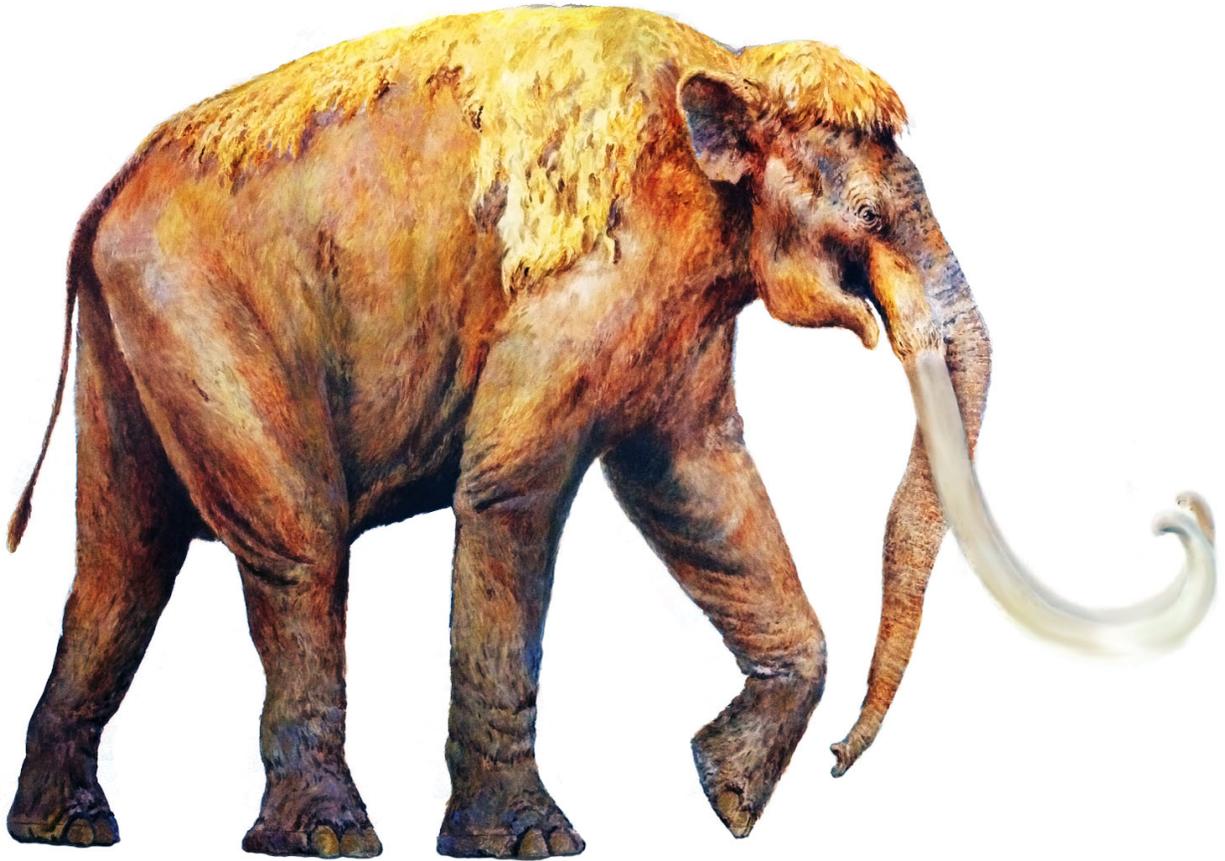
- Leave food and drinks outside.
- Throw away gum, candy, and tobacco.
- Leave wet umbrellas and raincoats outside.
- Secure your hats and sunglasses.

Help us protect others!

- Wear a face covering.
- Cover your nose and mouth with your elbow if you cough or sneeze.
- Use hand sanitizer as needed.

✓ **Photography is allowed.** ✓

## II. Life as a Columbian Mammoth



*Mural painted by Lee Jamison.*

**This is a life-size mural of an adult male Columbian mammoth.**

**ASK: Standing next to this mural, how tall are you? Do you know of any animals that live today that are this big? (Elephants.)** That's right! A mammoth is not a dinosaur—it is an extinct member of the elephant family.

- Columbian mammoths were much larger than woolly mammoths.
  - This male is 14-feet tall.
  - It would have weighed about 10 tons, the same weight as a school bus.
- It ate 300-700 pounds of **grass** and drank 50-75 gallons of water every day.

There are many things scientists don't know yet about Columbian mammoths. The artist who painted this mural had to make some educated guesses. **ASK: Can you see something the artist had to guess?**

Examples of correct answers:

- Color of hair
- Color of eyes
- Size of ears
- Length of trunk
- Amount of hair
- Number of toenails

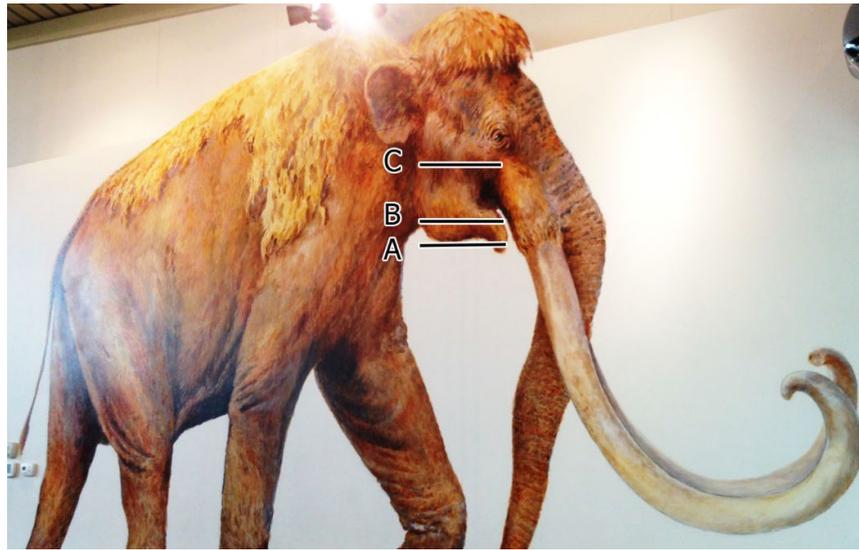


Photo by Jean Fioca.  
Used with permission.



Illustration by Carl Buell.  
Used with permission.



Photo by Dava Butler.  
Used with permission.

**A.** Asian elephants are the Columbian mammoth's closest living relative. They would stand up to the mammoth's chin.

**B.** Woolly mammoths, also closely related to Columbian mammoths, were just slightly larger than an Asian elephant.

**C.** African elephants are taller than woolly mammoths were. They would be almost at the Columbian mammoth's eye.



Murals painted by Lee Jamison.

In the other mural, you can see the nursery herd, which is a family. Nursery herds only have females and their babies. **ASK: Who protects the people in your family? (Parents, grandparents?)** In modern elephants, each herd has a matriarch, the oldest female of the group. This "grandmother" has the most experience finding food and defending against predators, so she leads and protects the group.

You also can see what the environment was like. Texas was warm during the Ice Age, with many open grasslands.

### III. Finding the Site's Clues



Strata diagram.

Look around—this is an *in-situ* site. **ASK: What do you think *in-situ* means?** (The fossils have not been moved from where they were found.)

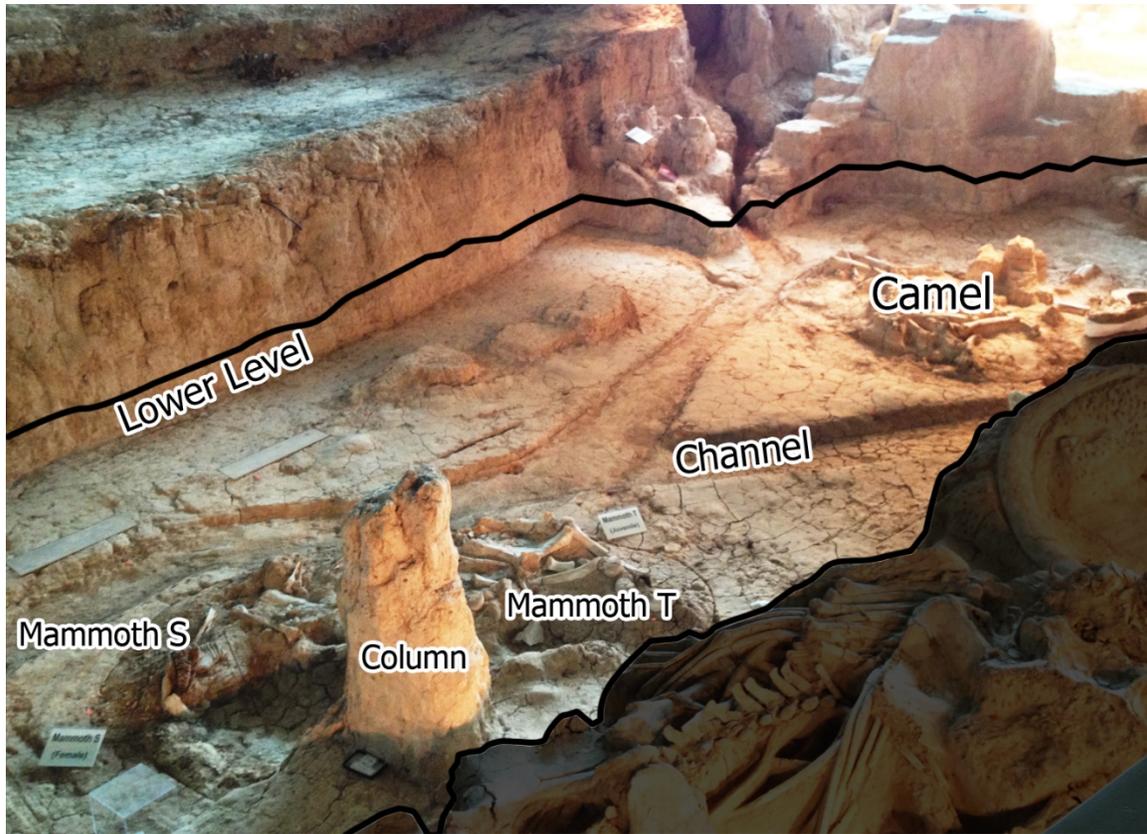
The fossils are buried in sediment. Sediment is a mix of rocks, minerals, and other small particles. If you look at the sediment, you may notice it has layers. Each layer was left behind by a natural event.

**ASK: What are some ways sediment might be moved by natural events?** (Rivers, storms, wind, etc.) The layers build up over time, so which is the oldest? Top or bottom? (Bottom!)

Scientists have uncovered these layers, or levels:

1. The lower level has more mammoths from the nursery herd. It also produced some other animals, which you'll see as you walk further into the building. According to test results, these fossils are 65,000 years old.
2. The upper level has produced 3 mammoths so far, including the site's only adult male, labeled Mammoth Q. Test results show these fossils are 50,000 years old.
3. Another level contains prehistoric sediment that has not been dated yet. This is one of the places scientists want to explore next.

## A. Clues from the Lower Level



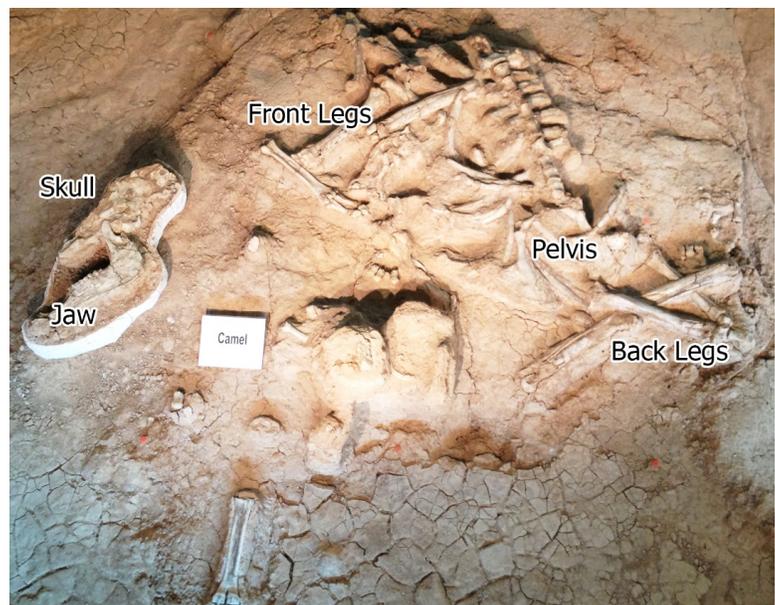
Lower level diagram.

- **Mammoth S and Mammoth T**—part of the nursery herd that was found outside.
- **Channel**—a path that scientists can walk without stepping on any fossils.
- **Column**—undisturbed sediment that has been left in place. This shows a scientist which level he or she is excavating.

### Camel

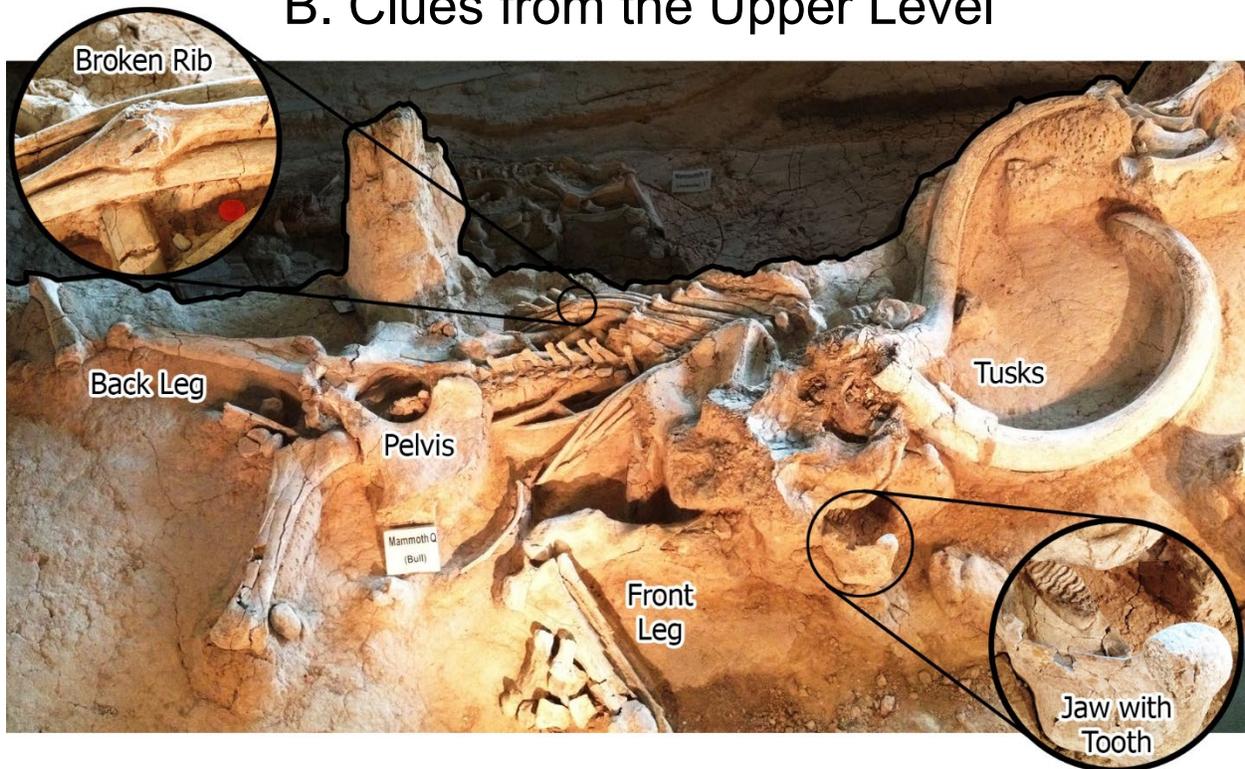
Also in the lower level—a camel! You will see it better as you walk further. Several of these two-toed animals have been found at this site. The camel family originated in North America. The camel you see at this site is called a Western camel. Their scientific name is *Camelops*.

**ASK: Why would camels and mammoths be together? What clues would you look for?**



*Camelops*.

## B. Clues from the Upper Level



- Fossils in the bottom level were buried **65,000** years ago.
- Moving up a level is like moving up in time.
- Mammoth Q is in the upper level, buried **50,000** years ago.
- He is the **only** adult male mammoth found at this site.

### Pelvis

This is the best clue to tell males and females apart. The opening of a male's pelvis tends to be circular, while a female's pelvis tends to have a diamond-shaped opening.

### Tusks

Female tusks are usually thinner than male tusks, but not always. **The tusk's length is not a good clue to tell males and females apart. Can you think of why? (Broken tusks are short. Young males' tusks have not had time to grow.)**

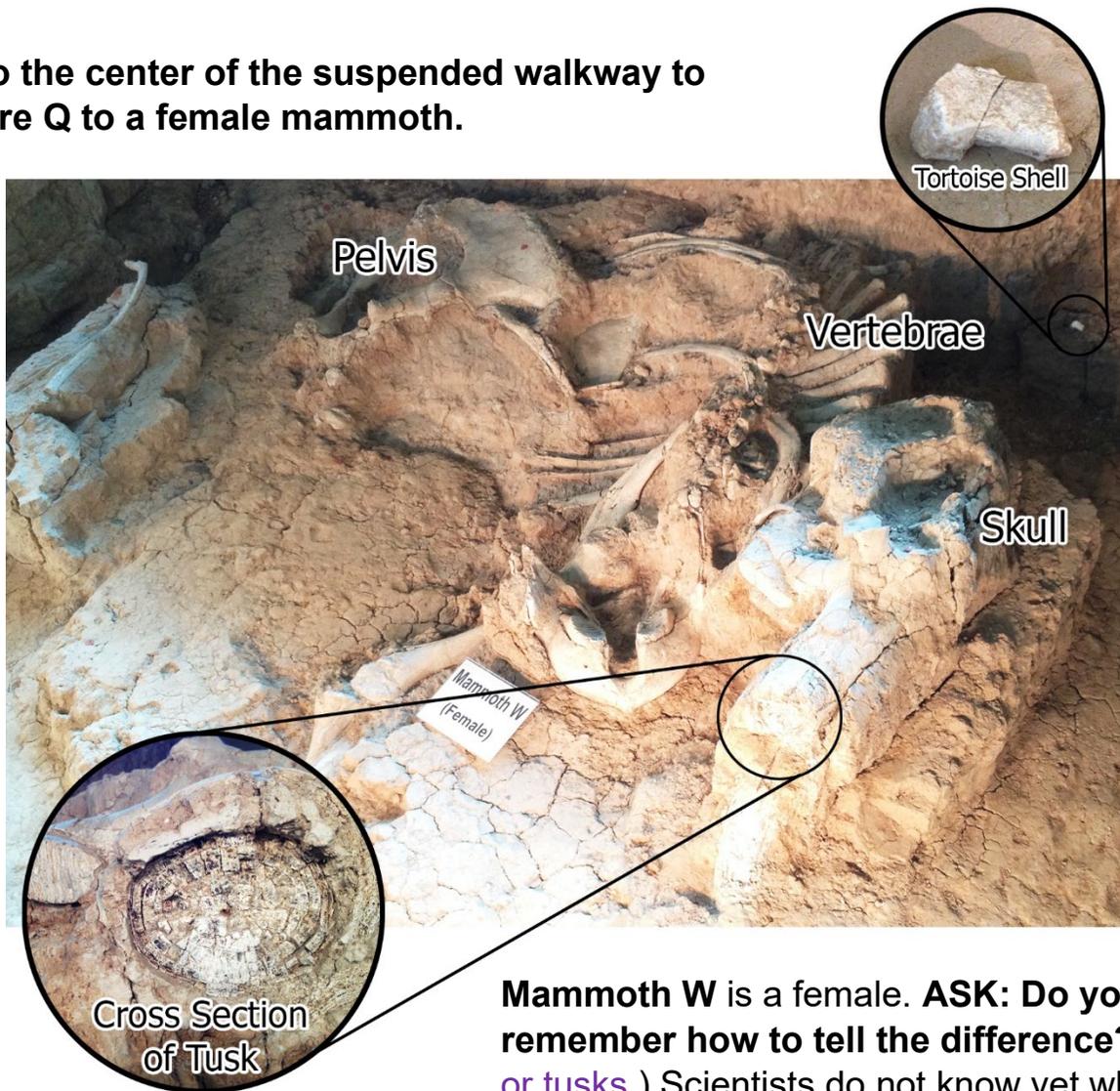
### Ribs

One of his ribs has a large lump, a possible clue about behavior! Broken ribs are a common injury in males. Modern male elephants hit and jab each other with their tusks. Q may have been healing from a fight.

### Teeth

Teeth are a clue about a mammoth's age. Mammoths got six sets of teeth during their life. Scientists can tell how old a mammoth was when it died by looking at the teeth. Q is on set five, so he was about 45 years old.

Walk to the center of the suspended walkway to compare Q to a female mammoth.



**Mammoth W** is a female. **ASK: Do you remember how to tell the difference? (Hips or tusks.)** Scientists do not know yet whether she is in the same level as Mammoth Q.

### Tusk “Rings”

One of W’s tusks was removed to be examined. The inside of a tusk has “rings,” which are clues about the health of an elephant or mammoth.

### Tortoises and Turtles

A small fossil sits against the wall behind W. This is a piece of a **giant tortoise shell**. Pieces of fossil tortoise shell are very common at this site. This is an important clue, about the climate here. **ASK: Do tortoises live in warm climates or cold? (Warm.)**

In addition to giant tortoise fossils, scientists also find many pond turtle fossils. These turtles are a clue about the environment. **ASK: What do you think the environment was like here, if it had so many pond turtles? (This area had water.)**

**More fossils** from Mammoth W's level are on the **other side of the walkway**. Scientists do not know yet if these are the same level as Mammoth Q or another level.



### **Sabertooth Cat**

Only a small part of Mammoth W's level has been explored. So far, it has produced five ribs from an animal that has not yet been identified, as well as a tooth from a saber-tooth cat. This cat was a juvenile, or cub.

### **Technology**

The tooth is very fragile, and so it was moved to a lab. The replica you see is an exact copy made with a 3D printer.



### **Clues to a Story**

Scientists hope to identify the five ribs. They may belong to the sabertooth cub or its mother. They may belong to a prey animal. **ASK: Putting all these clues together, what are some reasons we might find predator and prey bones in the same place?** (Both were attracted to the water here, this may have been a good place to hunt, etc.)

## IV. What is it Like to be a Paleontologist?



**Near the exit, you will see a lab area.** Paleontologists are scientists who study fossils, or the remains of ancient life. They are different from archaeologists, who study artifacts, or things that humans made. You will see many tools that paleontologists use, such as brushes and dentist picks.

**ASK: Think of a time when you worked on a jigsaw puzzle. What were some feelings you had while working on it? (Excited, frustrated, curious, etc.)**

Sometimes, paleontologists find fossils that are in many tiny fragments, and they must piece them back together. This is like working on a 3D, real-life, jigsaw puzzle. They will use special glues to repair these fossils.



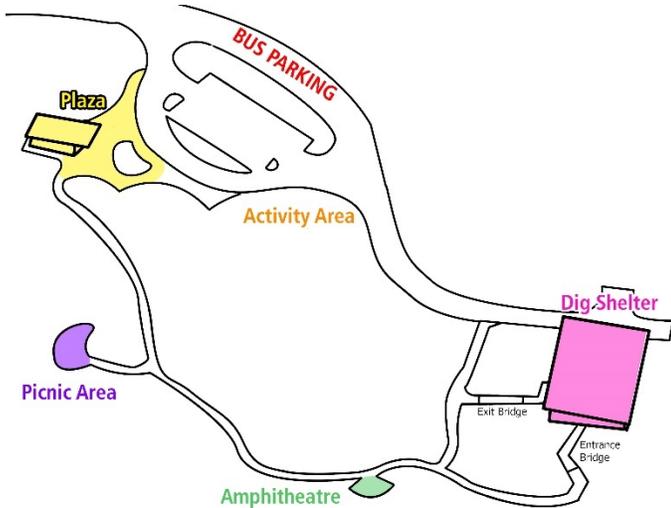
**ASK: What skills do you think a paleontologist needs to be good at this part of their job? (Patience, good eyesight, coordination, etc.)**

**ASK: What would make this puzzle more difficult than a regular jigsaw puzzle? (No picture to look at, missing pieces you didn't know were missing, etc.)**

**ASK: If you were a paleontologist at this park, where would you want to dig next? Why do you think that's a good spot to look?**

# Appendix A: Enrichment Activities

These optional enrichment activities offer more ways for your class to experience the park and its history. Classes may use the ●Activity Area, ●Amphitheatre, or ●Picnic Area for these activities.



Park Map



●Activity Area



●Amphitheatre



●Picnic Area

## I. I Spy

Works well at: ●Activity Area, ●Amphitheatre, ●Picnic Area



Describe something you can see, while the others try to guess what it is you are describing. “I spy with my little eye something... purple!”

## II. Alphabet Game

Works well at: ●Activity Area, ●Amphitheatre, ●Picnic Area



Go through the alphabet saying things you can see around you. For example, A= acorn, B=birds. Some of the letters will be tricky!

### III. Mammoth Simon Says

Works well at: ●Activity Area, ●Amphitheatre

Teach the group each of these Mammoth Motions, and then test their memory with a game of Simon Says!



HOLD OUT YOUR TUSKS



FLAP YOUR EARS



SWING YOUR TRUNK



WAVE YOUR TRUNK



CALL YOUR MOM (MAKE ELEPHANT NOISE)



FOSSILIZE!! (FREEZE IN PLACE)



WALK IN PLACE

# IV. Nature Scavenger Hunt

Works well at: ●Activity Area, ●Picnic Area

During the Ice Age, this area was covered with tall grass prairie, and there were fewer trees. There would have been many animals living there. The trees would house owls, and the tall grasses would hide their prey, such as rodents. The grass would have also hidden sabertooth cats as they lay in wait for their meal. Just as there was a lot of diversity in the Pleistocene Epoch, there is a lot of diversity in our woods now. Let's look for signs!

**Remember to leave what you find in place and only point it out to your classmates or teacher.**

- Find an acorn.
- Find a butterfly.
- Find a leaf that has been chewed.
- Find a flower.
- Find a tree with thorns.
- Find something smooth.
- Find something rough.
- Find an animal footprint. If you can't find one, what might be the reason for that?
- Find something left by an animal.
- Find two different types of leaves. How are they different?
- Find plants that are different shades of green.
- Find a bird's nest.
- Find a bird.
- Find a sign that shows you an animal has been in the area. What did you find?



**If you see a plant with leaves in groups of three, do not touch it!**

# V. Quiz Show

Works well at: ●Amphitheatre, ●Picnic Area

**Have you visited the Dig Shelter?** See who paid attention the best! Divide the class into teams and ask these questions about what they saw. If a student gets the answer wrong, they take a seat. At the end, the team with the most students standing wins.

QUESTION	ANSWER
Are mammoths a type of dinosaur?	No
How many adult male mammoths are at the dig site?	One
Which species of mammoth is here: woolly, Columbian, or southern?	Columbian
True or false? Columbian mammoths were bigger than woolly mammoths.	True
Which modern animal is the closest relative to a mammoth?	Elephant
True or false? Mammoths still live today.	False
The fossils were found in layers. Which layer is the oldest, the top or bottom?	Bottom
What was the main food for these mammoths?	Grass
Was Texas warm or cold during the Ice Age?	Warm
Which university dug out the nursery herd?	Baylor
How did the scientists label these mammoths, with numbers or letters?	Letters
Did nursery herds include adult male mammoths?	No
What is one way to tell male and female mammoths apart?	Hips or tusks
Which body part on Mammoth Q was healing from an injury?	Rib
Which body part would Mammoth Q use to fight other males?	Tusks
True or false? Scientists use brushes to uncover fossils at this site.	True
What long-legged, two-toed animal was found with the nursery herd?	Camel
Was this site's sabertooth cat an adult or juvenile?	Juvenile
In which city is this park located?	Waco
Do scientists know what color these mammoths were?	No
When was this site discovered, 1865, 1920, or 1978?	1978
A piece of shell was found next to Mammoth W. What animal did it come from?	Turtle
Which body part tells scientists how old a mammoth was when it died?	Tooth
Which type of scientist works with fossils, paleontologist or archaeologist?	Paleontologist
True or false? A <i>Tyrannosaurus rex</i> can be seen in the Dig Shelter.	False

## VI. Sabertooth!!

Works well at: ●Activity Area, ●Amphitheatre



Re-enact life in the Ice Age! Each student chooses a plant-eating or bug-eating animal to mimic. When the teacher says GO, students should move around like their animal. When the teacher says SABERTOOTH, students

should crouch down. The last student to crouch gets “eaten!” Repeat rounds until one animal is left—who can survive the sabertooth?

Don't know which animal to pick? Here are some ideas:

Armadillo

Ground Sloth

Opossum

Bison

Horse

Rabbit

Camel

Lizard

Raccoon

Deer

Llama

Snake

Duck

Mammoth

Squirrel

Fish

Mouse

Tortoise

## VII. Sidewalk Seaway

Works well at: ●Amphitheatre

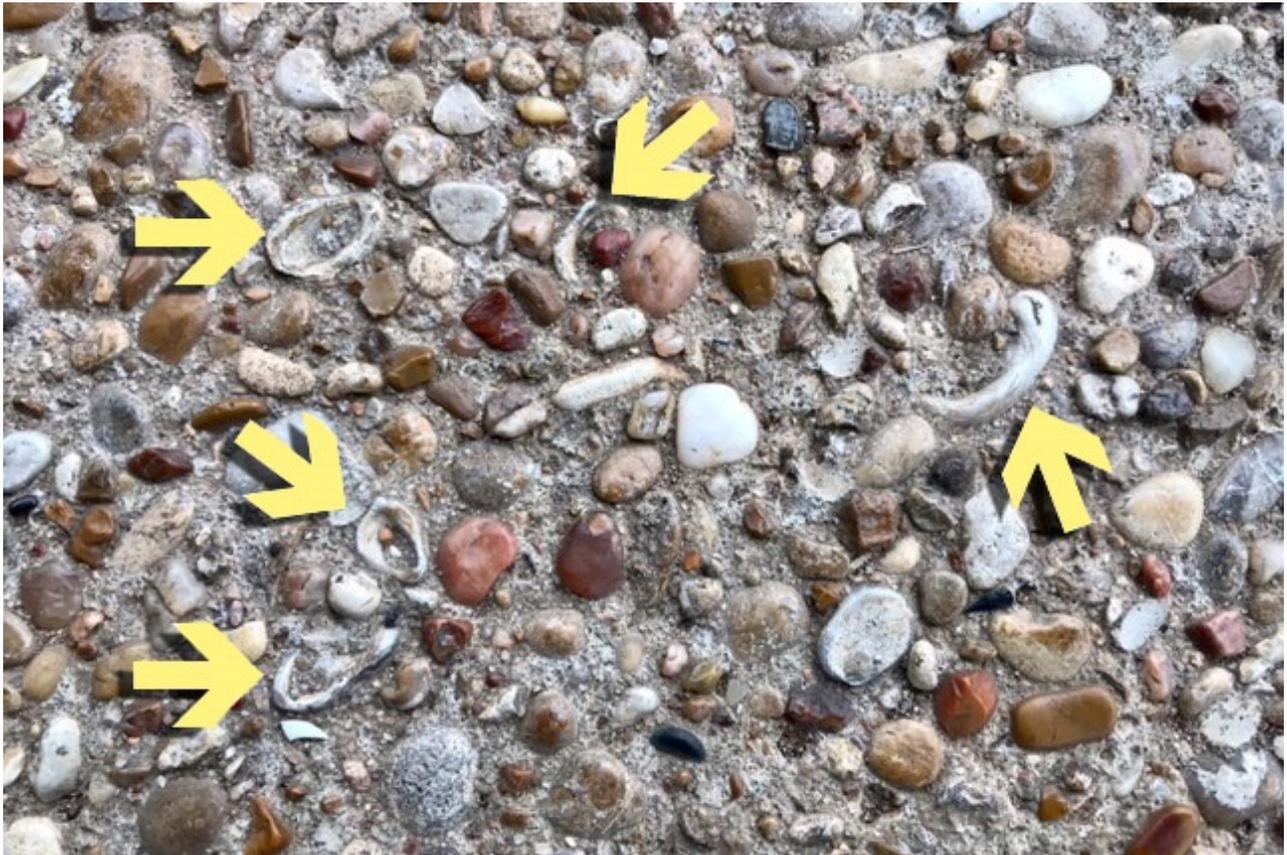
Did you know you're walking on top of history?

During the Age of Dinosaurs, 100 million years ago, Central Texas was underwater. We call this ocean the Western Interior Seaway. The mud at the bottom of this ocean turned into limestone filled with fossils.

Look at the amphitheatre. The seats are made of limestone. The pavement is made of gravel, which has fossils that eroded out of the limestone around Waco.

Look for snails, clams, and other ocean fossils in the pavement.

- Who can find one first?
- Who can find the most?
- Who can find the most unique fossil?



This photo shows five oyster fossils in the pavement at Waco Mammoth.

## VIII. Sound Scavenger Hunt

Works well at: ●Activity Area, ●Amphitheatre, ●Picnic Area

You can learn about the world around you even if you can't see things. You'd be surprised how many sounds are out in nature once we just become more aware of them. Take some time to really listen. You may want to close your eyes. Become a Sound Detective and make those ears work!

- Do you hear any voices? Do they belong to adults or to children?
- Do you hear any noises from the highway? Can you tell what kind of vehicle it is? Do you think it's big or small? Why?
- What kind of animal sounds do you hear? What kind of animal do you think is making the sound?
- What does the wind sound like when it blows through the trees?
- Do you hear any sounds as people walk? Can you describe them?
- Can you hear a bird that sounds like it is saying "teacher, teacher?"
- Can you describe what sounds other birds are making?
- Have you heard an insect fly by your head? What did it sound like?
- Do you hear any sounds of water?



# IX. How Big Were the Big Five?

Works well at: ●Amphitheatre, ●Picnic Area



*Cretaceous reptile image by Karen Carr, courtesy of the National Park Service.*

**Help your students understand earth history and big numbers by reading this script and guiding them through the Big Five extinction events. Read the sections in black out loud. Act out the sections in purple.**

Extinction is when a group of plants or animals all die out, and none of them are alive anymore. A species can go extinct at any time. When scientists study fossils, they learn that there have been five BIG events when a lot of species went

extinct all at once. Scientists call these events THE BIG FIVE. We're going to act out the Big Five to understand just how big they were.

**Ask the students to count off 1 through 10, repeating as needed until each student has a number. They will need to remember their number for the activity.**

1. The first of the BIG FIVE is called the Ordovician-Silurian (say: OR-doe-VISH-un sil-UR-ee-un) Extinction. About 444 million years ago, too much carbon dioxide was in the air, which caused some life to die out. You all represent all life on earth. Let's see how many species went extinct!
  - a. **Have students numbered 1 through 8 sit.**
  - b. This event killed 80-85% of all life! If you are sitting, your species went extinct. If you are standing, your species survived.
2. Okay, stand back up! The second of the BIG FIVE is called the Late Devonian (say: dev-OWN-ee-un) Extinction. This event took place over a long period of time, ending about 359 million years ago. Volcanic eruptions and growth of forests caused carbon dioxide levels to drop too low, which made the earth colder. Let's see how big this extinction was.
  - a. **Have students numbered 4 through 10 sit.**
  - b. This event killed 70-75% of all life. If you are sitting, your species went extinct. If you are standing, your species survived.
3. Stand back up! The third of the BIG FIVE is called the Permian-Triassic Extinction, which was 252 million years ago. Scientists don't agree yet on the cause—some think toxic gas may have erupted from the oceans, while others found evidence of a coal deposit in Siberia that burned for thousands of years, polluting land, air, and water. Still others think maybe an asteroid hit the earth.
  - a. **Have students numbered 5 stay standing—everyone else sits.**
  - b. This event killed 90% of all life. That is why scientists call this one the Great Dying. If you are sitting, your species went extinct. Look at how BIG this event was!

4. Stand up! The fourth of the BIG FIVE is called the Triassic-Jurassic Extinction. Life was finally recovering from the Great Dying when, 201 million years ago, the atmosphere got too much carbon dioxide again. The earth got hot and dry, and the oceans became acidic. Let's see how big this event was.
    - a. **Have students numbered 1, 2, 4, 5, 6, 8, 9, and 10 sit. (3 and 7 stand.)**
    - b. This event killed 80% of all life. If you are sitting, your species went extinct. If you are standing, your species survived.
  5. Stand up! The fifth of the BIG FIVE is the Cretaceous-Paleogene (say: creh-TAY-shus PAY-lee-oh-jeen) Extinction. A volcanic area of India was releasing a type of gas that causes cooling, which caused many species to disappear. Things got MUCH worse when, 66 million years ago, an asteroid hit the earth. Dinosaurs went extinct, but other species did too. Let's see how big this event was.
    - a. **Have students numbered 1, 2, 3, 7, 8, 9, and 10 sit. (4, 5, and 6 stand.)**
    - b. This event killed 70% of all life. If you are sitting, your species went extinct. If you are standing, your species survived.
  6. Stand up! Mammoths, saber-tooth cats, and many other Ice Age animals went extinct 10,000 years ago, during the Pleistocene (say: PLY-stuh-SEEN) Extinction. This extinction was caused by a combination of warming climates and humans overhunting animals. Why isn't this event one of the BIG FIVE? Let's find out.
    - a. **Have students numbered 4, 5, or 6 sit.**
    - b. About 30% of all life went extinct. That is a lot, but not as big as the BIG FIVE.
    - c. If you are sitting, your species went extinct. You might be a mammoth, saber-tooth cat, dire wolf, or another Ice Age species.
    - d. If you are standing, your species survived. Want to know something cool? A lot of the species that survived the Pleistocene Extinction still live today! You are species like white tail deer, coyotes, and snapping turtles.
  7. Today, we are in the middle of an extinction event. Some scientists say the Pleistocene Extinction isn't over, and that it is still going on today. Other scientists want to separate the current event from the Pleistocene Extinction, and they are calling it the Anthropocene (say: an-THROP-uh-SEEN) Extinction.
    - a. Many species have gone extinct due to this ongoing event.
    - b. Some of the animals lost include the dodo, Tasmanian tiger, passenger pigeon, and western black rhino.
    - c. Can you name other species that recently went extinct?
    - d. Can you name other species that are in danger of going extinct?
    - e. What might be some causes for this extinction event? (**Climate change, habitat loss, overhunting, plastic in the food supply, water pollution, etc.**)
    - f. What are some ways people can help?
-

# Appendix B: Texas Educational Standards Alignment

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Field trips to Waco Mammoth National Monument can be memorable learning experiences. This resource outlines how the activities in this guide align to the Texas Essential Knowledge and Skills (TEKS). Use this resource to choose activities that best fit your class's goals and desired outcomes.



# Kindergarten

## Science Standards

	Dig Shelter Tour pg. 2	I Spy pg. 14	Alphabet Game pg. 14	Mammoth Simon Says pg. 15	Nature Scavenger Hunt pg. 16	Sabertooth!! pg. 18	Sidewalk Seaway pg. 19	Sound Scavenger Hunt pg. 20
1. Use appropriate tools and safety, take actions to conserve resources	✓				✓		✓	
2. Investigate organisms, objects, and events observed in the natural world	✓	✓	✓		✓	✓	✓	✓
3. Make predictions based on observable patterns in nature	✓				✓	✓		
4. Collect information using tools and senses	✓	✓	✓		✓		✓	✓
5. Observe and record properties of objects	✓	✓			✓		✓	✓
6. Describe objects in relation to one another	✓				✓	✓		✓
7. Observe and describe rocks, and gives examples of how they are useful							✓	
8. Observe and describe repeating patterns in weather/climate	✓							
9. Examine the basic needs of organisms	✓				✓	✓		
10. Organize organisms by basic parts	✓	✓		✓	✓	✓	✓	

## Social Studies Standards

3. Understand relative location and use spatial terms	✓							
4. Understand Earth's resources and physical characteristics of landforms	✓						✓	
6. Identify jobs in the community	✓							
14. Place events in chronological order, express ideas based on knowledge and experience	✓				✓			

## Physical Education Standards

1. Bend and stretch, move in a group				✓		✓		
2. Move specific parts of the body				✓				
3. Participate in activities that improve flexibility				✓				
6. Respond to starting and stopping signals, play within the boundaries of games				✓		✓		
7. Follow rules and procedures				✓		✓		

# Grade 1

## Science Standards

	Dig Shelter Tour pg. 2	I Spy pg. 14	Alphabet Game pg. 14	Mammoth Simon Says pg. 15	Nature Scavenger Hunt pg. 16	Sabertooth!! pg. 18	Sidewalk Seaway pg. 19	Sound Scavenger Hunt pg. 20
1. Use appropriate tools and safety, take actions to conserve resources	✓				✓		✓	
2. Investigate organisms, objects, and events observed in the natural world	✓	✓	✓		✓	✓	✓	
3. Make predictions based on observable patterns in nature	✓				✓	✓		
4. Collect information using tools, take measurements								
5. Observe and record properties of objects, classify objects by material	✓	✓			✓		✓	
6. Explore force, motion, and energy between objects						✓		
7. Describe rocks, soil, and water, and how they are useful	✓				✓			
8. Observe and describe repeating patterns in weather/climate								
9. Examine the interdependence of organisms	✓			✓	✓	✓		
10. Examine the characteristics and life cycles of organisms	✓			✓	✓	✓		

## Social Studies Standards

3. Understand relative location and use spatial terms	✓							
5. Understand the physical characteristics of landforms	✓						✓	
6. Identify jobs in the community and the tools used by those jobs	✓							
12. Identify personal responsibility as a part of good citizenship	✓							
17. Express ideas based on knowledge and experience	✓				✓			

## Physical Education Standards

1. Demonstrate proper movement in hopping, jumping, skipping, leaping, galloping						✓		
3. Participate in activities that improve flexibility				✓				
6. Respond to starting and stopping signals, play within the boundaries of games				✓		✓		
7. Follow rules and procedures				✓		✓		

# Grade 2

## Science Standards

	Dig Shelter Tour pg. 2	I Spy pg. 14	Alphabet Game pg. 14	Mammoth Simon Says pg. 15	Nature Scavenger Hunt pg. 16	Sabertooth!! pg. 18	Sidewalk Seaway pg. 19	Sound Scavenger Hunt pg. 20
1. Use appropriate tools and safety, take actions to conserve resources	✓				✓		✓	
2. Investigate organisms, objects, and events observed in the natural world	✓	✓	✓		✓	✓	✓	✓
3. Make predictions based on observable patterns in nature	✓				✓	✓		
4. Collect information using tools, compare organisms					✓		✓	
5. Observe and record properties of objects and how actions can change properties	✓	✓			✓		✓	✓
6. Explore force, motion, and energy between objects						✓		
7. Describe and compare rocks, distinguish between artificial and natural substances	✓						✓	
8. Observe and describe repeating patterns in weather/climate								
9. Examine the interdependence of organisms and the effects of environment on behavior	✓				✓	✓		
10. Examine the characteristics and life cycles of organisms	✓			✓	✓	✓	✓	

## Social Studies Standards

1. Understand the significance of national landmarks, including monuments	✓							
2. Describe how people and events have influenced local community history	✓							
5. Identify how people can modify the terrain (land use)	✓						✓	
8. Understand the value of governmental services to the community	✓							
10. Identify personal responsibility as a part of good citizenship	✓							
13. Understand how science affects recreation	✓							
16. Describe events by using designations of time periods, express ideas based on knowledge and experience	✓							

## Physical Education Standards

1. Demonstrate proper movement in walking, hopping, skipping						✓		
2. Demonstrate the ready position				✓				
6. Identify strategies to accomplish goals in games				✓		✓		
7. Display good sportsmanship				✓		✓	✓	

# Grade 3

	Dig Shelter Tour pg. 2	Nature Scavenger Hunt pg. 16	Quiz Show pg. 17	Sabertooth!! pg. 18	Sidewalk Seaway pg. 19	Sound Scavenger Hunt pg. 20	How Big Were the Big Five? pg. 21
1. Use appropriate tools and safety, take actions to conserve resources	✓	✓	✓		✓		
2. Collect, organize, and communicate data	✓	✓	✓		✓	✓	✓
3. Use critical thinking and scientific problem solving	✓	✓	✓				✓
4. Collect, record, and analyze information using tools							
5. Observe and record properties of objects and how properties can change over time	✓		✓		✓	✓	✓
6. Explore force, motion, and energy between objects				✓			
7. Explore how soil forms and how the Earth's surface changes	✓		✓		✓		
8. Observe and describe repeating patterns in weather/climate							✓
9. Examine the interdependence of organisms and the effects of environment on behavior	✓	✓	✓	✓			✓
10. Examine the characteristics and life cycles of organisms	✓	✓	✓	✓	✓		✓

## Science Standards

## Social Studies Standards

1. Describe how people and events have influenced a community's history	✓						
3. Identify how people can modify the terrain (land use)	✓				✓		
7. Identify services commonly provided by local and national governments	✓						
9. Identify personal responsibility as a part of good citizenship	✓						
14. Compare and contrast information, understand cause and effect	✓						✓
15. Express ideas based on knowledge and experience	✓						✓

## Mathematics Standards

1. Use representations to communicate mathematical ideas							✓
3. Partition a set of objects into fractions							✓

# Grade 4

## Science Standards

	Dig Shelter Tour pg. 2	Nature Scavenger Hunt pg. 16	Quiz Show pg. 17	Sabertooth!! pg. 18	Sidewalk Seaway pg. 19	How Big Were the Big Five? pg. 21
1. Use appropriate tools and safety, take actions to conserve resources	✓	✓	✓		✓	
2. Collect, organize, and communicate data, make inferences	✓	✓	✓		✓	✓
3. Represent the natural world using models, understand limitations of data				✓		✓
4. Collect, record, and analyze information using tools						
5. Compare and contrast a variety of materials and mixtures	✓	✓	✓		✓	
6. Differentiate between different forms of energy						
7. Explore the composition of sediments and changes to the Earth's surface	✓		✓		✓	
8. Observe and describe repeating patterns in weather/climate						✓
9. Classify organisms as producers or consumers, organize organisms into food webs	✓	✓	✓	✓		
10. Examine the characteristics of organisms and inheritance of traits	✓	✓	✓	✓	✓	✓

## Social Studies Standards

6. Understand the characteristics of the Texas plains	✓					
8. Identify how people can modify the terrain (land use)	✓				✓	
15. Understand how citizens can participate in historic preservation	✓					✓
18. Describe how scientific discovery benefits communities in Texas	✓					
19. Compare and contrast information, understand cause and effect	✓					✓
21. Express ideas based on research and experience	✓					✓

## Mathematics Standards

1. Use representations to communicate mathematical ideas						✓
2. Represent decimals with visual models						✓

# Grade 5

## Science Standards

	Dig Shelter Tour pg. 2	Nature Scavenger Hunt pg. 16	Quiz Show pg. 17	Sidewalk Seaway pg. 19	How Big Were the Big Five? pg. 21
1. Use appropriate tools and safety, take actions to conserve resources	✓	✓	✓	✓	
2. Formulate testable hypotheses; collect, organize, and communicate data		✓			✓
3. Represent the natural world using models, understand limitations of data		✓			✓
4. Collect, record, and analyze information using tools					
5. Classify matter based on measurable, testable, and observable physical properties	✓	✓	✓	✓	
6. Differentiate between different forms of energy					
7. Explore the formation of sedimentary rocks and changes to the Earth's surface	✓		✓	✓	
8. Differentiate between weather and climate					✓
9. Identify fossils as evidence of past living organisms; organize organisms by producer, consumer, and/or decomposer	✓		✓	✓	
10. Compare the inherited traits of different species that help them live and survive in specific environments	✓	✓	✓	✓	✓

## Social Studies Standards

6. Describe regions in the US based on physical traits such as landform, climate, and vegetation	✓				
8. Identify how people can modify the terrain (land use)	✓			✓	
16. Explain the significance of important landmarks	✓				
23. Compare and contrast information, understand cause and effect	✓				✓
25. Express ideas based on research and experience	✓				✓

## Mathematics Standards

1. Use representations to communicate mathematical ideas					✓
9. Interpret categorical data					✓

# Grade 6

## Science Standards

	Dig Shelter Tour pg. 2	Quiz Show pg. 17	Sidewalk Seaway pg. 19	How Big Were the Big Five? pg. 21
1. Use appropriate tools and safety, take actions to conserve resources	✓	✓	✓	
2. Formulate testable hypotheses; collect, organize, and communicate data				✓
3. Represent the natural world using models, understand limitations of data				✓
4. Collect, record, and analyze information using tools				
5. Know that elements and compounds make up the earth, air, and life				✓
6. Test the physical properties of minerals				
7. Learn the advantages and disadvantages of different energy sources				✓
8. Measure motion, speed, and force				
9. Understand that energy is not destroyed; learn how it changes form				
10. Understand the structure of the earth, the rock cycle, and plate tectonics	✓	✓	✓	
11. Understand the organization of our solar system				✓
12. Organize life by taxonomy and understand life processes	✓	✓	✓	✓

## Social Studies Standards

3. Explain how geographic features, such as landforms and water bodies, affect patterns in population	✓		✓	
4. Explain how geographic factors influence economic activities in places and regions	✓		✓	
5. Identify and analyze ways people have modified the physical environment, such as excavation	✓		✓	
16. Identify examples of art that convey universal themes such as the passage of time	✓			

## Mathematics Standards

4. Compare real-world problems involving ratios and rates; represent percentages with models				✓
5. Find the percent given the part and the whole, including the use of concrete models				✓

# Grade 7

## Science Standards

	Dig Shelter Tour pg. 2	Quiz Show pg. 17	Sidewalk Seaway pg. 19	How Big Were the Big Five? pg. 21
1. Use appropriate tools and safety, take actions to conserve resources	✓	✓	✓	
2. Formulate testable hypotheses; collect, organize, and communicate data				✓
3. Represent the natural world using models, understand limitations of data				✓
4. Collect, record, and analyze information using tools				
5. Understand the flow of energy through living systems				✓
6. Distinguish between physical and chemical changes				
7. Understand how motion and energy affect organisms				
8. Understand weathering, erosion, deposition, and natural events, such as flooding	✓	✓	✓	✓
9. Understand how components of the solar systems make life possible on Earth				✓
10. Describe different environments, including microhabitats	✓	✓	✓	✓
11. Observe structures or organisms and organize them by inherited traits	✓	✓	✓	
12. Recognize levels of organization in plants and animals, including cells	✓	✓	✓	
13. Investigate how organisms respond to external stimuli				
14. Understand how genes are transferred during reproduction				

## Social Studies Standards

8. Identify the characteristics of the Texas plains and waterways	✓			
9. Identify ways in which Texans have modified the environment	✓		✓	

## Mathematics Standards

6. Use simulations to represent simple and compound events with and without technology				✓
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# Grade 8

## Science Standards

	Dig Shelter Tour pg. 2	Quiz Show pg. 17	Sidewalk Seaway pg. 19	How Big Were the Big Five? pg. 21
1. Use appropriate tools and safety, take actions to conserve resources	✓	✓	✓	
2. Formulate testable hypotheses; collect, organize, and communicate data				✓
3. Represent the natural world using models, understand limitations of data				✓
4. Collect, record, and analyze information using tools				
5. Know that matter is composed of atoms and has chemical and physical properties				
6. Understand that relationship between force, motion, and energy				
7. Know the effects resulting from cyclical movements of the sun, Earth, and moon, such as tides and seasons				
8. Know the components of the universe and identify wavelengths of the electromagnetic spectrum (light, radio)				
9. Understand how plate tectonics and erosion reshape the Earth's crust	✓	✓	✓	
10. Understand how oceans and solar radiation influence wind and weather patterns				
11. Understand that lifeforms, including humans, compete for resources	✓	✓		✓

# High School Science

	Dig Shelter Tour pg. 2	Quiz Show pg. 17	Sidewalk Seaway pg. 19	How Big Were the Big Five? pg. 21
<b>Biology Standards</b>				
7. Understand the evidence for common ancestry and that natural selection changes populations, not individuals	✓	✓		✓
8. Organize lifeforms by taxonomic groups	✓	✓	✓	
10. Understand the biological systems of plants and animal bodies	✓	✓		✓
11. Understand how ecological systems balance, and how environmental changes affect populations	✓	✓		✓
12. Understand the relationships between species, including symbiotic and trophic interactions	✓	✓	✓	✓

## Earth and Space Standards

6. Understand how the atmosphere, hydrosphere, and geosphere formed over time				✓
7. Understand relative dating and multiple types of absolute dating	✓	✓		
8. Understand that fossils provide evidence for biological and geological evolution	✓	✓	✓	✓
10. Understand plate tectonics and the development of geological features	✓	✓	✓	
11. Understand the history of the geosphere and its changes over time			✓	✓
13. Understand how fluid Earth systems affect life and the geosphere			✓	✓
14. Understand variables that cause changes in weather and climate				✓
15. Understand the effects of past, current, and future climates on the five Earth subsystems	✓	✓	✓	✓

## Environmental Systems Standards

4. Understand the relationships of biotic and abiotic factors in habitats, ecosystems, and biomes	✓	✓		✓
5. Understand land use and sustainability	✓	✓		✓
7. Explore how changes in carrying capacity alter a population				✓
8. Study the impacts of natural events, such as flooding or population growth	✓	✓		✓
9. Study the impact of human activities on the environment				✓

# Big Dig Class

This program scales to all ages and is the most TEKS-intensive program we offer.

## Educational Theory

1. This activity is heavily visual, spatial, and tactile. It reinforces and makes “real” the ideas that are taught on-site.
2. For the youngest crew members, the goal is to encourage cooperation and fine motor skills. In other words, make sure they have fun and don’t break anything.
3. Raise expectations with the age of the students. By 5<sup>th</sup> grade, students should be able to follow instructions, dig carefully, and *make inferences* about what they find.
4. Competition is a great motivator for middle and high school students.



## Setting Up

→ Thanks to a bunch of upgrades, setting up no longer involves hauling out equipment. **Take care** of the equipment, so we can keep it that way!

To set up, unlock the two bench boxes. Attach the Big Dig Class rules to one of the shade structure posts. Get a set of tools and set them in the center square for demo.

Left Box has buckets



Right Box has tools and interpretive props



## Sample Script

- I. "Hi! My name is \_\_\_\_\_, and I'm going to be your foreman today. Who knows what a foreman is? (The person who leads a dig crew.) What we are going to be doing is learning to excavate with the proper tools and techniques that are used by real scientists."
- II. Discovery and the Team
  - a. "A site usually is discovered when a fossil erodes out of the ground." (Point out anything that happens to be sticking out.)
  - b. "A team comes in, and they grid off the area so everything can be mapped as it's uncovered."
  - c. "We use metric in science, so these are not square yards. What are they?" (Square meters.)
  - d. "There are *a lot* of reasons to divide a site into squares like this. Who can think of one?" (Discuss ideas the kids suggest.)
    - i. "Mapping—maps are divided into a grid, so dividing the site into a grid makes mapping easier."
    - ii. "Coordinates—each grid has a number, and that makes it easy to point your foreman to the correct square." (Walk them through: "If this is A1, A2, and A3, then this is B1, B2...")
    - iii. "And if there's a toy *everybody* wants to play with, what do the grownups say you have to do? Share! This is a big ol' toy box, but each square is *equal*, so we all get a chance."
  - e. **OPTION**—if you have a student who cannot excavate, you can include them by making them the cartographer. Explain that the cartographer is second in charge, the foreman's assistant. You can give them a blank map to record the site. They also can help with distributing flags and bringing extra tools/buckets as needed.
- III. Technique Demo
  - a. Show the poster of Mammoth W with the grid (poster is in the right bench box).
  - b. Explain that surfaces should be kept level. Workers should move out from the bones and dig straight down, creating a "table" that each bone sits on. Do not dig under a bone, as this weakens the support.
  - c. Demonstrate the techniques and how tools are used. (Refer to Digging Techniques at the end.)
- IV. Rules
  - a. The Big Dig Rules (poster in the right bench box) should be attached to a shade structure post.
  - b. Have a kid read a rule, and then follow up with an explanation.

- i. "Do not throw sand! Have you ever gotten sand in your eyes? Was that fun? No.... If I see you throwing sand, I *will* have you leave this box."
- ii. "Do not pick up bones! One of the things that makes Waco Mammoth special is that we found a group of mother mammoths circled around baby mammoths. If we picked up the bones as soon as we found them, would we know they were in a circle?"
- iii. "Follow all directions. If your foreman asks you to "quit doing that," what should you do? Quit doing that!"

#### V. Dig!

- a. Have students grab tools and break into teams. For students 5<sup>th</sup> grade and up, you might consider using competition. Tell them that at the end, you will interpret the bones as a group, and you will grade or rate each team's square.
- b. As kids find bones, flag each one.
- c. Have students dig until there are about fifteen minutes of the hour left. As the time approaches, give them a five minute warning to clean up their square and make it presentable.

#### VI. Site Analysis

- a. Use the last fifteen minutes to move from square to square, helping students figure out which bones have been uncovered.
  - i. If you cannot identify a bone, tell them that this one appears to be outside your area, and call in an expert (that is, someone else on staff).
  - ii. You also can come up with something plausible (just say it with confidence), or if it's a fragment, say that it will have to be identified later in a lab.
  - iii. Point to especially fragmented bones as being chewed on.
    1. You can also state that a worn bone appears to be acid etched, and then ask how a piece of bone may be exposed to acid. (It was swallowed.)
    2. Emphasize how important the tiny pieces are—it makes the kids feel better about what they found, and it will come up later during Interpretation.
    3. There are some large bones with big dents and dings on them. Call these bite marks. (They're actually damage from kids digging, but we use what we have.)
  - iv. If you are motivating students with competition, give each square a letter grade after IDing the fossils, and compliment the kids on what they did well.

- b. As you go through, keep a running tally of the animals present. (For example, "Okay, so far we have a mammoth, a deer, a camel, and an unidentified animal.")
- c. MNI—as you identify bones, you eventually will find a double.
  - i. "Okay, we have a tusk from a mammoth, and now we have a leg bone from a mammoth. How many mammoths do we have?"
  - ii. ONE. (Kids will keep saying two. Wait until a kid figures out it's one.)
  - iii. "How would we know we have more than one mammoth?" (You'll find more than one *of the same part*.)
  - iv. You don't have to tell them this is called the "minimum number of individuals," but if you have a group of students who want scientific terms, feel free to tell them that is what this analytical process is called.

## VII. Interpretation

- a. "Now that we know which animals are here, we should try to figure out *why* they're here. So let's look at the evidence."
- b. "We have lots of chewed-up bones. The bones are scattered, too." Point to positions of related bones, such as the mammoth tusk being nowhere near the mammoth's tooth, even though they're both from the head.
- c. Lead kids to the idea that this is the remains of someone's meal.
- d. Eliminate suspects
  - i. Humans—has anyone found any tools?
  - ii. Wolves or cats—maybe, but the mammoth femur is broken wide open.
- e. The culprit
  - i. Only one animal was large enough to kill an adult mammoth.
  - ii. On all fours, it was six feet tall, but on its hind legs, it was almost as tall as this tent.
  - iii. It probably liked caves, and it may even have hibernated in the winter.
  - iv. GIANT SHORT-FACED BEAR
- f. Test the hypothesis
  - i. (Carefully) Take the GSFB skull from the right bench box. Hold the skull up at six feet, so kids can see the height.
  - ii. Ask how we could test the idea that a GSFB ate these animals. A kid will probably suggest holding the teeth up to a bite mark.



- iii.
- iv. Hold the bear's tooth up to a "bite mark." Ask the kids if it looks like a match.

#### VIII. Site Remediation

- a. Reflect on the experience.
  - i. "Okay, you've been digging for about forty minutes. Would you say this was easy or hard?"
  - ii. "At a real dig, you'll dig for two weeks for about ten hours a day. Does *that* sound easy or hard?"
  - iii. Paint a picture: The team has been digging for weeks. They eat out of cans and sleep in tents. They decide to go into town where they can take showers and eat a good supper. When everyone gets back, they discover the biggest bones are missing. What happened? (If the kids don't suggest thieves, elaborate further. You checked the tents, and the radios were gone too.)
- b. Explain that when real paleontologists have to leave bones at a site, they will cover them up and camouflage them to deter thieves.
- c. "Now, if someone is standing over there in the parking lot, what would they see from there?" (The flags!)
- d. "We need to get all these flags and tools out of here. That's a dead giveaway that we've been digging."
- e. Once tools are put back into the bench boxes, have the kids dump the dirt out of the buckets and rebury the bones. Encourage them to smooth out the dirt, to make it look like no one has been there.

#### IX. Wrap Up

- a. Tell the kids they did a GREAT job!
- b. Direct kids toward the restrooms for cleanup.

## Digging Techniques



Start with a trowel. Use the side of the trowel, not the tip. Your goal is to keep it level, not create a trench.



Move dirt out as you go. If you leave a pile of dirt, it can collapse and rebury what you just worked to uncover. Use a pan to move dirt to your bucket.

"A clean site is a happy site."



Scrapers can remove dirt near the bone. Don't do this with your trowel—at no point should the foreman hear scraping noises!



When in doubt, use a brush. A brush is the best tool for removing dirt from a bone.

Make sure not to dig under a bone, and resist the temptation to pick up a bone. We learn more from bones that are in their original position.



When you're sure you have something, call over your foreman, and they will flag your fossil. They will give you further instructions on how to dig and which direction to move in. You are now "chasing" a fossil.

If at any point you don't know what to do, call over your foreman!