Museum Detectives
Field Trip Program
Revised December, 2014

Petrified Forest Focus: Paleontology
School Subjects: Science, Reading and Literacy
Grade Levels: 6^{th} – 8^{th}
Duration: 30 minute pre-visit in class activity, 60 minute in-park activity, 30 minute post-visit in class activity

AZ Science Standards

SC06-S1C2-01.	Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.
SC06-S1C2-03.	Conduct a controlled investigation using scientific processes.
SC06-S1C3-01.	Analyze data obtained in a scientific investigation to identify trends (See M06-S2C1-03) .
SC06-S1C3-03.	Evaluate the observations and data reported by others.
SC06-S1C4.	Communication: Communicate results of investigations.
SC06-S2C2.	Nature of Scientific Knowledge: Understand how science is a process for generating knowledge.
SC06-S2C2-01.	Describe how science is an ongoing process that changes in response to new information and discoveries.
SC06-S4C4.	Diversity, Adaptation, and Behavior: Identify structural and behavioral adaptations.
SC07-S1C2-01.	Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.
SC07-S1C4.	Communication: Communicate results of investigations.
SC07-S2C2.	Nature of Scientific Knowledge Understand how science is a process for generating knowledge.
SC07-S2C2-01.	Describe how science is an ongoing process that changes in response to new information and discoveries.
SC07-S4C3-02.	Explain how organisms obtain and use resources to develop and thrive in: Niches; predator/prey relationships.
SC07-S6C1-03.	Explain the following processes involved in the formation of the Earth's structure: Erosion; deposition; plate tectonics; volcanism.
SC07-S6C1-04.	Describe how the rock and fossil record show that environmental conditions have changed over geologic and recent time.
SC08-S1C2-01.	Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.
SC08-S1C4-01.	Communicate the results of an investigation.
SC08-S2C1-04.	Evaluate career opportunities related to life and physical sciences.

SC08-S2C2.	Nature of Scientific Knowledge: Understand how science is a process for generating knowledge.
SC08-S2C2-02.	Describe how scientific knowledge is subject to change as new information and/or technology challenges prevailing theories.
SC08-S4C4-01.	Explain how an organism's behavior allows it to survive in an environment.

AZCCR Standards

(6.L.1) Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text

(7.L.3) Use knowledge of language and its conventions when writing, speaking, reading, or listening.
Choose language that expresses ideas precisely and concisely, recognizing and eliminating wordiness and redundancy.*

(6-8.RST.1)Cite specific textual evidence to support analysis of science and technical texts.

(6-8.RST.8) Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

(6-8.WHST.2) Provide a concluding statement or section that follows from and supports the information or explanation presented.

a. By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently.
   (6-8.RST.10) Use precise language and domain-specific vocabulary to inform about or explain the topic.
b. Establish and maintain a formal style and objective tone.

(6-8.WHST.4) Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Lesson Overview

Pre-visit: Students read background text on animals of the Late Triassic and complete a short writing assignment.

In Park-activity: Students will participate in a guided learning activity inside of the Rainbow Forest Museum identifying and matching replica fossil bones of Late Triassic animals to the museum exhibits. Students will work in groups or pairs to answer questions about the animals and present their answers to the whole class. Maximum group size - 30

Post-visit activity: Students complete the Triassic Anatomy worksheet.

Lesson Goals

- develop an understanding of the science of paleontology by learning the skills and concepts involved
- Be introduced to basic anatomy of animals by matching individual fossils to compete skeletons.
- Be introduced to the three types of consumer groups in nature
- Practice reading (binomial nomenclature) scientific names

- explore an aspect of paleontology through participation in an investigation activity.
- become aware of the importance of preservation of paleontological resources
- understand the role of the National Park Service in the preservation and protection of natural and cultural resources.

Learning Objectives

Students will be able to:

- describe paleontology as the study of ancient life on earth through fossils
- list geological time periods represented at the park
- recognize basic animal anatomy from fossil bones
- describe how an animal's teeth can help determine what type of food they ate.
- recognize that paleontological resources are nonrenewable
- describe at least one thing they learned about Petrified Forest National Park and/or the National Park Service.

Materials - All materials will be provided by the park excluding printing of worksheets for classroom activities.

Student Assessment Questions

Use the following questions to help your students prepare for their trip and to assess what they learned after visiting the park.

1. Can you think of two facts you know about Petrified Forest or the National Park Service?
2. What is a fossil? Give an example of a fossil found at Petrified Forest National Park.
3. It is important to protect our natural resources. Fossils are an example of resources that are in danger of being destroyed. Can you list two reasons for why fossils are being destroyed?
4. What is one way you might be able to tell a herbivore from a carnivore based on the animal's skeleton?
5. How can paleontologists use fossil bones to find out how animals moved or stood?
6. National parks were created to protect natural and cultural resources for future generations. Can you explain why this is important?

Related Vocabulary

- **Anatomy**: the branch of science concerned with the structure of living organisms' bodies and bones
- **Ankle –** the joint that connects the foot to the leg
- **Carnivore –** an animal that feeds on meat; typically has teeth that are long and pointed or serrated for tearing and separating flesh

- **Chinle Formation** - rock formation within Petrified Forest National Park and the larger area of the Painted Desert, containing several distinct rock layers, dating to over 200 million years ago; represents the Late Triassic Period
- **Erosion** - the movement of earth material from one place to another due to forces such as water, wind, gravity, or ice movements
- **Femur** – the thigh bone in humans and other animals
- **Fossil** - any record of past life found preserved in rock; can be plant materials such as stems, seeds, or cones, and pollen, or animal parts such as bone, shells, or teeth; can be trace impressions, such as tracks, footprints, trails, burrows, leaves, etc.
- **Fossilization** - a process by which plant and animal remains or their impressions are preserved in rock *(evidence of life preserved by a geologic process)*
- **Geology** - a science that concentrates on the origin, history, and structure of the earth including the study of rocks and the forces acting upon the earth
- **Herbivore –** an animal that feeds on plants; typically has teeth that are flat or have triangle shaped tips for chewing and grinding
- **Omnivore –** an animal that feeds no both plants and meat; Typically has a combination of flat and pointy teeth
- **Organic material** - dead plant and animal matter in various stages of decomposition or fossilization
- **Pelvis**: the large bony structure near the base of the spine to which the hind limbs or legs are attached in humans and many other vertebrates.
- **Scapula** – technical term for the shoulder blade.
- **Sedimentary** - rock formed from the deposition, accumulation, and cementation of sediments, usually forming layers, often including fossils
- **Skull -** a framework of bone or cartilage enclosing the brain of a vertebrate; the skeleton of a person's or animal's head.
- **Triassic Period** - the first geologic timespan within the Mesozoic Era, dating from 248-206 million years ago; the Late Triassic Period is well represented at Petrified Forest National Park
- **Vertebra** - each of the series of small bones forming the backbone, having several projections for articulation and muscle attachment, and a hole through which the spinal cord passes.

Pre-visit Lesson

Time Required – 30 minutes

Goals:

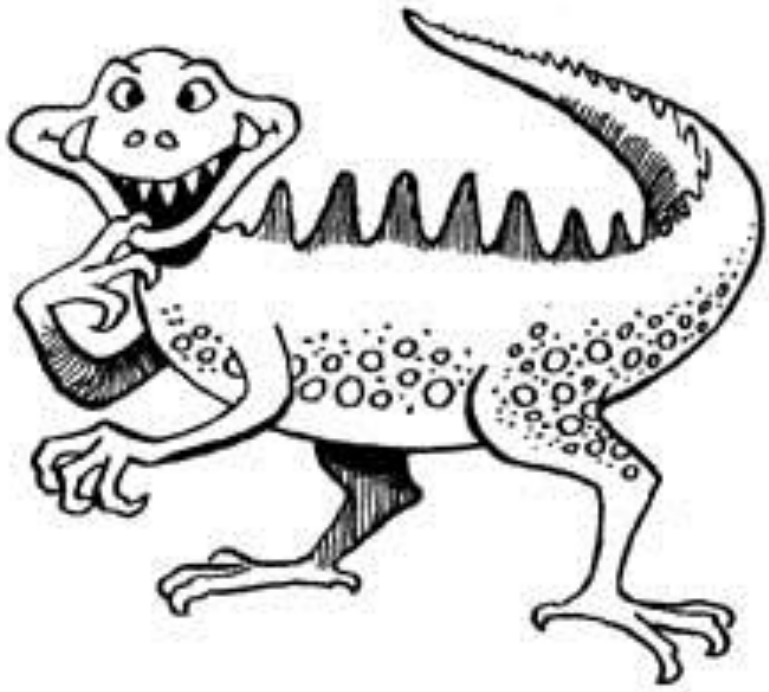
- Develop an understanding of the science of paleontology by learning the skills and concepts involved
- Be introduced to the three types of consumer groups in nature
- Describe how an animal's teeth can help determine what type of food they ate

Materials:

- background text (can be printed per student or read as a class)
- Background reading worksheet

Procedure:

- Students read the background text either individually or as a class then complete the background story worksheet.

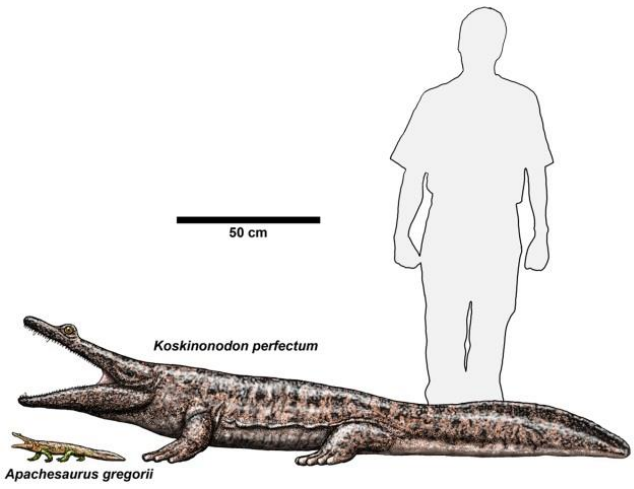


Background Knowledge (for students to read)

Petrified Forest National Park contains fossils from the Late Triassic epoch that are over 200 million years old. These fossils are found in layers of sediment called the Chinle Formation. Another name for these colorful layers is The Painted Desert. Science and field work is very important to telling the story of Petrified Forest. The first research on fossils, known as paleontology, began in the park in the early 1900's. This research is still going on today. The park tries to encourage public appreciation for the new information that is learned as part of a larger appreciation for protecting and learning in public lands.

Paleontology is a science that investigates evidence of ancient life and how organisms have changed through time. Paleontologists must also be geologists (geology is the study of the physical structures and processes of Earth), and know about biology (the study of living organisms), and ecology (the study of how living organisms interact with each other) to interpret clues from the ancient past. They piece together information from how rocks form, how they change over time, and what environments they represent to help know where to find fossils. Paleontologists can learn what past animals ate, how they moved, and how big they were by studying their fossilized bones.

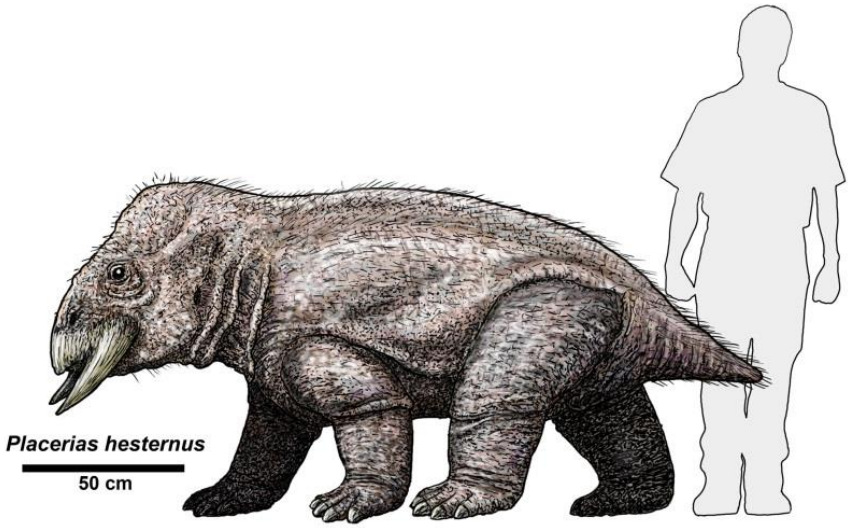
Understanding how animals and plants are put together (anatomy) and how they behave helps paleontologists read the clues from the fossils. By studying the relationships between organisms and their environment, paleontologists become can create pictures of entire ancient ecosystems. Because the past can never be recreated, paleontological resources are considered nonrenewable and are in need of protection and preservation.



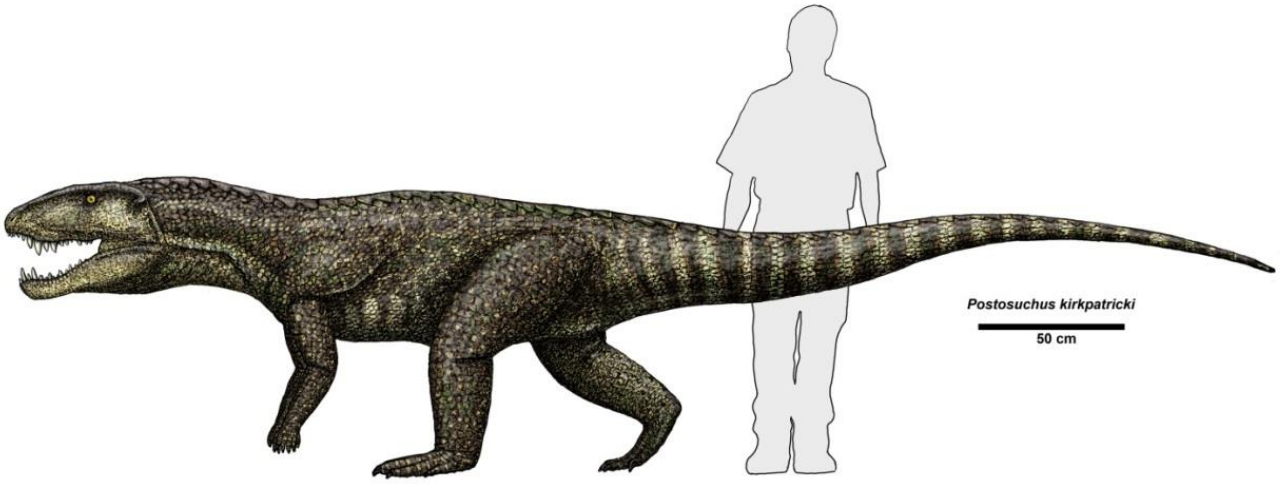
Animals of the Triassic:
Archosauriformes (pronounced Ark-o-sore-eh-forms) are a specialized group of reptiles that includes birds and crocodiles. In the Triassic, aetosaurs (a-ee-toe-sores), phytosaurs (fye-toe-sores), rauisuchians (raw-eh-su-key-ans), and dinosaurs represented this group.

Metoposaurs (meh-toe-poe-sores) were giant amphibians. A common fossilized animal found in the lower portion of the park is the large flat-headed amphibian *Koskinonodon perfectus (*kosk-in-on-o-don per-fect-us). It was 10 feet (3 m) long and weighing up to 1,000 pounds. These animals were predators,

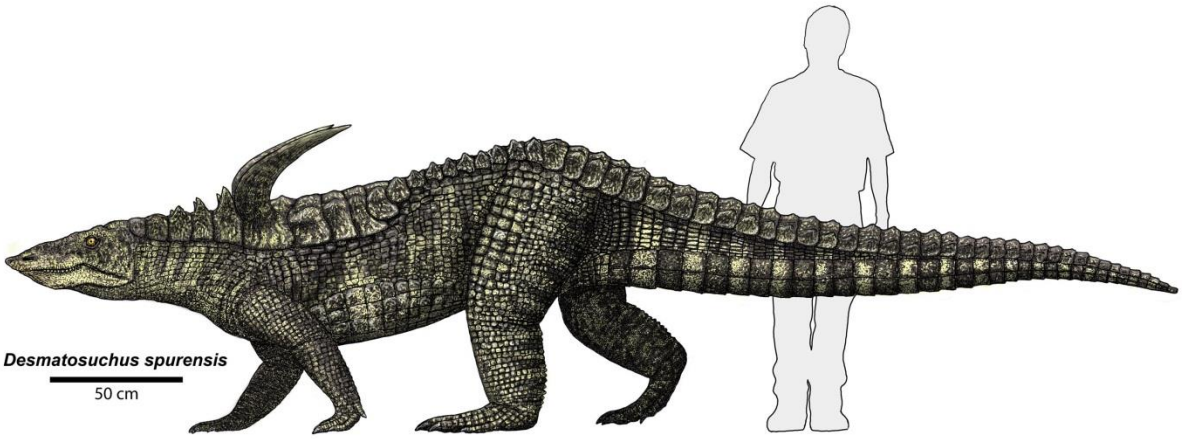
mostly likely with a large appetite. They would have fed on fish and smaller animals. With their flat heads and eyes on top of their head, *Koskinonodon* probably settled in the muddy bottom of ponds and attacked prey from below. Their teeth are cone shaped and pointed.



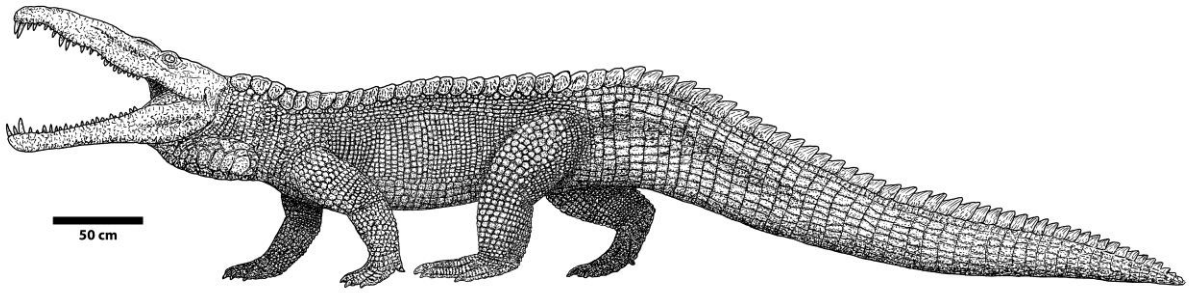
Therapsids (Thair-app-sids) were large reptiles that had some mammal like features such as a "cheek" bone, enlarged canine teeth, pelvis, and a specialized attachment of the skull to the spine. *Placerias hesternus* (pla-seer-ee-us) was a massive plant eater. It was up to 9 feet (2.7 m) long and might have weighed as much as 4,000 pounds. Placerias had a short neck, barrel-shaped body, small tail, and a beak-like skull with large tusk-like bones sticking out from its upper jaw. The beak-like jaws helped it pull up and tear plants and roots. Not many fossils of this animal are found inside the park. It is commonly found near the town of St. Johns, located southeast of the park, where many skeletons were found in one small area.



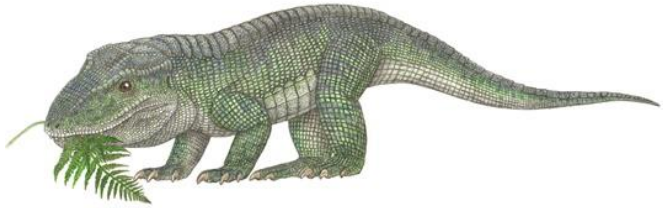
Rauisuchians (raw-eh-su-key-ans) were the top land dwelling predators of the Late Triassic. They had huge skulls and powerful biting jaws with 3 inch (7.6 cm) long serrated teeth. Species of rauisuchians found in the park include *Postosuchus kirkpatricki* and *Poposaurus gracilis*. Some rauisuchians could grow up to 20 feet (6 m) in length.



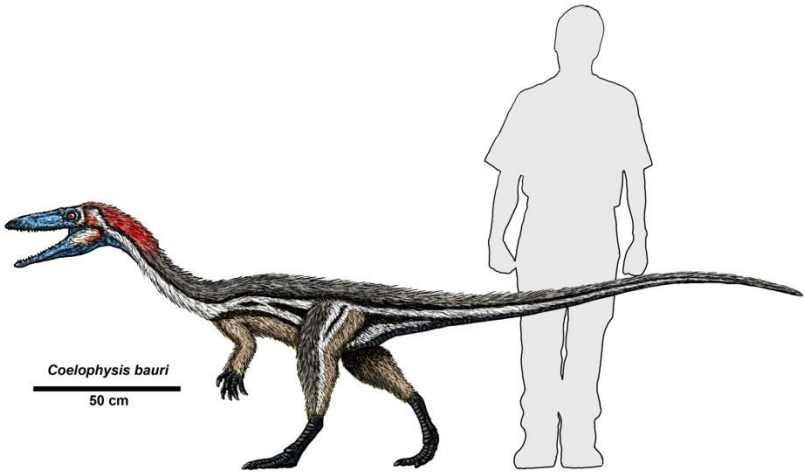
Aetosaurs (a-ee-toe-sores) were 3-18 feet (1-6m) long, plant eating reptiles with broad flat bodies protected by plate-like armor. Some species had large spikes on their sides or back that were possibly used for defense. Aetosaurs had short limbs and small skulls with a pig-like snout for digging out plants and roots from the ground. Three species of aetosaurs have been found in Petrified Forest National Park.



Phytosaurs (fie-toe-sores) were crocodile-like reptiles. Some species were possibly bigger than 20 feet (6.1 meters) long. Phytosaurs are distantly related to crocodiles and probably filled similar roles in their environment. They were predators with very large pointed teeth. They likely ate fish and any other animals that came too near to the river. Phytosaurs are the most common fossil animal found in the park. The species pictured above is *Smilosuchus gregorii*.



Revuetosaurus callenderi (rev-welt-o-sore-us) was a 3foot (1 m) long, plant eating reptile that was a bit of a mystery until more fossils were found in the park. At first it was only known from distinctive leaf-shaped teeth and was thought to be an early plant eating dinosaur. In 2004 hundreds of fossil bones from this animal were found in Petrified Forest. They showed that it was not a dinosaur but instead more closely related to other Triassic reptiles like Aetosaurs and Rauisuchians.



Dinosaurs- Most visitors to Petrified Forest are surprised to learn that paleontologists do not find dinosaur fossils very often in Triassic sediments. Dinosaurs are just a small part of the Triassic animals preserved at the park. They are different from the other animals in the archosaur group by the shape of their pelvis and ankle bones. Late Triassic dinosaurs were small, meat eating predators that walked on two legs. The example pictured above is *Coelophysis* (sealo-fie-sis). It was about 8 feet (2.4 m) long and could weigh 50 pounds (23 kg). It had small sharp pointed teeth.

Animal Adaptations
Below is a pictorial review of the differences between carnivore and herbivore teeth.
For information on skull morphology click here, and for information on homologous versus analogous traits, click here.

Fox skull: from a typical carnivore (meat-eater)

Carnivores generally have long, sharp front teeth which help them catch and tear into their prey. The back teeth are narrow and sharply serrated, much like the blade of a knife. They are used to cut meat into smaller chunks. **Insectivores** (like moles) eat insects almost exclusively, and have fine, needle-like teeth.

Squirrel jaw: from a typical herbivore (plant-eater)

Herbivores have broad, flat molars (back teeth) with rough surfaces, which are used for grinding up tough plant tissues. Many herbivores (like squirrels) have chisel-like front teeth used for gnawing through wood or hard seeds. These teeth grow continually to avoid being worn down with use. Herbivores often have a gap between the front and back teeth to allow space for repositioning plant tissue as it's chewed, since much chewing is required to break it up.

Omnivores (such as humans) eat both plants and animals, and have broad, flat molars for grinding up a variety of foods. The front teeth are wide, narrow at the tips, and somewhat chisel-shaped, making them useful for biting off chunks of meat or plant material.

http://www.nku.edu/~whitsonma/Bio120LSite/Bio120LReviews/Bio120LAnimalRev.html

Pre-visit Lesson Story Worksheet **Student Name_____**

Use the background reading to help you fill in the blanks of the story below.

Long, long ago and far, far away there was a hot and humid subtropical forest. We now call this time the Late Triassic, and we call the land Pangea. The plants and animals in the Late Triassic lived over _____ years ago. Giant _____ were crocodile-like reptiles that could grow up to 20 feet long! This sub-tropical environment existed for about 20 million years. Many different kinds of plants and animals existed and went extinct during this time. We know all this because of a science that investigates evidence of ancient life and how organisms have changed through time called _____. Even though it takes a very long time for fossils to form, Phytosaurs living at the end of the Triassic could have discovered fossils of their extinct phytosaur relatives.

These ancient creatures also had no idea that future scientists called _____ would study the physical structures and processes of the Earth to describe the large river system that existed here. The many layers of rocks created by the river form a geologic structure now called the _____ Formation. Each layer is a little different with sandstones, mudstones, claystones, conglomerates, and volcanic ash.

The river system also consisted of smaller streams, ponds, and even swampy areas. Many fossils found in Petrified Forest provide evidence for other animals, such as the giant amphibian _____, that lived in these watery habitats. Dinosaur fossils are rare in Petrified Forest but one example is _____ a small meat eating animal with sharp pointy teeth.

Post-visit Lesson

Time Required – 30 minutes

Goals:

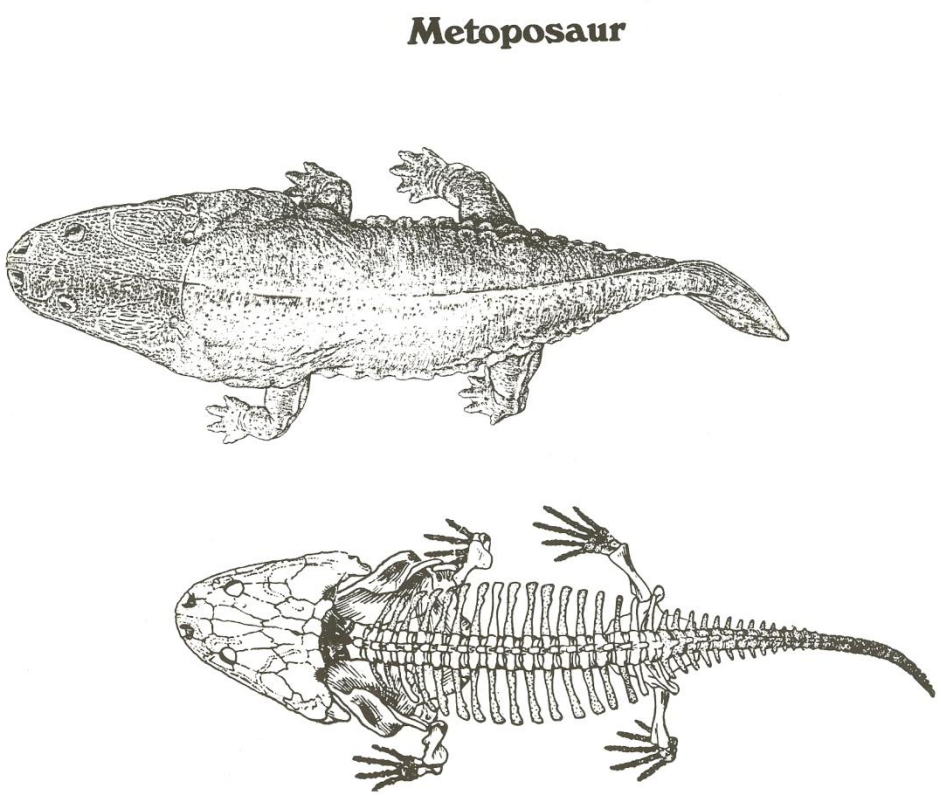
- Recognize basic animal anatomy from fossil bones
- Recognize that paleontological resources are nonrenewable
- Describe at least one thing they learned about Petrified Forest National Park and/or the National Park Service.

Materials:

- Triassic reptile anatomy worksheets

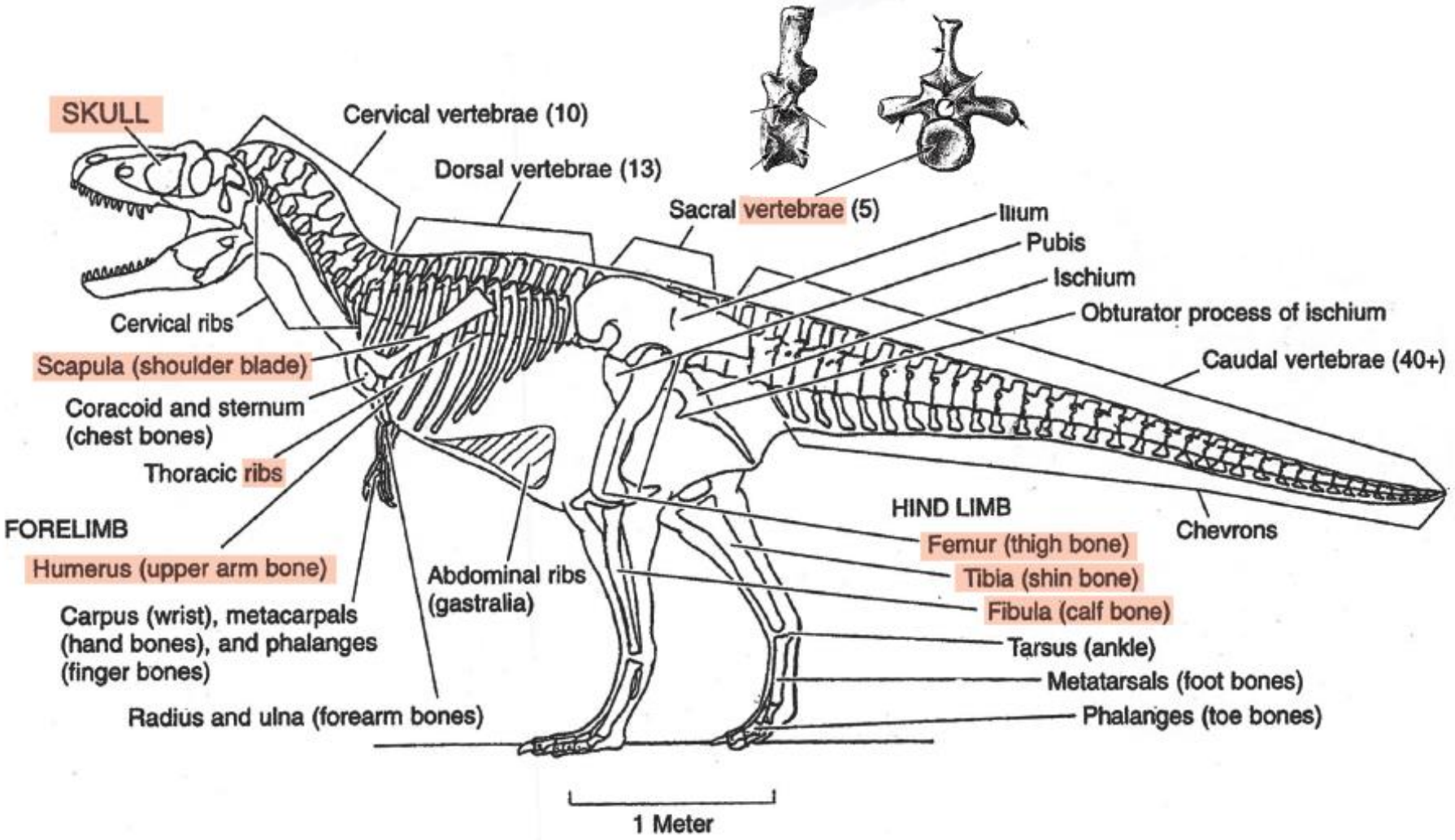
Procedure:

- Students use the skills and knowledge learned from the in-park program to compete the Triassic Anatomy worksheets.

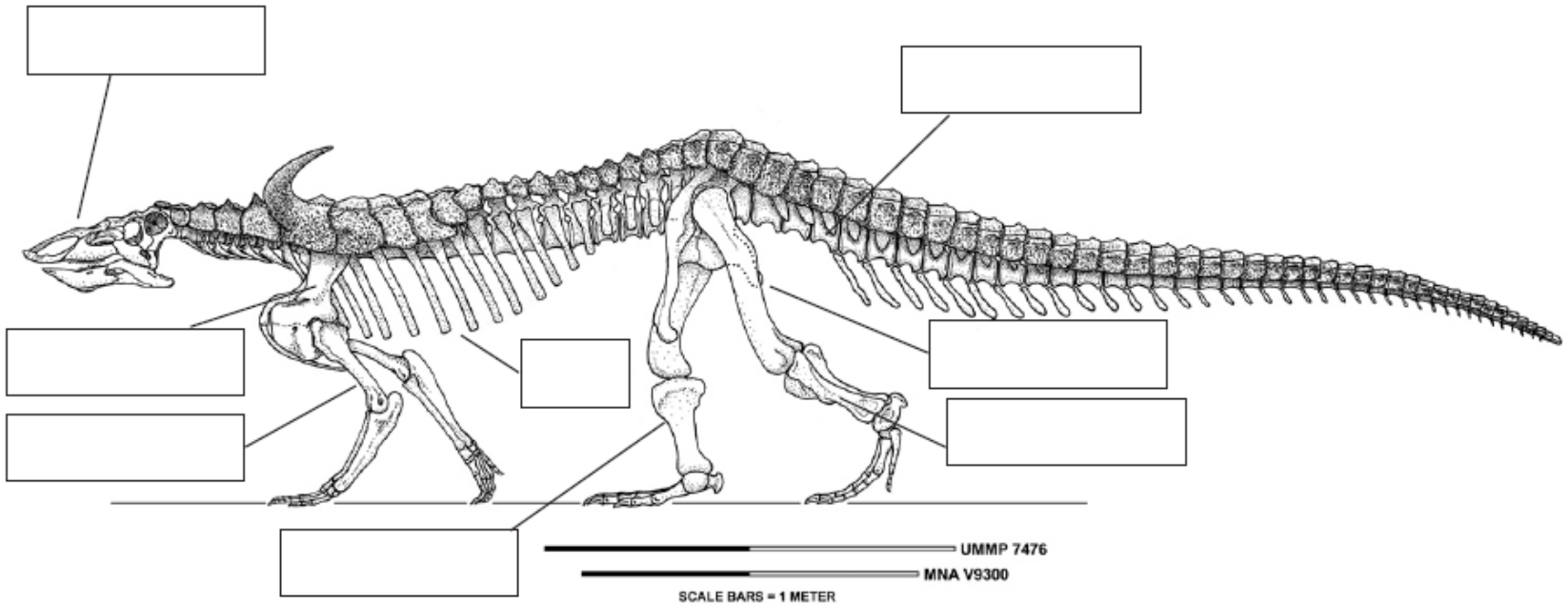


All vertebrate animals (animals with a spine) have the same pattern of bones in their skeletons. Paleontologists learn this pattern in order to recognize the fossilized bones that they discover.

Use the highlighted terms below as a guide to label the bones for the skeleton on the next page. It will also help to think about where these bones are located on your own body.



In the boxes provided label the bones on this Aetosaur, *Desmatosuchus spurensis*. These kinds of bones are also in your body!

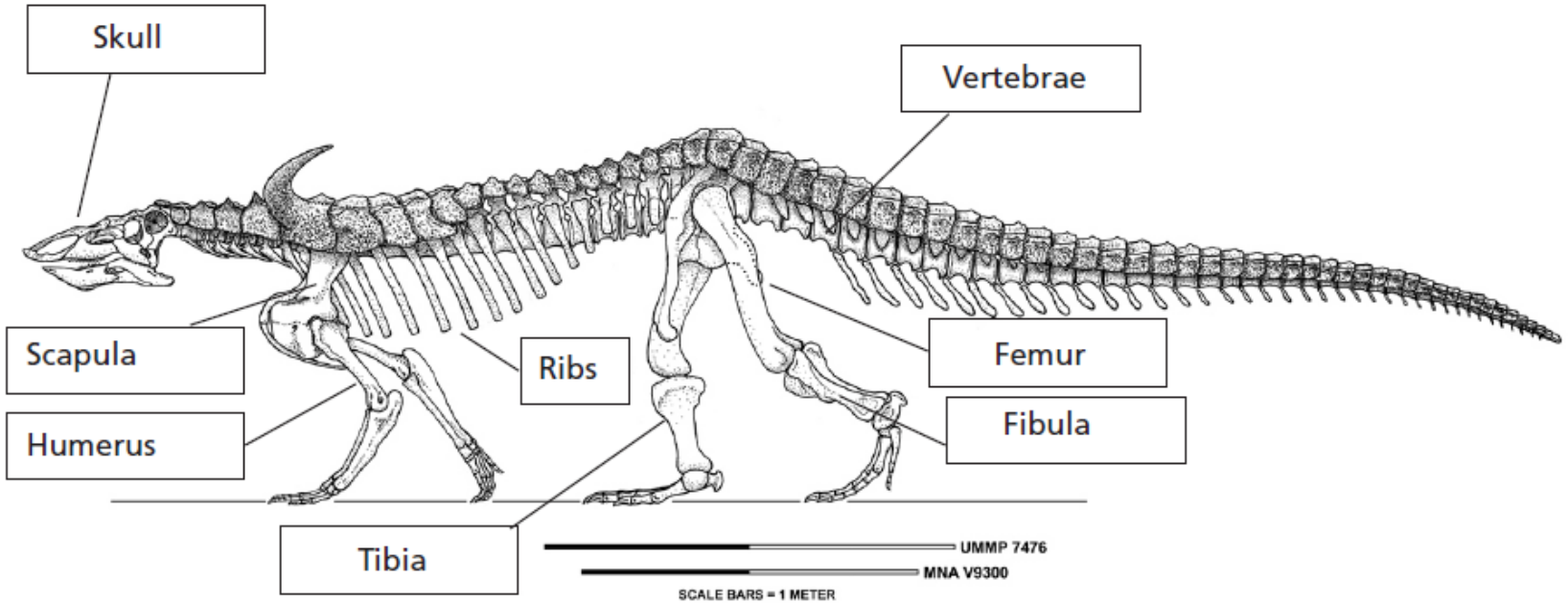


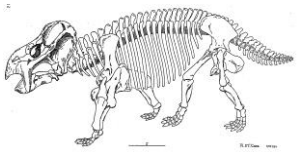
1. What are two facts you know about Petrified Forest or the National Park Service?

2. What is a fossil? Give an example of a fossil found at Petrified Forest National Park.

3. National parks were created to protect natural and cultural resources for future generations. Can you explain why this is important?

Answer Key


Skull
Vertebrae
Scapula
Ribs
Femur
Humerus
Fibula
Tibia
UMMP 7476
MNA V9300
SCALE BARS = 1 METER



Museum Detectives at Petrified Forest National Park

Making observations and looking for clues is an important part of doing paleontology (the study of ancient life). With your group or partner, look closely at your fossil. Try to match it with one of the fossils on display in an exhibit. Answer the questions below and be ready to share what you have learned with your classmates and the ranger.

1. What part of the animal's body is your fossil? (leg bone, skull, etc.)

2. What is the name of your animal and where did it live? (land or water?)

3. What kind of animal is it and what did it eat? (reptile, dinosaur, amphibian?)

4. What part of the body can be used to determine what this animal ate?

5. What is one other thing you learned or observed about your fossil?

Names: _____ and _____