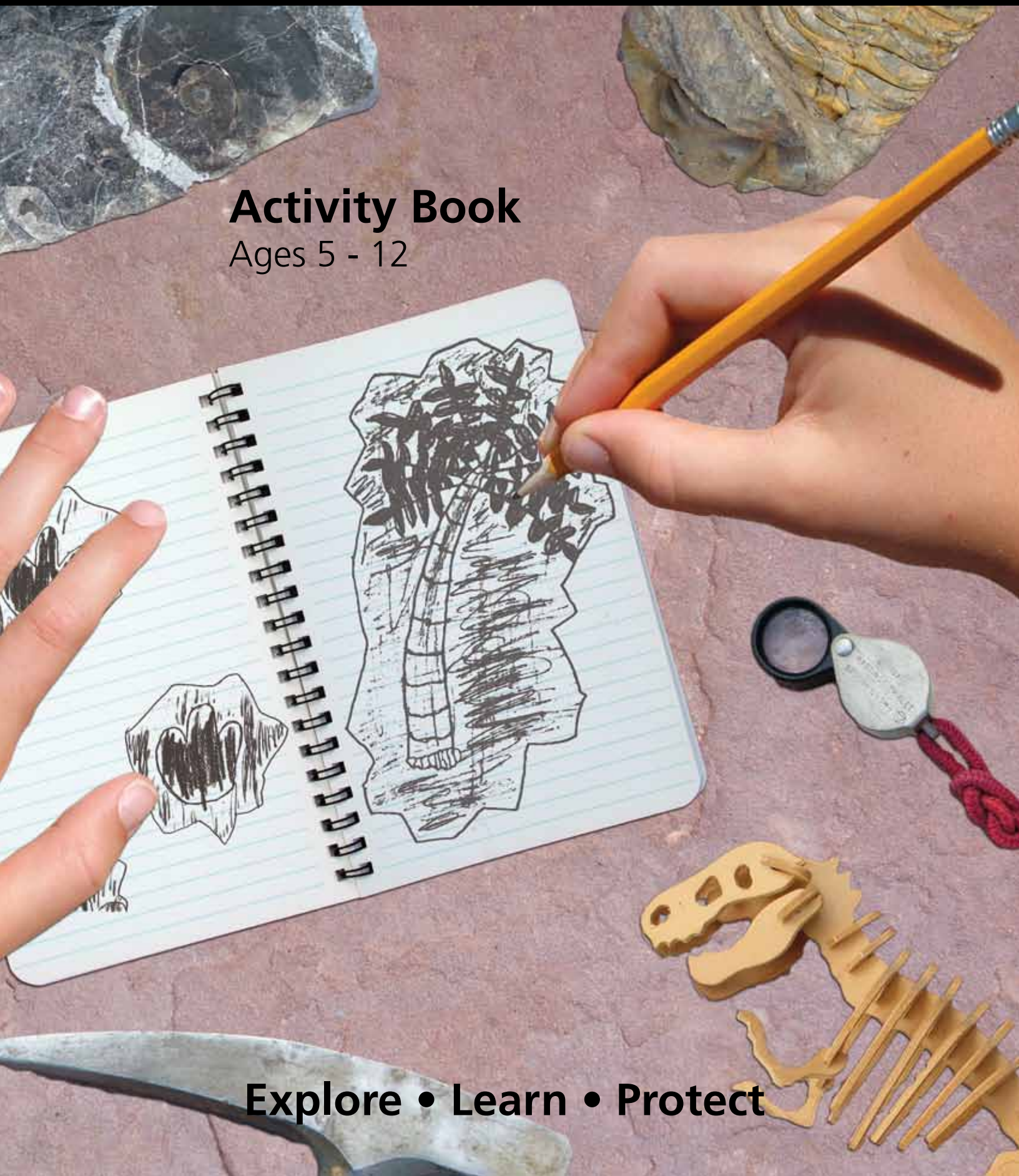
National Park Service
U.S. Department of Interior

Junior Paleontologist



Activity Book

Ages 5 - 12

Explore • Learn • Protect

Become a Junior Paleontologist

The National Park Service protects natural places and historic sites all across the United States. Today, more than 220 national parks are known to preserve fossils!

There are many places to see and discover these fossils in person.

In this book you can learn about ancient life, complete fun activities, and explore just some of the national parks that offer you a look into the past.

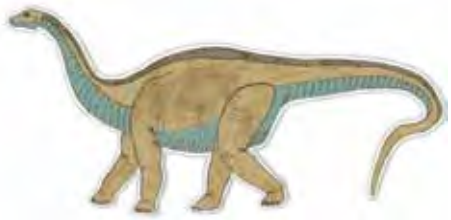
EXPLORE the ways that paleontologists work, and the methods and tools they use to understand ancient life.

LEARN about Earth's history, ancient plants and animals, and changes to past climate and environments.

PROTECT our national parks, including fossils and the rocks in which they are found.

Activities in this book are marked with an age indicator. Look for the symbols below:

TRILOBITE
Ages 5 and up.



SAUROPOD
Ages 8 and up.

SABER-TOOTH CAT
Ages 10 and up.

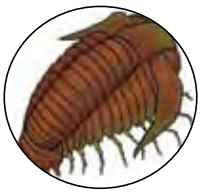
How old are you? _____ That is the number of activities you must complete to become a Junior Paleontologist. Feel free to complete more activities if you have the time.

Paleo-Park Passport

More than 220 national park areas preserve fossils. Some of these parks were created specifically because of the fossils. Use this page to collect cancellation stamps from fossil parks you visit.

Agate Fossil Beds National Monument, NE
Bering Land Bridge National Preserve, AK
Big Bend National Park, TX
Channel Islands National Park, CA
Death Valley National Park, CA & NV
Dinosaur National Monument, UT & CO
Florissant Fossils Beds National Monument, CO
Fossil Butte National Monument, WY
Glacier National Park, MT
Grand Canyon National Park, AZ
Hagerman Fossil Beds National Monument, ID
John Day Fossil Beds National Monument, OR
Joshua Tree National Park, CA
Mammoth Cave National Park, KY
Petrified Forest National Park, AZ
Yukon-Charley Rivers National Preserve, AK
Zion National Park, UT

Road to Fossilization (#1)



It takes a lot of luck and good timing to become a fossil. Big creatures with hard parts (bones and shells) that die where sediment is collecting have the best chance at preservation. Fragile or small things are rarer fossils.

Follow the Road to Fossilization and discover more about how fossils form.

To Play: Use something small like a dime or small candy as your game piece and place it on start.

With a partner, take turns flipping a coin to move your game piece: heads you move two spaces, tails you move three spaces.

Follow the instructions on the purple spaces along the way. The first player to discover the fossil wins!

Fossils are rare and cannot be replaced. It is exciting to find one, but important to protect it and keep it in place.

If you find a fossil in a national park, leave the fossil where it is and share your discovery with a park ranger.

Remains of the organism are turned slowly to stone over time.

MOVE AHEAD 1 SPACE

Erosion of rocks exposes fossils, but bones are damaged.

MOVE BACK 1 SPACE

Paleontologist makes a bad map of the fossil site.

MOVE BACK 3 SPACES

Paleontologists are very important in national parks. They help the National Park Service protect fossils by finding them and teaching visitors to protect them.

DISCOVERED!

Fossil Hunters (#2)

A paleontologist uses fossils to understand the story of Earth's history. This story includes the plants and animals that once lived on Earth. Evidence of this past life is found by paleontologists within sedimentary rocks. These rocks are made of the broken pieces of other rocks called sediment that have become compacted or cemented together over time.

Sediment can be clay, sand, or gravel. Rocks can form on land or in water. An ancient beach might leave behind sand which forms into sandstone. Ocean sediments could develop into marine shale made of clay, or limestone from broken down shells. If the remains of an animal or plant, like bones or leaves, are covered by sediments, a fossil may become preserved in the rock formed from these sediments.

Now it is your turn to hunt for fossil-bearing rocks and the stories they hold!

Find the underlined words in the text above in the word search. Words may go up, down, or diagonally.

When you finish, **write down the unused letters** in order in the spaces below to reveal a hidden message!

b	p	i	g	o	b	o	n	e	s
s	a	n	d	s	t	o	n	e	r
s	l	m	a	e	l	c	l	a	j
u	e	n	i	d	o	r	l	m	p
f	o	s	s	i	l	s	i	a	a
l	n	e	o	m	n	t	m	r	y
a	t	i	m	e	s	o	e	i	l
n	o	s	o	n	h	g	s	n	i
c	l	s	h	t	e	r	t	e	t
i	o	w	i	a	l	l	o	l	f
e	g	i	n	r	l	d	n	c	t
n	i	h	e	y	s	e	e	m	k
t	s	a	n	i	m	a	l	s	a
l	t	l	p	l	a	n	t	s	!

"____ __ _____, __ _____

_____

_____ _____ _____ _____"

Fossil Types (#3)

Did you know that footprints made by an ancient animal or the imprint of a leaf can be considered a fossil? Fossils are evidence of life preserved within a geologic context. Paleontologists study both the fossil and the rocks that they are preserved in to understand past life forms and the environment in which they lived.

Write the letter of each picture in the box of the fossil type it represents.

Vertebrate Fossils

Animals with backbones (vertebrae) are known as vertebrates. Mammal, fish, and dinosaur bones or teeth are all examples of vertebrate fossils.

Fossils:_____

Invertebrate Fossils

Animals without backbones are known as invertebrates. Shells and exoskeletons help organisms like clams and corals to be preserved.

Fossils:_____

Plant Fossils

Fossil plant remains include petrified wood, leaves, cones, seeds, pollen, and sometimes even flowers. Amber is tree sap and can preserve other organisms.

Fossils:_____

Trace Fossils

Trace fossils–tracks, burrows, and coprolites (ancient poop!)–are evidence of organisms interacting with their environment.

Fossils:_____

A

B

Hint: A is not a plant fossil.

C

D

E

F

Paleontology vs. Archeology

Fossil shark tooth

PALEONTOLOGISTS and ARCHEOLOGISTS are scientists who dig and study old things from the ground. They both use the same tools and techniques to look for things in sedimentary rocks, but there are some big differences too.

ARCHEOLOGISTS study the remains of human history, culture and civilizations. PALEONTOLOGISTS study the remains of past animals and plants and how they have changed.

Ancient arrowhead

Vertebrate: E
Invertebrate: B, F
Plant: D
Trace: C, F

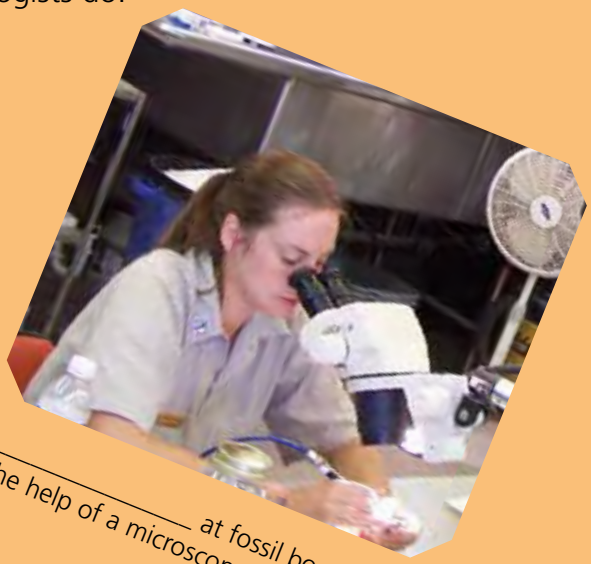
Paleontologist's Scrapbook (#4)

Paleontologists are scientists who study what life was like on Earth a very long time ago. They do this by "reading" fossils and rocks for clues about past environments and life. Look at the pictures below and **fill in the missing word** to find out some of what paleontologists do.

WORD BANK

Applying	Digging
Sealing	Looking
Brushing	

_____ fossil bones in plaster jacket for transport.



_____ at fossil bones with the help of a microscope.

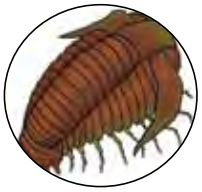
_____ glue to a petrified wood stump in the field.

_____ a jaw bone out of the rock with a rock hammer.

For every hour they spend in the field, paleontologists spend at least three hours in the lab. Imagine that for every hour you spent playing outside you then had three hours of homework!

Imagine yourself as a paleontologist. **Draw** a picture of yourself at work and **write** a caption to describe it.

_____ away sediment from bones inside an opened plaster cast.



The Right Stuff (#5)

Paleontologists use many tools to find and clean fossils.
Draw lines to **match** the images to what they are used for.

Toilet Paper

Dental Picks

Brush

Wipe away sediment from fossils

Move large amounts of sediment

Wrap up fossil material before applying plaster

Pick grains of sediment out of cracks

Break open fossil-bearing rocks

Take notes on fossil collection site

Rock Hammer

Shovel

Notebook

Find the Fossil (#6)

It is not always easy to see fossils in rocks.

Search the pictures below carefully
and **circle** your 9 fossil finds.

The fossils in these pictures are very different from each other. Each lived at a different time and formed in different ways.
More information about fossil types can be found on page 6 of this book.

Geologic Time (#7)

Earth formed 4.6 billion years ago. We can divide that time into smaller sections called eons, eras, and periods. Paleontologists are interested in these different times because each had unique plants and animals.

The colors below represent 4 major divisions of geologic time–the Precambrian, Paleozoic Era, Mesozoic Era, and Cenozoic Era. First, **draw** a line from each picture of a major event to where it would fall on the time line. Then, using the pictures and events as clues, **label** each colored section as one of the following Ages: **Mammals, Fishes, Early Life, or Reptiles**.

25 Thousand years ago: *Smilodon* and other mammals dominate.

220 million years ago: Dinosaurs like *Coelophysis* appear.

500 million years ago: Trilobites and fish dominate the seas.

From 4.6 billion years ago until 542 million years ago was a time period called the Precambrian.

If we made this timeline to scale the red bar would take up 4 pages!

TODAY

CENOZOIC

65 Million Years Ago
Mass Extinction

MESOZOIC

251 Million Years Ago
Mass Extinction

PALEOZOIC

542 Million Years Ago
Explosion of Diverse Life

PRECAMBRIAN

4.6 Billion Years Ago

125 million years ago: Flowering plants appear.

440 million years ago: Cycads and ferns grow on land.

2 billion years ago: Stromatolite colonies formed in shallow warm waters.

Precambrian: Early Life
Paleozoic: Fishes
Mesozoic: Reptiles
Cenozoic: Mammals

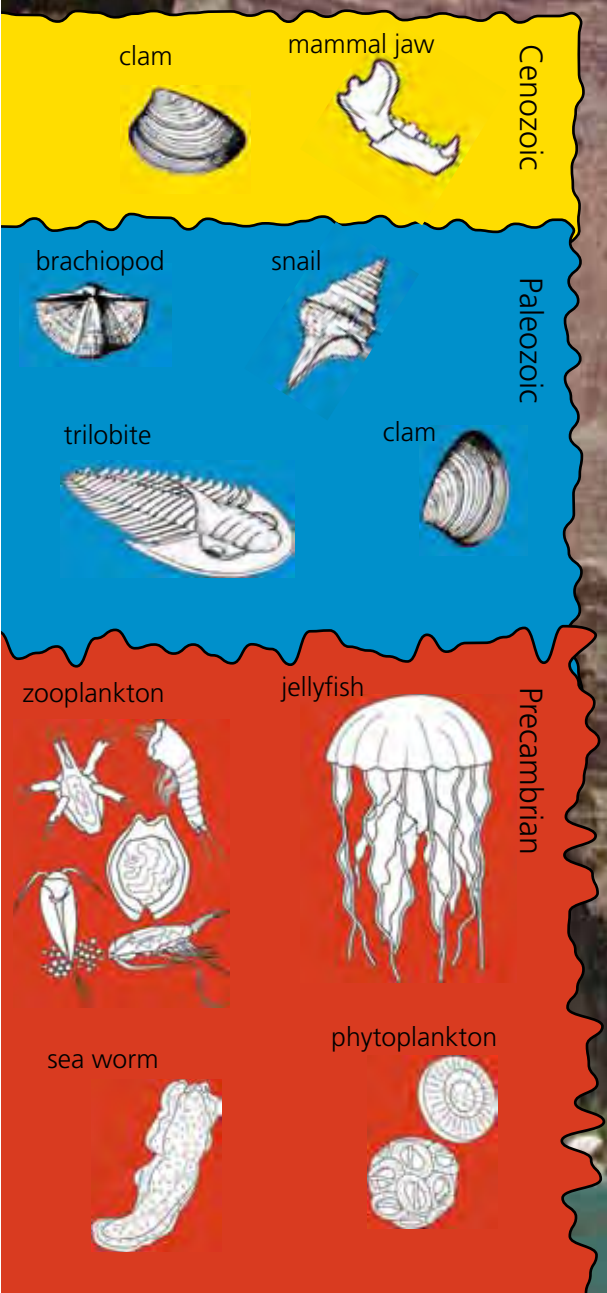
It's All Relative (#8)

At Grand Canyon National Park, Arizona, the rocks form neat layers. You can see their different colors in this picture. These layers can help paleontologists find out the age of a fossil by using relative age dating.

Relative age dating is a way to compare the age of different fossils in a section of rock based upon their position. This gives a general idea of what is older or younger.

To get exact ages, paleontologists use absolute age dating techniques like testing the minerals of volcanic rocks.

Grand Canyon National Park is home to a great collection of Paleozoic fossils. They're hiding in these layers!



RULES OF RELATIVE AGE DATING:
#1: Sediments were originally laid down flat.
#2: The oldest rocks are found on the bottom.
#3: Fossils in the same layer are the same age.

Using the rock column to the left and the rules found above, **compare** the ages of the fossils and **answer** some questions.
(HINT: Use the timeline on page 9 to help you!)

Which is older: the mammal jaw or the sea worm?

Which is older: the trilobite or the jellyfish?

What time period is not shown?

Which organism was around for the most time periods?

Climate Change (#9)

The story of life on Earth began in a time known as the Precambrian. During this time soft-bodied creatures like worms and jellyfish lived in the world's oceans while the land remained barren. Looking at the world today, we can see that things have changed a lot.

In Glacier National Park, Montana, we can learn about climate change from some of the first life forms: ancient plant-like organisms called algae (**al-gee**). Precambrian algae formed large colonies called stromatolites in warm, tropical waters. Over time these colonies were buried under sea sediment and turned to stone.

The landscape also tells us about climate change. When the Rocky Mountains formed, rocks that had been at the bottom of the ocean were folded and pushed up high into the sky while the North American continent moved north. Glaciers carved the landscape creating rugged mountains that we see today and paleontologists find ancient tropical algae under ice and snow!

Modern stromatolites forming near Shark Bay, Australia.

Fossilized stromatolites in Glacier National Park, Montana.

Ranger Talk

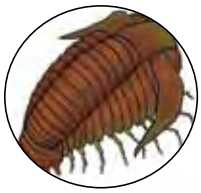
Climate has changed many times in the Earth's history. Many scientists are studying how climate is changing today. Ask a Ranger:

Does this park have any evidence of climate change?

How have plants and animals changed here over time?

Climate change is not a thing of the past. Today, scientists are studying how quickly temperatures and weather patterns are changing on Earth. With over 6 billion people on the planet, humans are affecting the climate.

Buried Treasures (#10)



You can trace the transition from Precambrian life to more complex creatures in Yukon-Charley Rivers National Preserve in Alaska. This park protects one of the best continuous records of ancient life in the world – from 800 million to 40 million years ago.

Fossils found there include everything from Precambrian sea creatures like jellyfish and worms to Pleistocene pollen from land plants that lived in the area tens of thousands of years ago.

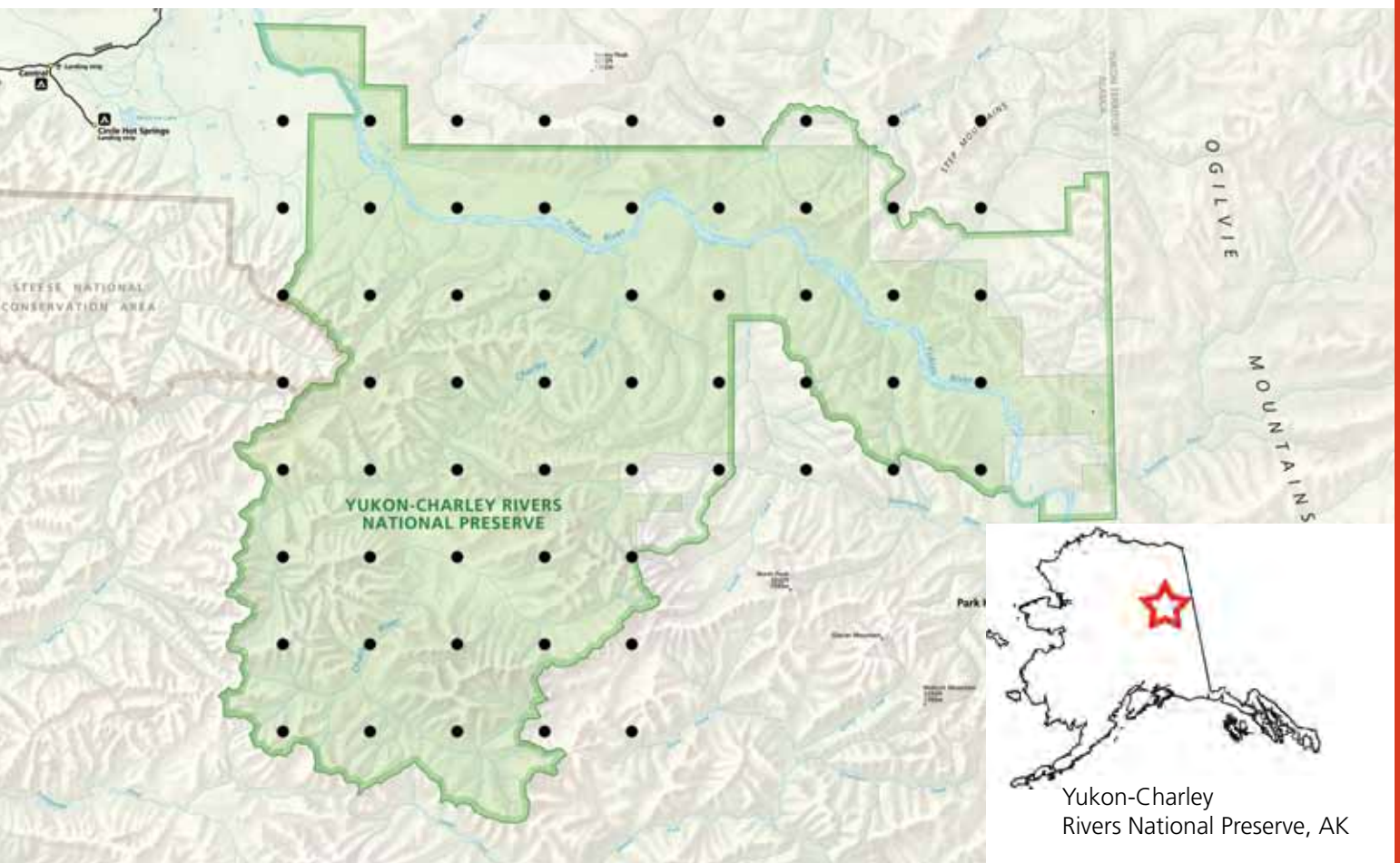
The fossils found within the preserve are not the only treasures. Gold mines were active through the 1930s, with the last mine closing in 1977. Creating this national preserve has saved these fossils for study and discovery.

You can practice stewardship–protecting natural areas–by helping to preserve Yukon-Charley Rivers in this game.

Follow the directions to save squares of land one at a time.

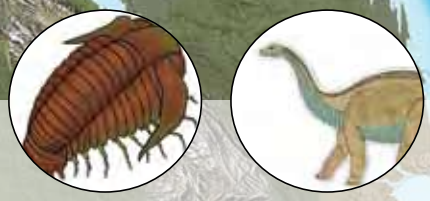
Citizens concerned with protecting a natural or historic area may work to get that place designated as a national park. What else can you do to protect important areas around you?

To Play: Take turns connecting 2 dots with a solid line. When a player's line makes a square, that player puts initials the square and takes another turn. The player with the most squares wins!



Yukon-Charley Rivers National Preserve, AK

Wet and Wild (#11)



The Paleozoic began with a huge change in life called the Cambrian Explosion. Many never-before-seen creatures with shells and new body designs are found in rocks from this time period. The late Paleozoic Era is known as the Age of the Fishes because the first fish appeared and rapidly evolved during this time period.

Read the bubbles of information to find out more about the Paleozoic era and answer the **questions.**

North America looked very different during this time. It was near the equator with water covering much of today's dry land.

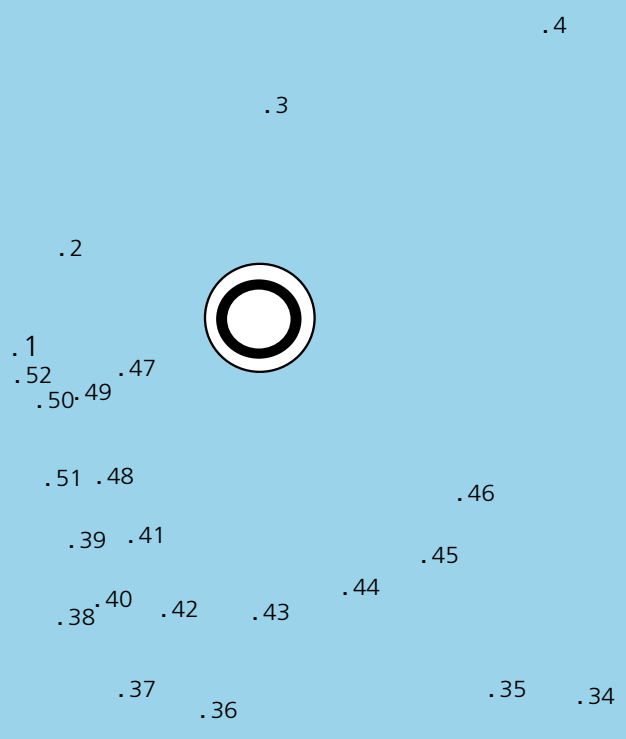
Would your hometown have been dry during this time?

United States during the late Paleozoic Era, 400 million years ago.

Plants began to take root on land, with ferns and conifers providing food to land animals.

How are these plants different than those near your home?

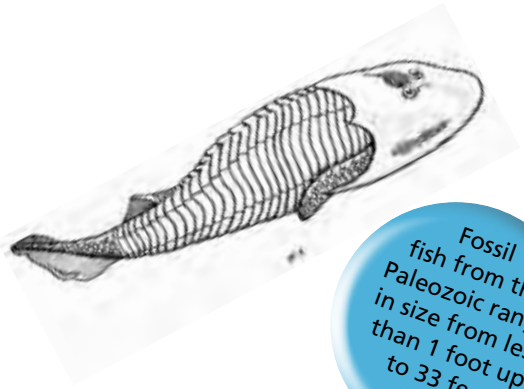
Connect the dots to see a Paleozoic Era fish called a placoderm.



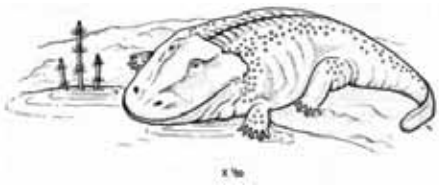
Mammoth Cave National Park, Kentucky, formed out of Paleozoic limestone. This limestone eroded as water flowed through and created magnificent caves.

Other sea life, like the trilobites, also thrived in the Paleozoic waters. Trilobites were marine arthropods, meaning they are distantly related to shrimp, lobsters, and crabs!

What do you think a trilobite felt like?



Fossil fish from the Paleozoic range in size from less than 1 foot up to 33 feet long.



Fish-like creatures moved onto land, using strong fins to move about the shores.

Some fish, called placoderms, had hard armor and sharp jaws making them fierce predators of the Paleozoic seas.

What animals today live part of their lives in the water and part on land?

.15 .16 .14 .17 .18 .7 .8 .9 .5 .6 .10 .13 .11 .12 .19 .20 .21 .22 .23 .24 .25 .27 .26 .28 .29 .33 .30 .31 .32

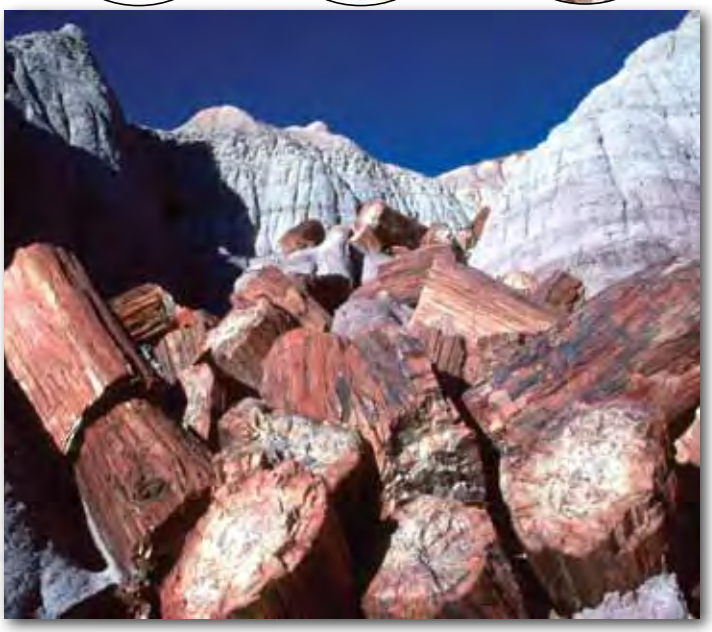
At the end of the Paleozoic, a huge extinction event changed life on the planet once again. 70% of all land organisms and 95% of all marine species became extinct at that time.

A-maze-ing Finds (#12)

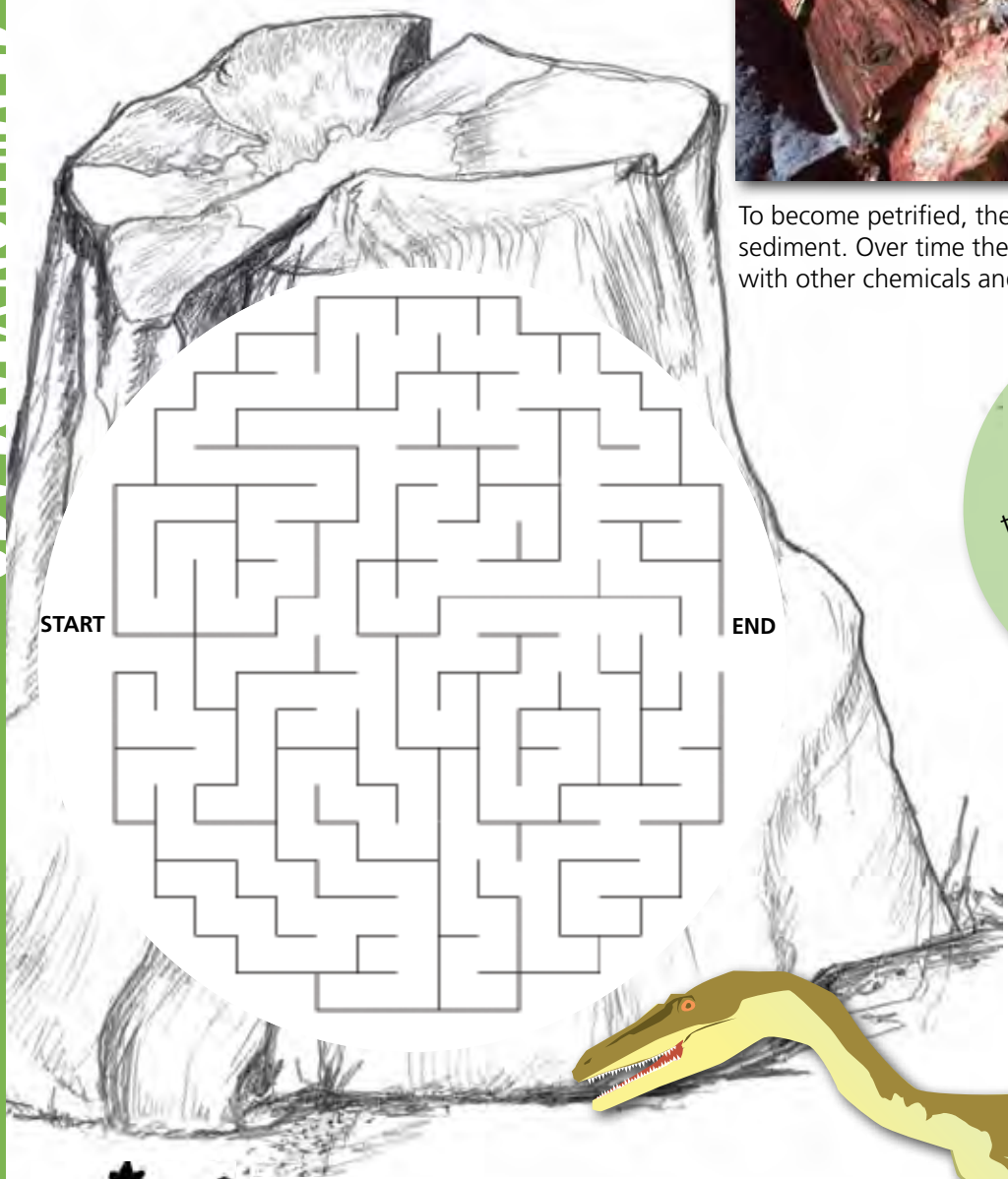
The Mesozoic Era began with recovery from the Permian Extinction. During the Triassic Period, reptiles started taking over many environments including the hot, forested environments of North America.

Today, you can imagine the 250 foot tall trees that lived here by visiting the fossilized trees of Petrified Forest National Park, Arizona.

Complete the maze to find your way through the petrified tree stump.

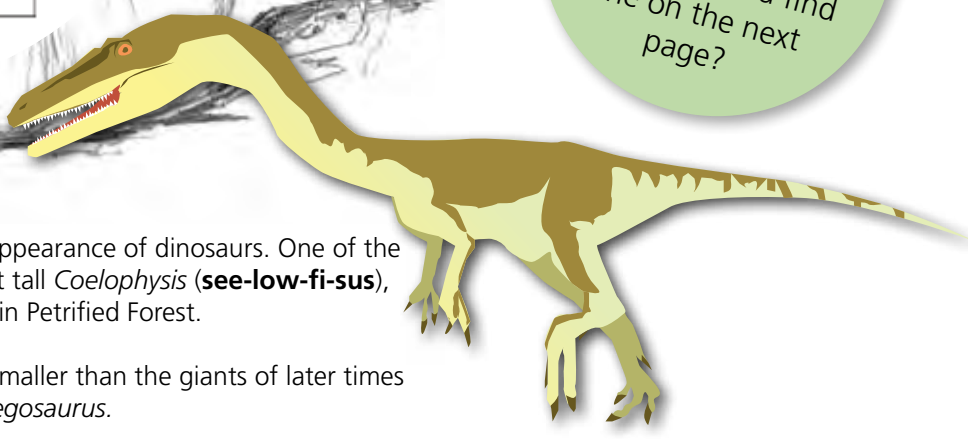


To become petrified, the trees above were covered in wet sediment. Over time the chemicals in the trees were replaced with other chemicals and the wood turned to stone.



Grass and flowering plants did not appear until the end of the Mesozoic Era, about 120 million years ago. Until then ferns, cycads, and conifers dominated.

Cycads have tough, scaley bark on their trunks and bright cones. Can you find one on the next page?



The Triassic marks the first appearance of dinosaurs. One of the earliest dinosaurs, the 4 foot tall *Coelophysis* (**see-low-fi-sus**), lived among the giant trees in Petrified Forest.

Early dinosaurs were often smaller than the giants of later times like *Tyrannosaurus rex* or *Stegosaurus.*

The Real Jurassic Park (#13)

Dinosaur National Monument, Utah and Colorado preserves an amazing record of Jurassic fossils including dinosaur bones and fossilized clams. Dinosaurs, just like living things today, were specially suited for their environments. Plant-eating *Diplodocus* and meat-eating *Allosaurus* both had to find food and shelter in the environments of the time.

Imagine what the Jurassic forest of conifers, ferns, and cycads would offer to a dinosaur that lived there. **Draw** your Jurassic creature below.

Everything is Bigger in Texas (#14)

Giants ruled the late Mesozoic Era. Paleontologists have found the remains of dinosaurs, flying reptiles called pterosaurs, and others in the Cretaceous rocks of Big Bend National Park, Texas. These enormous creatures (some bigger than blue whales!) dominated the land for millions of years before they became extinct at the end of the Cretaceous Period, about 120 million years ago.

Compare yourself to these giant creatures and find out how big they really were! **Fill in** your height and **answer the questions.**

Could you have fit inside the mouth of a hungry *Deinosuchus*? Could your parents?

_____

How many people your height could lay down for a ride on the wings of *Quetzacoatlus*?

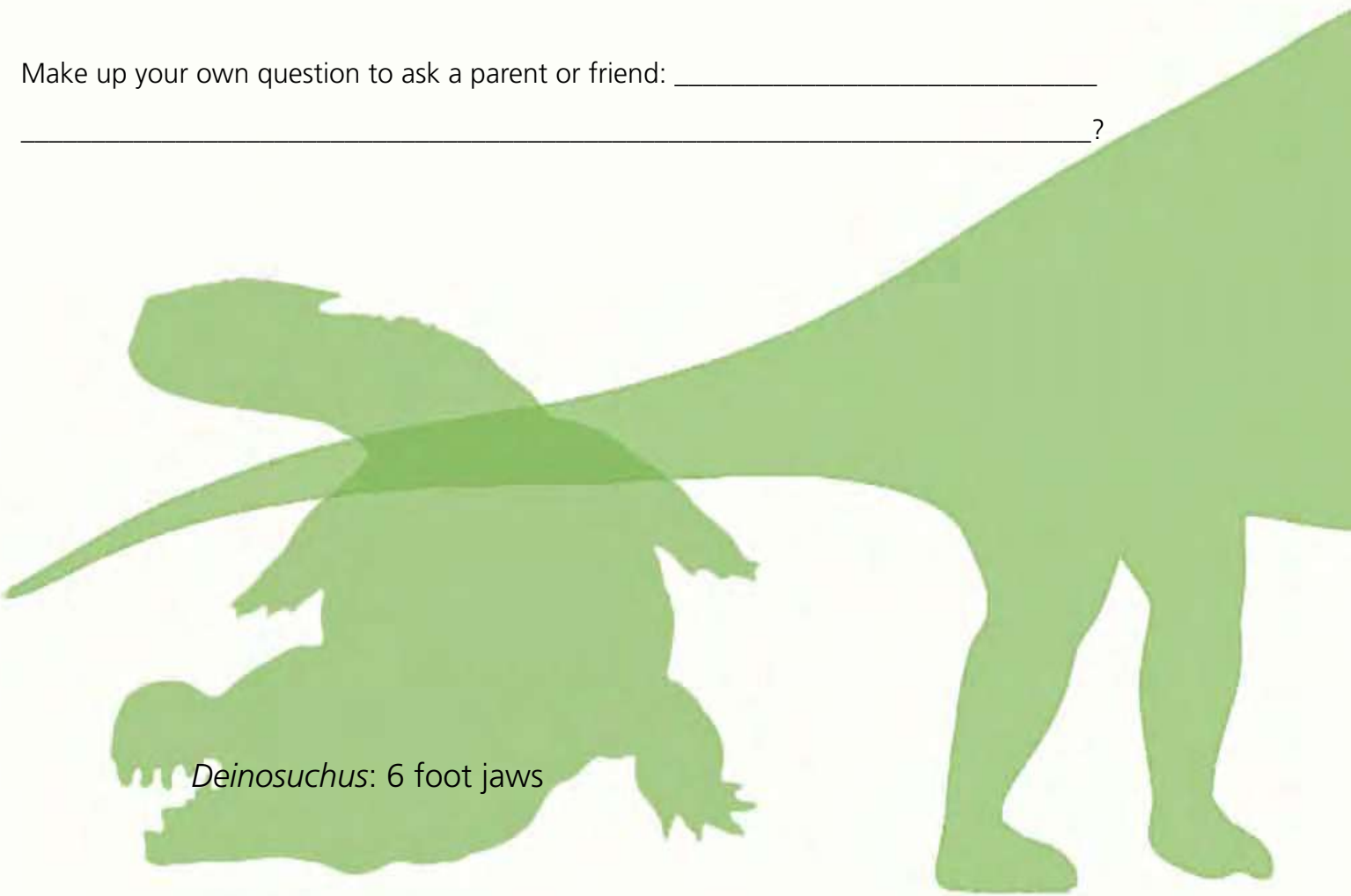
_____

How many feet longer is the *Alamosaurus* than you are tall?

_____

Make up your own question to ask a parent or friend: _____

_____?



Deinosuchus: 6 foot jaws

Quetzacoatlus: 40 foot wingspan

Big Bend National Park also preserves evidence of the Cretaceous-Tertiary (K-T) boundary. This is the layer which separates the Mesozoic Era from the Cenozoic Era and contains evidence of a large impact thought to be one of the causes of dinosaur extinction.

Alamosaurus: 100 feet long

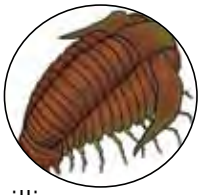
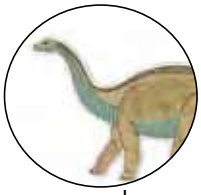
What's in a name?

Deinosuchus (**di-no-soo-kuss**) means terrible crocodile.

Quetzacoatlus (**ket-za-co-ot-lus**) was named for the Aztec feathered serpent god Quetzalcoatl.

Alamosaurus (**al-uh-mo-sore-us**) was not named for the famous Texas landmark, but for the rock formation in which the bones were first found (Ojo Alamo formation, New Mexico).

You: _____ feet tall

Cenozoic Round-Up (#15)

With the extinction of dinosaurs and giant reptiles 65 million years ago, mammals were able to diversify and grow in numbers. Evidence of these recent wild creatures is well represented in the fossil record. Some look like animals alive today.

Guess the ***modern relatives*** of each animal and write them on the cards. Then **answer the questions** below.

CARNIVORES

SCIENTIFIC NAME: *Smilodon*
AGE: 1.8 Million - 10 Thousand Years
HEIGHT: 4 foot **LENGTH:** 7 foot
DIET: bison, deer, horses, ground sloths
FUN FACT: This giant predator's teeth could grow to almost 1 foot in length!
PARK: Valley Forge NHP, Pennsylvania
MODERN RELATIVES:

SCAVENGERS

SCIENTIFIC NAME: *Archaeotherium*
AGE: 30 - 40 Million Years
HEIGHT: 4 feet **LENGTH:** 5 feet
DIET: Remains of dead animals, plants
FUN FACT: His nickname is "Big Pig."
PARK: Badlands NP, South Dakota
MODERN RELATIVES:

CARNIVORES

SCIENTIFIC NAME: *Miacis*
AGE: 60 - 55 Million Years
HEIGHT: 6 inches **LENGTH:** 1 foot
DIET: small birds, reptiles, and mammals
FUN FACT: This carnivore lived in trees.
PARK: Fossil Butte NM, Wyoming
MODERN RELATIVES:

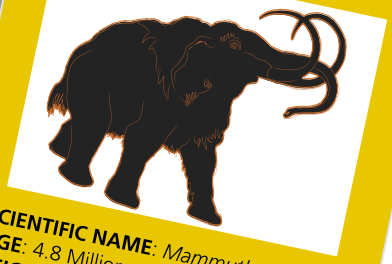
HERBIVORES

SCIENTIFIC NAME: *Glyptodon*
AGE: 2 Million - 10 Thousand Years
HEIGHT: 4 foot **LENGTH:** 6 foot
DIET: Grasses and plants near rivers
FUN FACT: This animal was the size of a small car.
PARK: Not found in a national park yet.
MODERN RELATIVES:

HERBIVORES

SCIENTIFIC NAME: *Mesohippus*
AGE: 30 - 40 Million Years
HEIGHT: 2 feet **LENGTH:** 4 feet
DIET: Grasses, leaves, shrubs
FUN FACT: This animal had three toes instead of hooves.
PARK: Death Valley NP, California
MODERN RELATIVES:

HERBIVORES



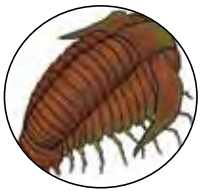
SCIENTIFIC NAME: *Mammuthus*
AGE: 4.8 Million - 5 Thousand Years
HEIGHT: 16 foot **LENGTH:** 8 foot
DIET: Grasses and small shrubs
FUN FACT: Human ancestors lived alongside the Mammoth.
PARK: Bering Land Bridge N PRES, Alaska
MODERN RELATIVES:

If you could choose one of the animals above to be a pet, which would you choose? Why?

Paleontologists name plants and animals based on characteristics such as: what they look like, what they eat, and where they were found. What would you name your new pet?

What could you buy at the grocery store to feed your new pet?

Eye of the Beholder (#16)



Paleontologists find and study fossils, but they often rely on artists to bring ancient creatures to life. By studying fossils and comparing them to living plants or animals artists can create a picture of what the organism might have looked like when it was alive.

Examples of an artist's reconstructions of 52 million year old fish from Fossil Butte National Monument, Wyoming are shown below. **Match** the 2 illustrations to the fossils (blue box) they were based on.

Diplomystus dentatus

Knightia alta

Phareodus encaustus

Knightia eocaena

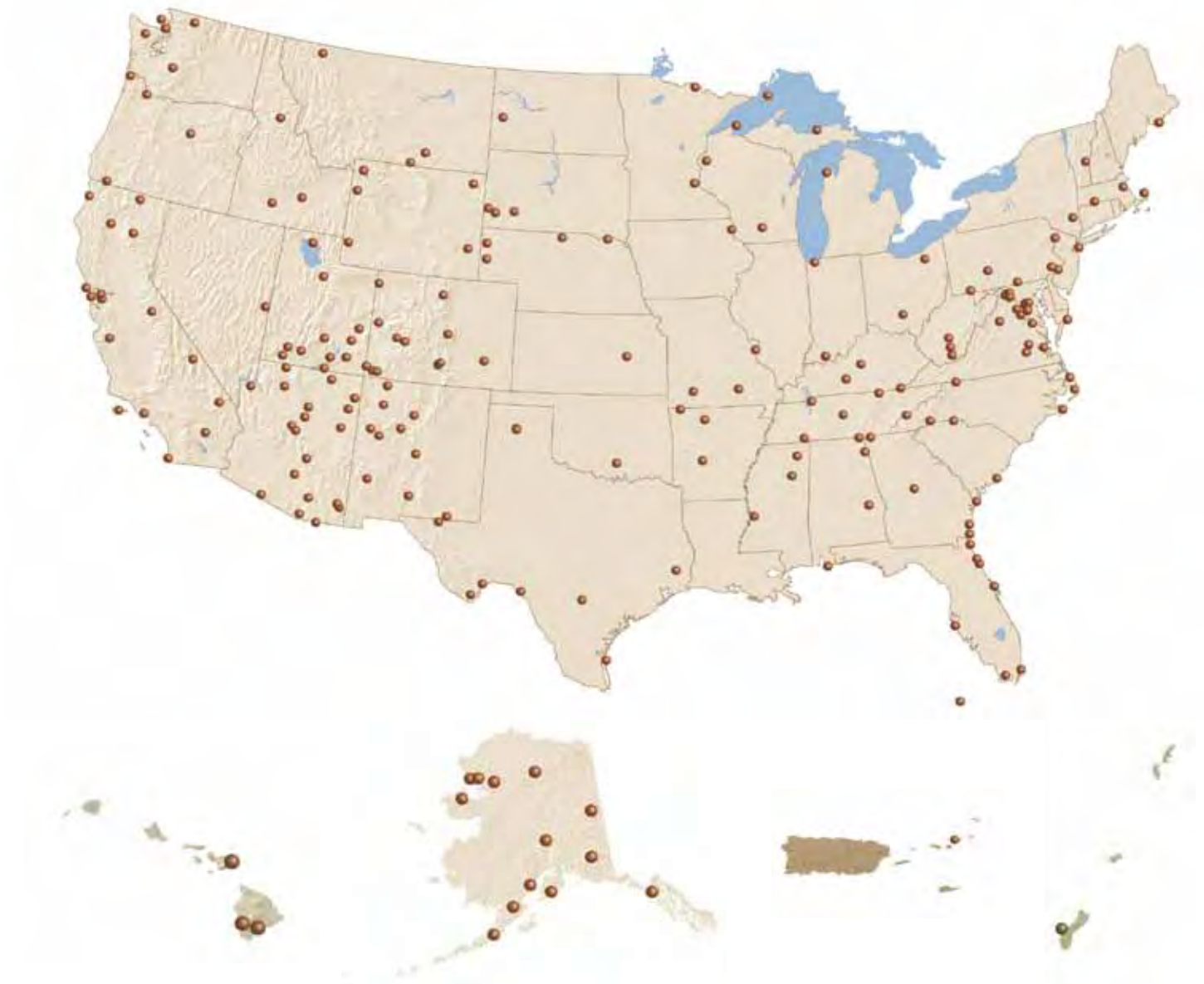
It is unusual for soft-bodied animals to be well preserved. Fish with tough bones and scales have a better chance. Quick burial in calm lake waters preserved amazing complete fish skeletons.

Now it is your turn! **Draw** what you think the Cenozoic fish below would have looked like during its life. **Imagine** what colors or patterns its scales might have had.

Crossopholis magnicaudatus

Fossil Nation

What kind of fossils might you find where you live? Here is a map of parks that preserve fossils across the United States. How many are in your home state? You can find out more about parks near you at http://www.nps.gov.



The map above shows more than 220 parks that preserve fossils, but one is missing! In 1922 Fossil Cycad National Monument was established in South Dakota. This monument preserved one of the largest deposits of Cretaceous cycad fossils (palm-like tree), many nearly perfectly preserved. The fossils were so spectacular, in fact, that researchers collected nearly all of the fossils from the monument. Removal of fossil material was so great that the site was withdrawn as a national park unit in 1956.

The National Park Service is much more careful with fossil resources today. With the help of Junior Paleontologists like you we can protect the remaining fossils from disappearing.

State Fossils

Fossils are such a popular resource that many states have chosen a "State Fossil" or "State Dinosaur". Typically, the State Fossil represents a fossil which is well known or common in that state.

Check at your library or on the internet to find your state's special fossil. If your state hasn't chosen one, choose a fossil to represent your state. You can even write a letter to your state legislature and encourage them to adopt your fossil choice as the state fossil!

State:

Fossil:

Where was it found?:

How does it represent your state?

Draw your state fossil below!

National Park Service
U.S. Department of Interior

Content
Krista L. Jankowski

Layout and Design
Krista L. Jankowski
Caroline Marshall Hill

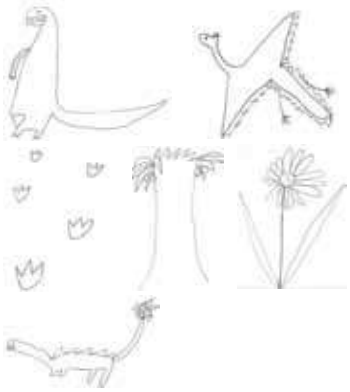
Illustration

Elizabeth Fodde-Reguer

Jose Garcia

Thea Price-Eckles

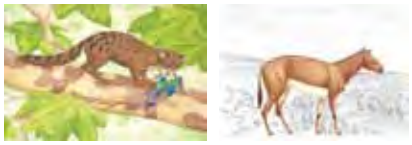
Errolyn Weston Daley



Jessie Katz

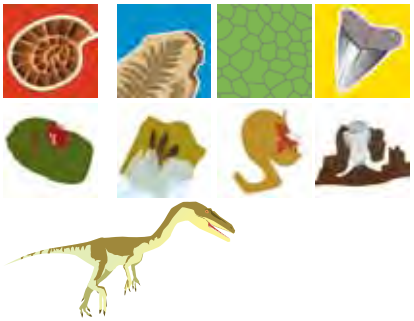
Simone?! Satchell

Jennifer McDonald



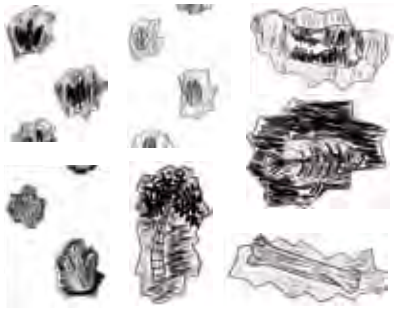
Jonathan Steadman

Hermes Arriola



Andrew Hartsock

Ethan Wood



Photographs and Images
Krista L. Jankowski - Grinnell Glacier background photo, pg 11
Catherine Riihimaki - Stromatolites, Glacier National Park, pg 11
Ron Blakey - US map, pg 13
TheColoringSpot.com - Precambrian life, pg 10
Additional images courtesy of the National Park Service.

Additional Support

Vincent Santucci	Marcia Fagnant	Jeff Wolin	Annette Rousseau
Jim F. Wood	Arvid Aase	Matt Greuel	Erica Clites
Jason Kenworthy	Victoria Stauffenberg	Christie Young	
Melanie Ransmeier	Bruce Nash	Allyson Mathis	
Elena Evans	Jeff Selleck	Laine Weber	

Find out more at http://www.nature.nps.gov/geology/paleontology/

© National Park Service 2009