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Exploring the Submerged New World 2009

The Pleistocene Zoo

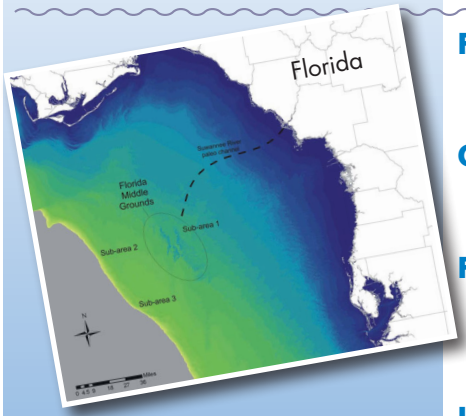


Image captions/credits on Page 2.

lesson plan

Focus

Pleistocene Mammals

Grade Level

5-6 (Life Science)

Focus Question

What processes and conditions may have caused extinctions of animals in the Pleistocene Epoch?

Learning Objectives

- Students will be able to describe at least three now-extinct Pleistocene mammals, and explain three theories for why extinction occurred.

Materials

- ❑ Copies of *Pleistocene Animal Inquiry Guide,* one copy for each student group

Audio-Visual Materials

- ❑ (Optional) Video projector or similar equipment for displaying geologic timeline (see Learning Procedure, Steps 1 and 2)

Teaching Time

One to three 45-minute class periods, plus time for student research

Seating Arrangement

Groups of 2-3 students

Maximum Number of Students

32

Key Words

Jefferson's Ground Sloth
Woolly Mammoth
American Mastodon
North American Short-Faced Bear
American Lion
Giant Beaver
American Scimitar Cat
Steppe Bison

Beringia Ice Age Yukon and Alaskan Camel
North American Saiga
Ancient Caribou
Helmeted Muskox
Yukon Horse
Beautiful Armadillo
Dire Wolf
Saber-toothed Cat
Peccary
Stag-moose
Pleistocene
Extinction
Paleoamerican

Background Information

NOTE: Explanations and procedures in this lesson are written at a level appropriate to professional educators. In presenting and discussing this material with students, educators may need to adapt the language and instructional approach to styles that are best suited to specific student groups.

The origin of the first people to inhabit North and South America has been a subject of controversy for decades. In 1927, archaeologists working near Folsom, New Mexico discovered a stone spearhead point embedded in the rib cage of an extinct bison. Several years later, distinctive long spearpoints were discovered at an archaeological site near Clovis, New Mexico, along with mammoth bones dated to as far back as 11,200 years ago. These discoveries provided direct proof that humans and large extinct mammals co-existed for a time, and that humans had arrived in North America by the end of the Pleistocene Epoch (about 11,000 years ago).

Discoveries at Clovis also became the springboard for the Clovis First theory, which proposes that a small group of hunters migrated from Asia about 13,500 years ago, walked across a land bridge between Asia and North America, and passed through an inland ice-free corridor in western Canada to become the first human inhabitants of North and South America. These pioneers carried thrusting spears tipped with specialized stone points that made them very successful hunters of the large mammals that inhabited the North American continent. According to the theory, their success allowed the first group to rapidly expand throughout North and South America, and after approximately 1,000 years the Clovis people are supposed to have exterminated 33 genera in North America and more than 50 genera in South America.

Current evidence (Goebel, *et al.*, 2008) disputes many aspects of the Clovis First theory, and indicates that humans migrated from Siberia around 15,000 years ago, crossed a land bridge to the Pacific coast of North America, and continued southward, possibly using boats.

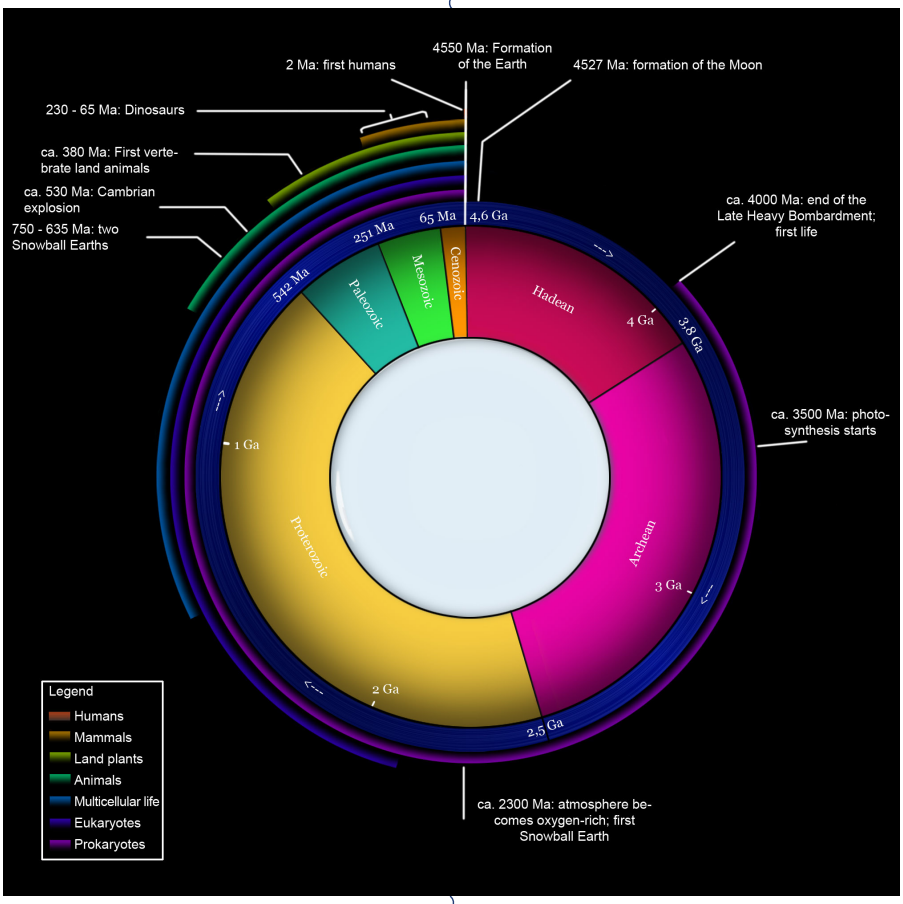
Images from Page 1 top to bottom:
The eastern Gulf of Mexico showing the three sub-areas examined in 2008, the Florida Middle Grounds, and the Suwanee River paleo channel.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/plan/media/fmg_surveyareas.html

During the Late Pleistocene Florida's shoreline extended much farther offshore than the present coast. The Florida Middle Grounds were part of the exposed coastal margin.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/climatechange/media/pleistocene.html

Map of the Bering land bridge during the late Wisconsin glaciation, when global sea level dropped to about 120 meters or more below its present position.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/occupation/media/beringia_late_wisconsin.html

This image portrays a more accurate reconstruction of Ice Age human behavior with a focus on small familial groups and the processing and use of plants as opposed to athletically fit young men attacking large, dangerous animals.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/beliefs/media/correctpaleobehavior.html

All images courtesy NOAA.

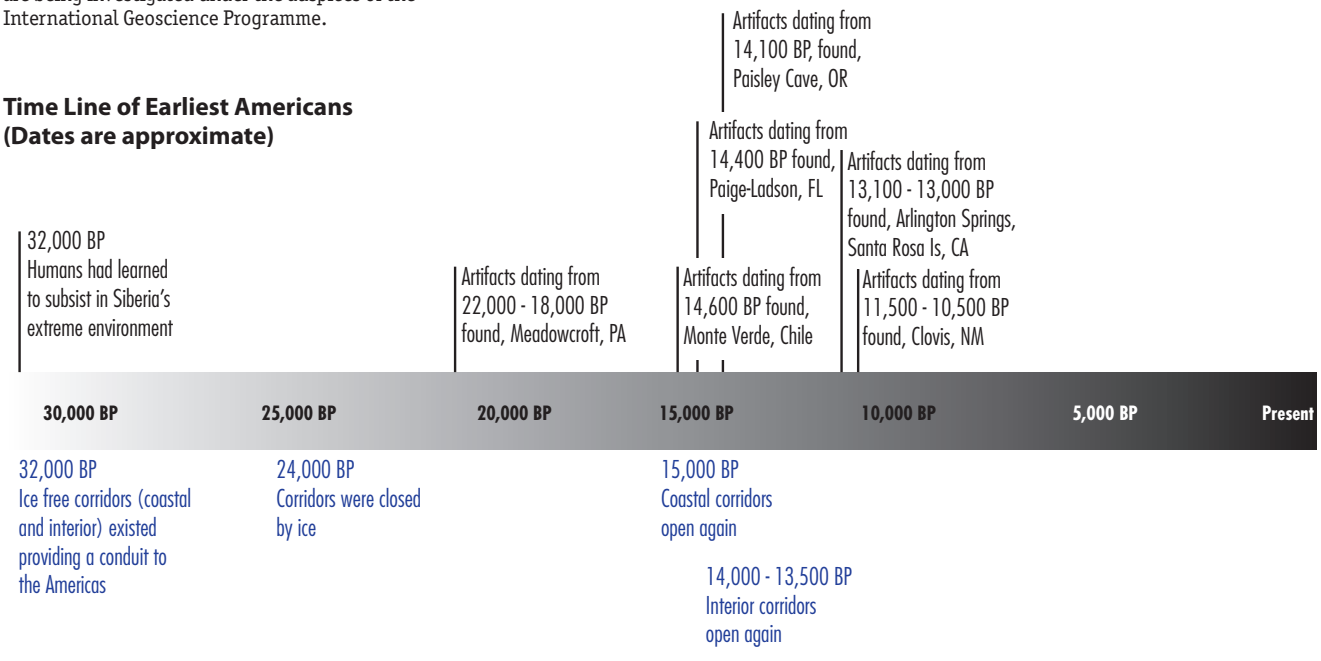


The geological clock: a projection of Earth's 4.5 Ga history on a clock ("MA" = a million years (Megayear) ago; "GA" = a billion years (Gigayear) ago). Image credit: Woudloper, Wikipedia. http://en.wikipedia.org/wiki/File:Geologic_clock.jpg
Note: "Snowball Earth" refers to periods of widespread glaciation; details of the Snowball Earth theory continue to be controversial and are being investigated under the auspices of the International Geoscience Programme.

Descendants of these migrants spread across what is today the United States, eventually reaching the Atlantic coast. Others continued southward into South America. When the first humans arrived in Florida, sea level was much lower and there was more than twice as much dry land as exists today. The climate was considerably drier, and water was scarce. Not surprisingly, early American settlements that have been discovered in the state are almost always associated with a reliable water supply such as rivers and springs. These areas would also have been attractive to animals, increasing the likelihood that human hunters would be able to find food.

Limestone bedrock that underlies the Florida peninsula strongly influences the state's landscape. Limestone dissolves in acidic solutions, and over time has been sculpted by rainwater which is weakly acidic. This sculpting includes the formation of underground caves. When the roof of a cave becomes unstable, it collapses to form a hole in the ground called a sinkhole.

Time Line of Earliest Americans (Dates are approximate)



Florida has hundreds of sinkholes, some of which became natural reservoirs for fresh water. Not surprisingly, some of the most artifact-rich paleoamerican sites are located near sinkholes. This association means that archaeologists looking for early American settlements along drowned shorelines of Florida can look for sinkholes as indicators of promising sites.

Coastal areas inhabited by early Americans are difficult to explore because the coastlines of 15,000 years ago are now under more than 300 feet of water! As the last ice age drew to a close, melting ice sheets caused a rapid rise in sea level just as the first Americans were entering the New World. Drowned settlements may contain well-preserved artifacts that can provide important new information about how the first Americans lived and when they arrived at various locations in North and South America. The eastern Gulf of Mexico in the vicinity of the Ocala Uplift Zone (Florida) is particularly promising as a potential location for drowned coastal settlements because:

- There are numerous onshore archaeological sites along the same zone that are more than 13,000 years old;
- Clusters of similar sites have been identified along drowned shorelines in the northern Gulf of Mexico;
- Rivers that discharge into this part of the Gulf do not carry large quantities of sediment, so sites should not be deeply buried;
- The coastal shelf is gently sloped which would reduce the impact of waves and storms; and
- Rapid sea level rise would have reduced the impact of waves as coastal settlements were inundated.

The Northeastern Gulf of Mexico 2008 expedition focused on ancient river channels in the vicinity of the Florida Middle Grounds, which are now several hundred feet below the Gulf's surface. Major accomplishments included:

- Locating and high resolution mapping of a large, essentially intact, and infilled ancient river channel several kilometers long east of the Florida Middle Grounds;
- Identifying additional stream and river channels, some with clearly visible deposits along the banks;
- Locating and identifying more than 100 sinkhole features filled with material in stratified layers that may contain human artifacts as well as plant and animal material from early American times; and
- Mapping nearly 10 square kilometers of intact, shallow-water, nearshore sand ripples/ridges adjacent to an area that would have been Florida's shoreline when sea level was at it lowest point during the last glacial period.

The latter achievement is particularly important because it shows that the oldest shoreline is extraordinarily well preserved. Most interesting, though, are the infilled sinkholes with multiple layers of distinct strata.

These sinkholes are a potential treasure trove of new information about the late Pleistocene landscape and environment, as well as about the humans who lived there.

Many archaeological sites provide evidence that the first Americans probably encountered mastodons, sabre-toothed cats, giant sloths, and many other animals that are now extinct. This lesson guides student inquiries about some of these animals and possible reasons for their extinction.

Learning Procedure

1. To prepare for this lesson:
   (a) Review introductory essays for the Exploring the Submerged New World 2009 Expedition at http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html; and
   (b) Review questions *Pleistocene Animal Inquiry Guide* activities.

   You may also want to download a geologic timeline (e.g., http://www.sdnhm.org/exhibits/mystery/fg_timeline.html) to help orient students to the position of the Pleistocene epoch in geologic time.

2. Briefly introduce the Exploring the Submerged New World 2009 Expedition. Be sure students understand that the Pleistocene epoch covered a time span of 1.8 million years, and included a series of ice ages during which glaciers covered large areas of the northern hemisphere. These glacial periods were separated by warmer interglacial intervals of 10,000 to 20,000 years. The last great ice age ended about 10,000 years ago.

   Highlight the timing of human migration into North and South America, and the fact that these people were hunters who co-existed with mammoths, mastodons, sabre-toothed cats, giant sloths, and many other animals that are now extinct. Tell students that they will be investigating some of these animals, and will try to find some of the reasons for their extinction. Provide each student group with a copy of the *Pleistocene Animal Inquiry Guide* and assign one of the following animals to investigate:

   Jefferson's Ground Sloth
   Woolly Mammoth
   American Mastodon
   North American Short-Faced Bear
   American Lion
   Giant Beaver
   American Scimitar Cat
   Steppe Bison
   Yukon Horse
   Beautiful Armadillo

Dire Wolf
Saber-toothed Cat
Peccary
Stag-moose

3. Have each group present the results of their research.
The following points should be included for individual species:

Jefferson's Ground Sloth

Scientific name: *Megalonyx jeffersonii* (named after Thomas Jefferson)
Size: 2.5 – 3.0 m long; about the size of a modern ox
Food: herbivorous
Lived: 150,000 – 9,400 years ago

Woolly Mammoth

Scientific name: *Mammuthus primigenius*
Size: similar to the modern Asian elephant, about 3 m high at the shoulder
Food: herbivorous
Lived: 150,000 – 11,000 years ago; but remains of dwarf woolly mammoths dated between 7,000 and 3,700 years ago have been found on Wrangel Island off the coast of northeastern Siberia

American Mastodon

Scientific name: *Mammut americanum*
Size: squatter, longer bodies than the modern elephant, 2 – 3 m high at the shoulder, about 4.5 m long
Food: herbivorous
Lived: at least 3.7 million – 9,000 years ago

North American Short-Faced Bear

Scientific name: *Arctodus simus* and *Arctodus pristinus*
Size: *A. simus* was largest, about 1.5 m high when walking normally, about 3.4 m on hind legs, with a vertical reach of more than 4.3 m
Food: carnivorous; diet could have included bison, musk ox, caribou, deer, horses and sloths
Lived: 800,000 – 11,500 years ago

American Lion

Scientific name: *Panthera leo atrox*
Size: as much as 25% larger than the modern African lion
Food: carnivorous; diet probably included bison, horses, possibly small mammoths
Lived: about 300,000 – 10,000 years ago

Giant Beaver
Scientific name: *Castoroides ohioensis*
Size: about 2.5 m long, weighing as much as 200 kg (a modern beaver is about 1 m long and weighs about 30 kg)
Food: herbivorous
Lived: about 300 million to 10,000 years ago

American Scimitar Cat
Scientific name: *Homotherium serum*
Size: about 1.1 m shoulder height, similar to the modern lion; weighed about 230 kg
Food: carnivorous; diet probably included juvenile mammoths
Lived: about 1.5 million to 10,000 years ago

Steppe Bison
Scientific name: *Bison priscus*
Size: length up to about 3.6 m
Food: herbivorous
Lived: about 2 million to 10,000 years ago

Yukon Horse
Scientific name: *Equus lambei*
Size: about 3.3 m tall at the withers (the ridge between the shoulder blades)
Food: herbivorous, probably fed extensively on grasses
Lived: about 200,000 to 12,000 years ago

Beautiful Armadillo
Scientific name: *Dasypus bellus*
Size: about 1 m long
Food: omnivorous; diet probably included insects, plants, fruits, lizards and frogs
Lived: about 2.5 million to 10,000 years ago

Dire Wolf
Scientific name: *Canis dirus*
Size: about 1.5 meters long, weight about 50 kilograms
Food: carnivorous; massive teeth suggest that it may have been a scavenger, similar to the modern hyena
Lived: about 1.8 million to 11,000 years ago

Saber-toothed Cat
Scientific name: *Smilodon fatalis*
Size: about 1.1 m shoulder height, similar to the modern lion
Food: carnivorous; diet probably included bison, deer, camels, horses, ground sloths, and juvenile mastodons and mammoths
Lived: about 1.8 million to 10,000 years ago

Peccary

Scientific name: *Platygonus compressus* and *Mylohyus nasutus*
Size: about 0.75 m tall at the shoulder
Food: omnivorous; diets included small animals as well as roots, grasses, seeds, and fruits
Lived: about 33 million to 11,500 years ago

Stag-moose

Scientific name: *Cervalces scotti*
Size: slightly larger than the modern moose; about 2 m tall at shoulder
Food: herbivorous, able to feed in wetlands, tundra, and forests
Lived: origins unknown; present from at least 25,000 to about 10,000 years ago

4. Lead a discussion of potential causes for Pleistocene extinctions. Three factors are widely mentioned:

Human Hunting — One aspect of the Clovis First theory is that many extinctions were caused by humans equipped with efficient stone weapons. There is little doubt that the first Americans hunted many species that are now extinct; but they also hunted other species that did not become extinct.

Climate Change — The climate and ecosystems of North America changed rapidly at the end of the Pleistocene Epoch, causing similarly rapid changes in the distribution of plants and animals. Loss of food sources and exposure to unfavorable climatic conditions may have contributed to the disappearance of some species.

Hyperdisease — Highly infectious diseases are a third possible explanation for some extinctions. Such diseases might have been brought by humans when they entered North America, and could have been devastating to populations of animals that had not developed immunity to these exotic infections. This hypothesis has been investigated particularly as a potential cause of mammoth extinctions (for more information, see the American Museum of Natural History Internet Biobulletin, "What Killed the Mammoths?"; http://www.amnh.org/sciencebulletins/biobulletin/biobulletin/story981.html

Point out that these factors may have acted in combination to produce conditions that some species could not survive. Even if a species was able to tolerate these conditions, it might still have become extinct if its prey species disappeared. Another potential cause for extinction is the appearance of a new species that is better equipped to compete for food or habitat resources.

Students should realize that all of these factors and conditions may cause present-day extinctions. Other factors that may contribute to the disappearance of modern species include environmental toxins and cataclysmic events such as meteor impacts. While there are many naturally-occurring toxins, synthetic chemicals from human activities are particularly dangerous because living organisms may have no defenses against such chemicals. Be sure students understand that major extinctions occurred before humans existed as a species; in fact, it is estimated that 99.9% of all species that have ever lived are now extinct. Many scientists are concerned about human-caused extinctions, however, because the present rate of species extinctions is estimated to be 100 to 1000 times the average extinction rate during the history of life on Earth.

The BRIDGE Connection

http://www2.vims.edu/bridge/ – Type "paleontology" into the search box on the left side of the page to locate links to resources about prehistoric life.

The "Me" Connection

Have students write a short essay about the personal impact of Pleistocene extinctions from the perspective of someone living in North America 10,000 years ago.

Connections to Other Subjects

English/Language Arts, Earth Science

Evaluation

Students' answers to inquiry topics provide a basis for assessment.

Extensions

1. Visit http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html for more about the Submerged New World 2009 Expedition.

Other Relevant Lesson Plans from NOAA's Ocean Exploration Program

(The following Lesson Plans are targeted toward grades 5-6 unless otherwise noted)

Shipwreck Explorers (12 pages, 299 kb) (from the *Lophelia* II 2008 Expedition)
http://oceanexplorer.noaa.gov/explorations/08lophelia/background/edu/media/shipwreck.pdf

Focus: Marine Archaeology (Physical Science)

In this activity, students use data about the location and types of artifacts recovered from a shipwreck site to draw inferences about the sunken ship and the people who were aboard.

Ship of the Line (9 pages, 293k) (from AUVfest 2008)
http://oceanexplorer.noaa.gov/explorations/08auvfest/background/edu/media/shipline.pdf

Focus: Maritime History (Physical Science/Social Science)

In this activity, students will be able to describe general characteristics and technologies used in 18th century naval ships; draw inferences about daily life aboard these ships; and explain at least three ways in which simple machines were used on these vessels.

Looking for Clues (8 pages, 556k) (from the RMS *Titanic* Expedition 2004)
http://oceanexplorer.noaa.gov/explorations/04titanic/edu/media/Titanic04.Clues.pdf

Focus: Marine Archaeology of the *Titanic* (Physical Science)

Students will be able to draw inferences about a shipwreck given information on the location and characteristics of artifacts from the wreck, and will list three processes that contribute to the *Titanic*'s deterioration.

Wreck Detectives (5 pages, 384k) (from the 2003 Steamship *Portland* Expedition)
http://oceanexplorer.noaa.gov/explorations/03portland/background/edu/media/portlandwreckdetec.pdf

Focus: Marine Archaeology (Physical Science)

In this activity, students use a grid system to document the location of artifacts recovered from a model shipwreck site, use data about the location and types of artifacts recovered from a model shipwreck site to draw inferences about the sunken ship and the people who were aboard, and identify and explain types of evidence and expertise that can help verify the nature and historical context of artifacts recovered from shipwrecks.

Other Resources

The Web links below are provided for informational purposes only. Links outside of Ocean Explorer have been checked at the time of this page's publication, but the linking sites may become outdated or non-operational over time.

http://oceanexplorer.noaa.gov – NOAA's Ocean Explorer Web site

http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html – Web site for the Submerged New World 2009 Expedition

http://celebrating200years.noaa.gov/edufun/book/welcome.html#book – A free printable book for home and school use introduced in 2004 to celebrate the 200th anniversary of NOAA; nearly 200 pages of lessons focusing on the exploration, understanding, and protection of Earth as a whole system

http://centerfirstamericans.org/index.php – Web site for the Center for the Study of the First Americans

http://www.jqjacobs.net/anthro/paleoamericans.html – Online article on issues and evidence relating to peopling of the New World

http://www.nps.gov/history/aad/eam/index.htm – National Park Service Archaeology and Ethnography Program's Web site, The Earliest Americans

Goebel, T., M. R. Waters, and D. H. O'Rourke. 2008. The Late Pleistocene Dispersal of Modern Humans in the Americas. Science 319:1497-1502.

http://www.sdnhm.org/exhibits/mystery/fg_timeline.html – Geologic timeline on the "Fossil Mysteries" Web page from the San Diego Natural History Museum

http://www.amnh.org/sciencebulletins/biobulletin/biobulletin/story981.html – "What Killed the Mammoths?" BioBulletin from the American Museum of Natural History

http://www.museum.state.il.us/exhibits/larson/ice_age_animals.html – Web page about Pleistocene Animals of the Midwestern U.S. from the Illinois State Museum

http://www.beringia.com/research/index.html – Web page about research on Pleistocene animals at the Yukon Beringia Interpretive Centre

National Science Education Standards

Content Standard A: Science As Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C: Life Science

- Populations and ecosystems

Content Standard D: Earth and Space Science

- Earth's history

Content Standard F: Science in Personal and Social Perspectives

- Populations, resources, and environments
- Natural hazards
- Science and technology in society

Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 1. The Earth has one big ocean with many features.

Fundamental Concept d. Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools.

Essential Principle 2.
The ocean and life in the ocean shape the features of the Earth.

Fundamental Concept b. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas, and shaped the surface of land.

Essential Principle 6.
The ocean and humans are inextricably interconnected.

Fundamental Concept f. Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).

Send Us Your Feedback

We value your feedback on this lesson.
Please send your comments to:
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The Pleistocene Zoo
Pleistocene Animal Inquiry Guide

Common name: _____

Scientific name: _____

What did your animal look like? (Find a picture.)

The Pleistocene Zoo
Pleistocene Animal Inquiry Guide – 2

How big was your animal?

What did your animal eat?

When did your animal live?

Explain at least three things that may have caused your animal to become extinct: