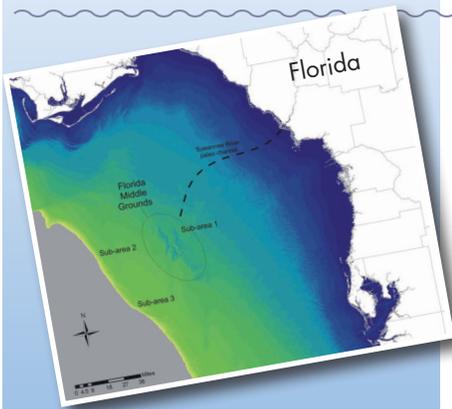


The Puzzle of the Ice Age Americans

(Adapted from the 2002 Submarine Ring of Fire Expedition)



Focus

Origin of the first humans in the Americas

Grade Level

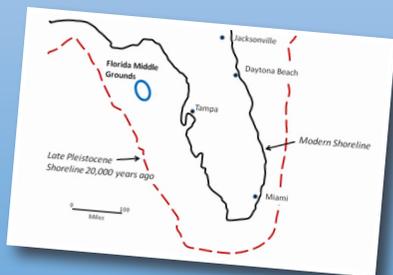
9-12 (Biology/Anthropology)

Focus Question

When did the first humans arrive in North America, where did they come from, and how did they get here?

Learning Objectives

- Students will be able to describe alternative theories for how the first humans came to the Americas and explain the evidence that supports or contradicts these theories.
- Students will be able to explain how exploration of a submerged portion of the northeastern Gulf of Mexico coast may provide additional insights about the origin of the first Americans.
- Students will be able to describe the role of skepticism in scientific inquiry.



Materials

- Copies of *History of Ice Age Americans Inquiry Guide*, one copy for each student or student group

Audio-Visual Materials

- None

Teaching Time

One or two 45-minute class periods

Seating Arrangement

Classroom style or groups of two to four students

Maximum Number of Students

32

Key Words

Monte Verde
Beringia



Image captions/credits on Page 2.

lesson plan

Daisy Cave
Ice-free corridor
Meadowcroft Rock Shelter
Kennewick Man
Clovis First
Clovis points
Sinkhole

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 spear point embedded in the rib cage of an extinct bison. This discovery 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). Several years later, distinctive long spear points were discovered at an archeological site near Clovis, New Mexico, along with bones of prey dated to as far back as 11,200 years ago.

During the years following discovery of sites at Folsom and Clovis, a theory developed that became widely accepted as fact, even though there was very little supporting evidence. This theory proposed that the first humans to enter North America were a small group of hunters that migrated from Asia by walking across a land bridge between Asia and North America about 13,500 years ago, passing through an inland ice-free corridor in western Canada. These pioneers, called “Clovis people,” carried thrusting spears tipped with specialized stone points that made them very successful hunters of the large mammals that inhabited North America. 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. The key element of this theory is that the “Clovis people” were the first human inhabitants of North and South America; hence this theory has come to be known as the Clovis First model.

There were several problems with the Clovis First model. One problem is that the distinctive stone spear points that are a key part of the model have not been found in Siberia which is supposed to have been the point of departure for the pioneers. A related problem is that the stone points found in the United States appear to be older than points found in the far north. In addition, other stone projectile points, shaped

Images from Page 1 top to bottom:

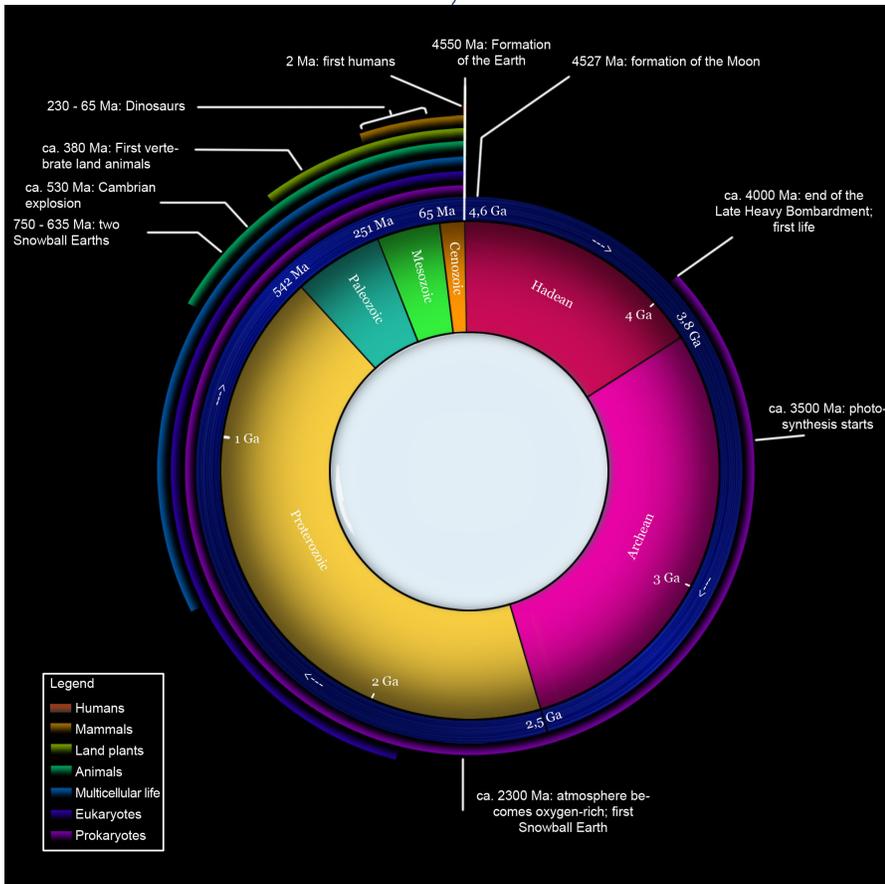
The eastern Gulf of Mexico showing the three sub-areas examined in 2008, the Florida Middle Grounds, and the Suwanee River paleo channel.
http://oceanexplorer.noaa.gov/explorations/09newworld/background/plan/media/fmg_surveyareas.html

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.



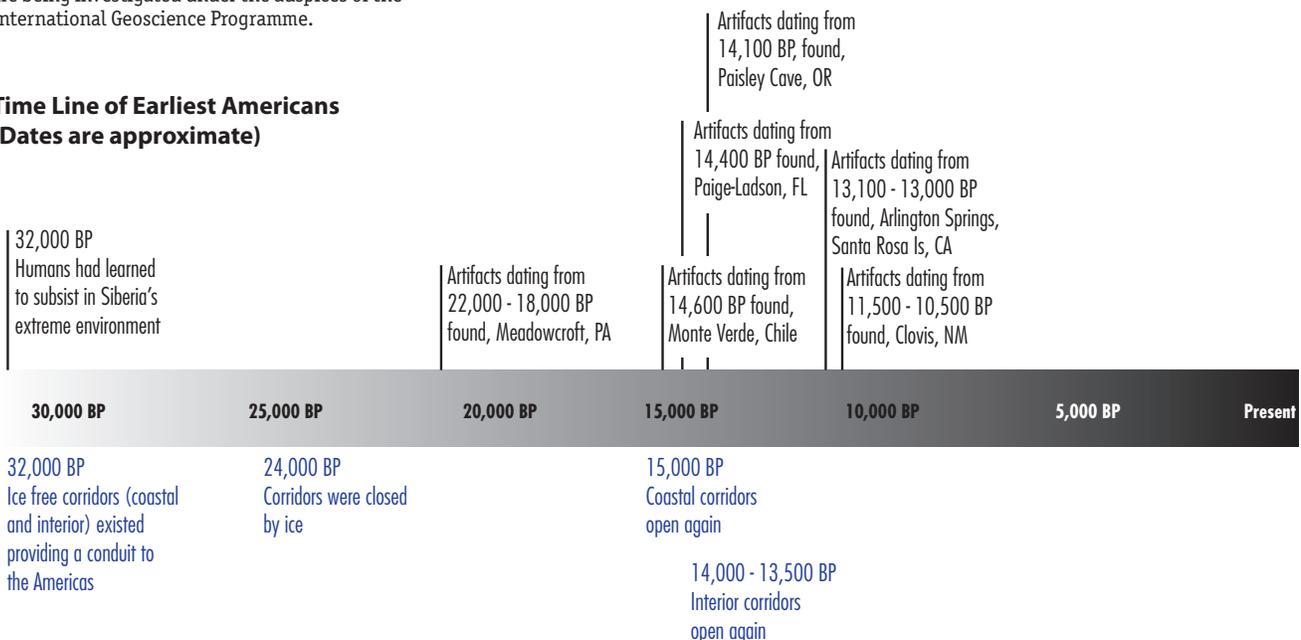
differently than the Clovis points, have been found at sites in the United States that are just as old as the Clovis specimens. Possibly the most serious problem was the discovery of sites in North and South America that are much older than the Clovis sites.

There are also difficulties concerning the proposed timing of the "Clovis migration." When humans arrived in the Siberian arctic about 32,000 years ago, there were ice-free corridors along the Pacific coast and inland east of the Canadian Rockies which provided a conduit to the Americas. By about 24,000 years ago these corridors were closed by ice. The coastal corridors were probably open again by 15,000 years ago, but the interior corridor did not re-open until 14,000 -

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.

13,500 years ago. A Paleoamerican settlement in southern Chile named Monte Verde was in existence 14,600 years ago, so it is unlikely that the humans who settled there had migrated via the inland corridor; but they could have arrived via the coastal route.

Time Line of Earliest Americans
 (Dates are approximate)

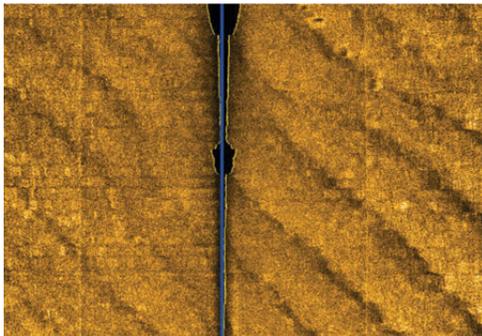


Recently, molecular genetics has provided new insights into the origins of the first Americans, and archaeologists have studied new sites and re-visited others with new methods. Genetic evidence now suggests that members of a single population of modern humans (*Homo sapiens*) entered North America from Siberia sometime between 30,000 and 13,000 years ago. Most studies suggest that the migration occurred less than 22,000 years ago, and probably involved boats. Once they reached the Pacific Northwest they could have continued dispersing south along the coast to eventually reach Chile, as well as dispersing eastward along the margins of the continental ice sheets. Some of the oldest archaeological sites discovered in North America are in the eastern United States. The Meadowcroft, Page-Ladson, and Paisley Cave sites, for example, have ages estimated at 18,000 - 22,000, 14,400, and 14,100 years ago, respectively (Goebel et al. 2008) (see Learning Procedure, Step 4). Other sites may be even older, but are still being evaluated. There are also numerous quarry-campsites in the southeastern states. Quarries are locations where raw rock material was mined and processed to make tools. If a reliable source of water is nearby, residential sites are often found near the quarry. These observations may indicate that these sites were occupied longer than sites in other regions.

Coastal areas were almost certainly inhabited by early Americans, but 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 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.

When the first Americans 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



Side scan sonar image showing near shore sand ridges associated with the Last Glacial Maximum. The blue line in the center of the figure shows the track of the side-scan sonar. Image credit: NOAA.

http://oceanexplorer.noaa.gov/explorations/09newworld/background/plan/media/lgm_ripples.html

and springs. These areas would also have been attractive to animals, increasing the likelihood that human hunters would be able to find food. Florida is sometimes nicknamed the “sinkhole state” because the limestone that underlies much of the state is gradually dissolved by acidic water (normal rainwater is slightly acidic) that creates underground caves, which sometimes collapse to form sinkholes. Sinkholes provide natural reservoirs for fresh water, and some of the most artifact-rich paleoamerican sites are located near these formations. This association means that archaeologists looking for early American settlements along drowned shorelines of Florida can look for sinkholes as indicators of promising sites.

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 its 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, and the humans who lived there.

This lesson guides a student inquiry into theories about the origins of humans in the Americas, and provides an opportunity for reflection and discussion about the process of scientific inquiry.

Learning Procedure

1. To prepare for this lesson:

- Review introductory essays for the Exploring the Submerged New World 2009 Expedition at <http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html>; and
- Review questions on the *History of Ice Age Americans Inquiry Guide*.

2. Briefly review the background and mission of the Exploring the Submerged New World 2009 Expedition. Explain the background to the Clovis First theory and the theory's major features. List some of the problems with the theory. Lead a discussion of how scientific theories evolve and change. In general, skepticism of change is an important part of science, and new theories have to be supported by substantial evidence. On the other hand, it is also important for new evidence to receive a fair hearing. The history of science contains many examples of visionaries whose ideas were considered ridiculous for many years before they were finally accepted as correct.
3. Distribute the *History of Ice Age Americans Inquiry Guide*. Divide the questions evenly among students or student groups. Have students prepare oral or written reports on the questions they are assigned to research. Emphasize that there may be more than one answer for some questions.
4. Have students present results of their inquiries in a seminar format. Encourage discussion of various pieces of evidence, as well as speculation on possible explanations that have not been investigated. When all results have been presented, have each student write a brief summary describing what they believe to be the most probable explanations of when, how, and from where the first Americans arrived in North America. The following points should be included in the discussion:
 - (1) Monte Verde, an archaeological site in Chile, is widely acknowledged to have been inhabited between 12,500 and 14,600 years ago, and has a large number of artifacts that are exceptionally well-preserved. This evidence conflicts with the Clovis First theory.
 - (2) Beringia is a region that includes present-day Alaska, the Yukon Territory, northeast Siberia, and the now-submerged Bering Sea platform. It is believed that during the last Ice Age, the Bering Sea platform formed a land bridge that connected Asia and North America.
 - (3) The Meadowcroft Rock Shelter site in Pennsylvania contains artifacts that may be 18,000 - 22,000 years old. The Page-Ladson site in Florida contains tools and a mastodon tusk that are estimated to be about 14,400 years old. At Paisley Cave, in Oregon, three human coprolites (fossilized fecal material) were found with an estimated age of about 14,100 years. All of these observations are inconsistent with the Clovis First theory.
 - (4) The Ice Free Corridor hypothesis is part of the Clovis First theory. This hypothesis suggests that the first humans to enter North America arrived from Siberia after crossing a land bridge, then

migrated through an inland passage between the Laurentide and Cordilleran ice masses. These ice masses blocked all inland routes from 24,000 years ago until 14,000 - 13,500 years ago.

- (5) Dr. Carol Mandryk is a paleoecologist at Harvard University who has investigated prehistoric vegetation in Alberta, which would have been at the southern end of the "ice-free corridor." She has found that there was not enough biomass to support humans until after 13,000 years ago, and that the corridor was not open until 11,500 years ago. In addition, her research shows that even after the ice sheets began to open a path, there was not enough vegetation there to support the large animals that migrating people would have had to depend on for food.
- (6) While inland routes were blocked by ice until at least 14,000 years ago, coastal routes were open to migration at least 15,000 years ago. So, the first Americans could have arrived by boat.
- (7) Arlington Springs is on Santa Rosa Island in the northern Channel Islands off the southern coast of California. Human remains have been found at Arlington Springs that are estimated to be 13,000 - 13,100 year old. Santa Rosa Island was an island even during the Ice Ages, so it could only have been reached by boat. These observations support the idea that some of the first Americans may have traveled by sea, which is an alternative to the land migration proposed in the Clovis First theory.
- (8) Australia has been isolated by water since at least 60 million years ago. There is evidence that humans have been present in Australia for at least 40,000 years, and no explanation has been proposed for how they could have arrived other than by boat. This suggests that boats may also have been available to the first humans to enter the Americas; again, suggesting water travel as an alternative to the land migration proposed in the Clovis First theory.
- (9) DNA studies suggest that the first Americans came from a single population in Siberia, and migrated from Beringia sometime after 16,500 years ago.
- (10) Students should realize that the scientific method is based on testing hypotheses. To help resolve debates about theories such as Clovis First, scientists need to make predictions based on the theory, and then test whether these predictions are true. In the case of Clovis First, one prediction might be, "There is no evidence of human occupation in North America before 11,500 years ago." If no evidence was found after investigating many sites, this would support the theory. But the theory would not be proven, because

a single site older than 11,500 would demonstrate that the theory is incorrect. But if supporters of the theory deliberately block funding for research on sites that might be older, then the theory cannot be disproven—even though such sites might exist. With this kind of constraint, key predictions cannot be tested, so the scientific method cannot be applied.

The BRIDGE Connection

www.vims.edu/bridge/archeology.html – For links to lesson plans and resources about marine archeology

The “Me” Connection

Have students write an essay on why the question of the origin of the first Americans is or is not worthy of publicly supported research.

Connections to Other Subjects

English/Language Arts, Geography, Earth Science

Evaluation

Students’ research reports and class discussions provide opportunities for assessment.

Extensions

1. Visit <http://oceanexplorer.noaa.gov/explorations/09newworld/welcome.html> for more about the Submerged New World 2009 Expedition.
2. Visit <http://www.pbs.org/wgbh/nova/first/> for information and resources about the discovery and controversy surrounding a well-preserved, 9,000-year-old human skeleton called Kennewick Man.

Multimedia Discovery Missions

<http://oceanexplorer.noaa.gov/edu/learning/welcome.html>
Click on the links to Lessons 7 and 10 for interactive multimedia presentations and Learning Activities on the Water Cycle and Tides.

Other Relevant Lesson Plans from NOAA’s Ocean Exploration Program

(The following Lesson Plans are targeted toward grades 9-12)

The Robot Archaeologist

(17 pages, 518k) (from AUVfest 2008)

<http://oceanexplorer.noaa.gov/explorations/08auvfest/background/edu/media/robot.pdf>

Focus: Marine Archaeology/Marine Navigation (Earth Science/Mathematics)

In this activity, students will design an archaeological survey strategy for an autonomous underwater vehicle (AUV); calculate expected position of the AUV based on speed and direction of travel; and calculate course correction required to compensate for the set and drift of currents.

My Wet Robot

(300kb) (from the Bonaire 2008: Exploring Coral Reef Sustainability with New Technologies Expedition)
<http://oceanexplorer.noaa.gov/explorations/08bonaire/background/edu/media/wetrobot.pdf>

Focus: Underwater Robotic Vehicles (Physical Science)

In this activity, students will be able to discuss the advantages and disadvantages of using underwater robots in scientific explorations, identify key design requirements for a robotic vehicle that is capable of carrying out specific exploration tasks, describe practical approaches to meet identified design requirements, and (optionally) construct a robotic vehicle capable of carrying out an assigned task.

Do You Have a Sinking Feeling?

(9 pages, 764k) (from the 2003 Steamship Portland Expedition)
<http://oceanexplorer.noaa.gov/explorations/03portland/background/edu/media/portlandsinking.pdf>

Focus: Marine Archaeology (Earth Science/Mathematics)

In this activity, students plot the position of a vessel given two bearings on appropriate landmarks, draw inferences about a shipwreck given information on the location and characteristics of artifacts from the wreck, and explain how the debris field associated with a shipwreck gives clues about the circumstances of the sinking ship.

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://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://www.kumeyaay.com> – Web site dedicated to the promotion and preservation of the Kumeyaay culture, with extensive information presented from the Kumeyaay perspective

<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.pbs.org/wgbh/nova/first/> – Web site to accompany the NOVA presentation, “Mystery of the First Americans” (originally broadcast on February 15, 2000) documenting the discovery and controversy surrounding a well-preserved, 9,000-year-old human skeleton called Kennewick Man; includes “Does Race Exist?,” “Meet Kennewick Man,” “Claims for the Remains,” “The Dating Game” (about carbon-14 analysis), and links to resources

<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.sciencemag.org/cgi/content/abstract/sci;319/5869/1497> Full article available from *Science Magazine* for \$15.

Bowdler, S. 1997. The Pleistocene Pacific. In D. Denoon (ed). *The Cambridge History of the Pacific Islanders*. pp. 41-50. Cambridge University Press, Cambridge. Article by Bowdler is available on line at http://www.archaeology.arts.uwa.au/about/research/bowdler/the_pleistocene_pacific.

National Science Education Standards

Content Standard A: Science As Inquiry

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

Content Standard G: History and Nature of Science

- Science as human endeavor
- Nature of scientific knowledge
- Historical perspectives

Ocean Literacy Essential Principles and Fundamental Concepts

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.

Fundamental Concept e. Tectonic activity, sea level changes, and force of waves influence the physical structure and landforms of the coast.

Essential Principle 6.

The ocean and humans are inextricably interconnected.

Fundamental Concept a. The ocean affects every human life. It supplies freshwater (most rain comes from the ocean) and nearly all Earth's oxygen. It moderates the Earth's climate, influences our weather, and affects human health.

Fundamental Concept b. From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.

Fundamental Concept c. The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.

Fundamental Concept d. Much of the world's population lives in coastal areas.

Essential Principle 7.

The ocean is largely unexplored.

Fundamental Concept a. The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.

Fundamental Concept d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

Send Us Your Feedback

We value your feedback on this lesson.

Please send your comments to:

oceaneducation@noaa.gov

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The Puzzle of the Ice Age Americans

History of Ice Age Americans Inquiry Guide

1. The Clovis First theory proposes that the first human inhabitants of North and South America crossed a land bridge from Siberia at some time before 13,000 years ago. These people were sophisticated hunters, and spread rapidly across North America. This theory was proposed after stone spear points were discovered near Clovis, NM with an estimated age of 11,200 years.

Does evidence from an archaeological site named Monte Verde support or conflict with the Clovis First theory? Explain why.

2. What is Beringia?

3. How do discoveries at Meadowcroft Rock Shelter, Paisley Cave, and the Page-Ladson site relate to the Clovis First theory?

4. What is the "ice-free corridor hypothesis," and how is it related to the Clovis First theory?

The Puzzle of the Ice Age Americans History of Ice Age Americans Inquiry Guide – 2

5. Who is Carol Mandryk and what does her research show?

6. If inland migration routes were blocked by ice until at least 14,000 years ago, how could people have entered North America to inhabit sites such as Meadowcroft, Paisley Cave, and Page-Ladson?

7. What is the significance of Arlington Springs to the Clovis First theory and alternative migration routes?

8. How does the arrival of humans in Australia relate to findings at Arlington Springs?

9. What do DNA studies reveal about when early Americans may have left Asia?
