

The Limestone Supermarket



Image captions/credits on Page 2.

Focus

Lifeways of Maya at Vista Alegre

Grade Level

5-6 (Life Science/Earth Science/Social Studies)

Focus Question

What are some features of life among ancient Maya at a maritime trading settlement on the northern Yucatán Peninsula?

Learning Objectives

- Students will discuss the maritime cultural landscape approach, describe some of the interactions between human activities and ecological resources, and explain how artifacts may provide clues about these interactions.
- Students will investigate lifeways in “mainstream” Maya culture during the four periods in which Vista Alegre was occupied, and make inferences about how these might have been different in Vista Alegre based on its geographic setting.
- Students will use the engineering design process to infer ways that indigenous food sources might have been supplemented through human manipulation of the local environment.
- Students will discuss the potential role of maritime trading during each occupation period.

Materials

- Copies of *Ancient Maya Lifeways Inquiry Guide*, one copy for each student group

Audio-Visual Materials

- (Optional) Interactive white board or other technology to display Figure 1

Teaching Time

One or two 45-minute class periods, plus time for student research; more time may be required depending upon specific student assignments

Seating Arrangement

Groups of two to four students

Maximum Number of Students

30

Key Words

Maya
Vista Alegre
Archaeology
Yalahau
Yucatán
Maritime trading

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.

For 3,000 years, Maya seafarers inhabited Mexico's Yucatán Peninsula. Vista Alegre is the site of a Maya settlement on a small mangrove-shrouded island on the southern coast of the Yalahau Lagoon at the northeastern tip of the Yucatán Peninsula. The lagoon connects to the Gulf of Mexico, and most of Vista Alegre is surrounded by lagoons or estuaries. This community was part of the great Mesoamerican civilization that developed true writing, sophisticated mathematics and astronomy, and trade networks that spanned thousands of miles. Archaeologists first visited the site in 1954, and subsequent research has recovered pottery remains that suggest Vista Alegre has been used by the Maya for about 3,000 years. The site has not been used continuously, however; and archaeological evidence suggests that there have been four distinct periods of occupancy:

Vista Alegre I (800/700 BC to 450/400 BC)

Vista Alegre II (100/150 AD to 650 AD)

Vista Alegre III (850/900 AD to 1100 AD)

Vista Alegre IV (1100 AD to 1521 AD)

For more information about these periods and their relationship to the overall chronology of the Maya civilization, please see the Expedition Purpose for the Exploring the Hidden World of the Maritime Maya 2011 Expedition, <http://oceanexplorer.noaa.gov/explorations/11maya/background/edu/purpose.html>.

This discontinuous occupancy raises many questions: What challenges did the first settlers face as they established the community of Vista Alegre? What attracted them to this place, and how did they make a living? What kept people at Vista Alegre after inland sites were abandoned during the Early and Middle Classic Periods? Why did the

Images from Page 1 top to bottom:

Canoe-based reconnaissance along the Yucatan's north coast. Dominique Rissolo and Jeffrey Glover (pictured) along with Zachary Hruby explored the north coast of the Peninsula in 2006 searching for Prehispanic and historical sites. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/canoexploration2006_hires.jpg

A profile view of a partially preserved stucco floor that would have covered the entire plaza area north of the main pyramid at Vista Alegre. The profile allows one to study the construction technique of the stucco floor, including the subfloor ballast. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/u2_piso_profile_2619_hires.jpg

Mold-made ceramic spindle whorl from Vista Alegre. These disks functioned as fly-wheels for handheld fiber spinning rigs. Spindle whorls are quite common at Vista Alegre and suggest that the site's ancient inhabitants were manufacturing cotton yarn or even bulk cloth, a major trade item at the time of Spanish Contact. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/spindlewhorl_kh_hires.jpg

The Castillo at Chichén Itzá is one of the most well-known buildings in Mesoamerica. It is a radial pyramid (with a set of stairs on each side) and is positioned in the middle of the massive plaza area that would have held large numbers of visitors at the height of Chichén's power much as it still does today during the Equinox and Solstice. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/castillo_chichen_hires.jpg

settlement eventually fail? What brought settlers back to the site in the Terminal Classic Period and why did they eventually leave?

The Yucatán Peninsula rests on a foundation of limestone bedrock. Limestone is gradually dissolved by acidic water (normal rainwater is slightly acidic). This process creates underground caves, and makes the Yucatán limestone highly porous. In many places, underground limestone caves collapse and form sinkholes. Yucatán's sinkholes are called cenotes (pronounced "seh-NO-tehs"), and are very important in Maya history. Besides being a major source of fresh water, cenotes had religious significance and were sometimes sites of human sacrifice.

Yucatán's limestone bedrock slopes gradually downward from south to north. The peninsula is often described as being divided into northern and southern lowlands with a boundary at about 19° N. The southern lowlands include numerous rivers, streams, and wetlands; although water is scarce in the central interior area. The northern lowlands have almost no surface streams, and fresh water is found only in cenotes and a few small lakes. At the northern tip of the Yucatán, however, an area known as the Yalahau region includes a series of north-south oriented freshwater wetlands that receive higher-than-average rainfall, possibly because of sea breezes that converge over this area.

Environmental conditions in the vicinity of Vista Alegre are very different from those around other Maya settlements. Fresh water is scarce; the complex coastal ecology is not suitable for the types of agriculture practiced by Maya in other regions; and the coastal environment offers food resources and transportation opportunities that are not available to inland inhabitants. Maya living at Vista Alegre must have developed specialized ways to live with these conditions, and these different lifeways may have caused Vista Alegre Maya to become culturally distinct from Maya living elsewhere. In fact, records from early European contacts state that the coastal Maya saw themselves as more "refined" than inland peoples. These considerations cause archaeologists to ask whether physical evidence at Vista Alegre demonstrates that its inhabitants had a distinct coastal identity that was significantly different from that of Maya living inland.

In this lesson students will investigate lifeways of the Maya at Vista Alegre and elsewhere during the four periods of occupancy, and infer ways that inhabitants of Vista Alegre may have been able to use the settlement's ecological setting to supply themselves with food.

Learning Procedure

1. To prepare for this lesson:
 - a. Review introductory essays for the Exploring the Hidden World of the Maritime Maya 2011 Expedition at <http://oceanexplorer.noaa.gov/explorations/11maya/welcome.html>.
 - b. Review papers by Fedick, (1997) and Fedick *et al.* (2008); www.famsi.org/reports/95087/95087Fedick01.pdf and <ftp://ftp.flmnh.ufl.edu/Projects/EmeryPublications/ForestLegacy/FedicketalJEthnobi-28-2-290.pdf>, respectively. These papers describe two ways that Maya living in the Yalahau region might have manipulated the ecological context to produce food, and may be useful when discussing students' responses to Part III of the *Ancient Maya Lifeways Inquiry Guide*.
 - c. Decide whether you want to have students sample some Maya foods (Step 4). If so, there are a variety of options for preparing the food, including providing each student group with a recipe to prepare, or providing only the name of a dish for which they must find a recipe that they will subsequently prepare.
2. Introduce Exploring the Hidden World of the Maritime Maya 2011 Expedition, briefly describe the Maya civilization. See the resources listed below and the Expedition Purpose for the Exploring the Hidden World of the Maritime Maya 2011 Expedition (<http://oceanexplorer.noaa.gov/explorations/11maya/background/edu/purpose.html>) for more information. Show students the map of the Yucatán Peninsula (Figure 1, page 5), and point out the location of Vista Alegre, the Yalahau region, and the wetlands near the northern tip of the peninsula.

Describe the maritime cultural landscape approach, and emphasize that this concept is based on recognizing that artifacts and structures that form the archaeological record are the result of complex interactions between human activities and geographical and ecological features and events that provided the context for these activities. Point out that archaeologists often excavate trash pits (also called middens) to find objects that give clues about these interactions, ecological features, and events. Tell students that when this type of archaeological study is applied to modern cultures it is sometimes called "garbology."

3. Provide each student group with a copy of the *Ancient Maya Lifeways Inquiry Guide*. For Part I, you may want to provide one or more of the references listed under "Other Resources," or allow students to find their own sources. The Canadian Museum of Civilization Web site (<http://www.civilization.ca/cmce/exhibitions/civil/maya/mmc01eng.shtml>) is particularly useful. Students may need to look up unfamiliar terms.

Figure 1. Map of the Yucatán Peninsula including Vista Alegre, the Yalahau region, and the wetlands near the northern tip of the peninsula





Aerial map showing a portion of Laguna Holbox where Vista Alegre is located. Click on the link below to see the entire picture. Image courtesy of Proyecto Costa Escondida Maritime Maya 2011 Expedition, NOAA-OER.

http://oceanexplorer.noaa.gov/explorations/11maya/background/hires/va_plan.jpg

Depending upon students' research skills, you may want to do Part II as an activity involving the entire class by assigning different portions of the research problem to different student groups.

Before students begin Part III, be sure that they understand the Engineering Design Process, and emphasize that this process is useful for solving many types of problems, not just those involving engineering. Point out that some steps in the Process will not be used, because their assignment does not include actually testing whether their ideas will work.

4. Discuss students' answers to questions posed in the *Inquiry Guide*.

This discussion should include:

- Vegetables eaten by the ancient Maya included maize, beans, chile peppers, squash, manioc, avocado, papaya, guava, tomatoes, sweet potatoes, hogplums, palms, cactus fruits, mint, persimmon, jicama, custard apple, and cacao fruits and seeds.
- Meats consumed by the ancient Maya included fish, turkey, wild pigs, dogs, deer, duck, armadillo, quail, tapir, monkeys, iguana, oysters, conch, other shellfish, turtles, and sea birds.

Xikilpak

This is a hummus-like dip that is excellent with corn tortillas or tortilla chips.

Ingredients:

- 4 oz peeled and roasted squash seeds or pumpkin seeds
- Juice from 3 limes
- 1 small red onion, minced
- 2 large red tomatoes, minced
- 1/4 cup cilantro leaves, finely chopped
- 1/2 small orange habanero chile, minced (substitute serrano or jalapeno chile for less heat)
- Pinch of sea salt

Using a mortar and pestle, crush the roasted seeds into a fine paste. Mix with the tomato, chile, red onion, cilantro leaves, and lime juice to form a smooth paste. Add salt to taste.

Notes:

- Be careful when working with habanero chiles! Wear gloves, wash hands thoroughly after handling the chiles, and do not touch your eyes.
- Onions and limes are not native to the New World, but are common ingredients in modern Maya cuisine.

- The “three sisters” were corn, squash, and beans which provide many important nutrients when eaten together. The plants were often grown together as well, with the corn providing a support for the beans, and the squash plants providing mulch and protection from pests. Beans also add nitrogen to the soil.
- Xikilpak (pronounced SHE - keel - pock) is a hummus-like food made from ground seeds, limes, onion, tomatoes, cilantro, and chile (see sidebar). It is said to have been a royal treat among the Maya, and may also boost the immune system with vitamins B and E as well as antioxidants.
- Slash and burn agriculture involves clearing forest lands by cutting and burning the native vegetation, then planting crops such as maize, beans, and squash. After about two years, they moved their fields to new locations, allowing the old fields to recover for ten years or more before reusing them.
- The Yucatán Peninsula rests on a foundation of limestone bedrock and soils are thin.
- A “karst landform” is an area where limestone is the major rock underlying the land surface (that is, limestone is the “bedrock”), and the limestone has been partially dissolved to form caves and sinkholes.
- Aquifers are rocks and sediments that contain large amounts of water. Students may infer that in areas where there is a lot of limestone rock, aquifers might be formed by acidic rainwater dissolving part of the rock.
- The Yucatán Peninsula is generally drier than many other areas inhabited by ancient Maya, and the karst landscape provides less soil than jungle environments farther south.
- Students may speculate that Maya inhabiting Vista Alegre probably had to alter traditional agricultural methods, and may have been more reliant on hunting wild game and harvesting fish and other edible marine animals from nearby coasts.
- Spindle whorls are used to make thread, so their presence may suggest that residents of Vista Alegre had access to cotton or some other fiber that could be used to make thread.
- Ceramic weights might have been used for fishing nets, but archaeologists working with the Exploring the Hidden World of the Maritime Maya 2011 Expedition also believe they may have been used on looms to make fabrics.

Students' answers to Part II will vary. Be sure students realize that occupation during Vista Alegre II continued for about two hundred years after inland portions of the Yalahau region were abandoned, and that the re-occupation during Vista Alegre III coincided with the increasing power of Chichén Itzá. For additional discussion, please see the Expedition Purpose for the Exploring the Hidden World of the Maritime Maya 2011 Expedition, <http://oceanexplorer.noaa.gov/explorations/11maya/background/edu/purpose.html>. Vista Alegre offered a protected harbor that would have been useful to coastal traders. Archaeologists are now working to determine whether maritime trading actually occurred during all periods of occupancy. To some extent, this settlement was isolated from large Maya cities, and this may have delayed the impact of changes that took place in inland areas. Maritime trading almost certainly offered a variety of foods and other products from different areas, as well as access to new ideas and knowledge that could have been useful to residents of Vista Alegre.

Students' answers to Part III will vary. Be sure students document their use of the Engineering Design Process in developing their ideas. Papers by Fedick (Step 1b) describe how Maya in northern Yucatán may have manipulated wetlands and grown "container gardens" in limestone pockets. Students may also speculate on the importance of edible marine resources, and the possibility that some foods came from distant locations via maritime trading. Salt from evaporated seawater may have been used to preserve fish and other foods.

Ask students how garbology might reveal whether their ideas were actually used by Maya at Vista Alegre. Encourage students to imagine what sorts of durable remains might be associated with their ideas. Fish bones and shells, for example, could indicate consumption of various types of seafood.

4. (Optional) Have a taste of Maya foods! In addition to Xikilpak (also spelled Sikil Pac), easy-to-prepare Maya foods include:

- Maya Hot Chocolate
- Fresh Avocado Salad
- Maya Citrus Salad
- Shrimp Maya Ceviche
- Lime Soup (Sopa de Lima)
- Tikin Xic (grilled fish)
- Pumpkin Soup
- Tamales

A keyword search on these names together with "Maya" will provide a variety of recipes. These may be distributed among student groups to prepare, or finding recipes may be part of students' assignment.

The BRIDGE Connection

www.vims.edu/bridge/archeology.html

The “Me” Connection

Have students write a brief essay about how knowledge of ancient Maya settlements might be of personal importance or benefit.

Connections to Other Subjects

English/Language Arts, Geography

Assessment

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

Extensions

1. Visit <http://oceanexplorer.noaa.gov/explorations/11maya/welcome.html> for more about the Exploring the Hidden World of the Maritime Maya 2011 Expedition.
2. For more activities about the Maya civilization, see Other Resources, below.
3. Have students investigate techniques for producing atlatls (spear thrower) and flint tools, and use these to create examples of tools that might have been used by the Maya. Be careful with flint knapping—wear gloves, because these tools really are very sharp!

Other Relevant Lesson Plans from NOAA’s Ocean Exploration Program

What’s a Karst?

(from the Submerged New World 2009 Expedition)
<http://oceanexplorer.noaa.gov/explorations/09newworld/background/edu/media/karst.pdf>

Focus: Limestone landforms and aquifers (Physical Science/Earth Science)

Students compare and contrast igneous, sedimentary and metamorphic rocks, and name examples of each. Students will define karst landforms, describe typical features of these landforms, explain processes that shape them, and discuss their relevance to aquifers.

Shipwreck Explorers

(from the *Lophelia* II 2008 Expedition)
<http://oceanexplorer.noaa.gov/explorations/08lophelia/background/edu/media/shipwreck.pdf>

Focus: Marine archaeology (Physical Science)

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.

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/explorations/11maya/welcome.html>
– Web site for the Exploring the Hidden World of the Maritime Maya 2011 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

Glover, J. B., D. Rissolo, and J. P. Mathews, 2011. The Hidden World of the Maritime Maya: Lost Landscapes Along the North Coast of Quintana Roo, Mexico. -in- B. Ford, ed. When the Land Meets the Sea. Volume 2, pp 195-216, The Archaeology of Maritime Landscapes. Springer Science+Business Media. New York.

<http://www.smm.org/sln/ma/> – Maya Adventure, from the Science Museum of Minnesota; includes science activities and information related to ancient and modern Maya culture

<http://teacher.scholastic.com/lessonrepro/lessonplans/profbooks/ss970818d.htm> – Peoples of Mexico - The Maya from Scholastic.com

http://www.pbs.org/wgbh/nova/teachers/programs/2804_maya.html
– Teacher's Guide to accompany the NOVA production, Lost King of the Maya; includes an activity using the Maya calendar

<http://www.civilization.ca/cmcc/exhibitions/civil/maya/mminteng.shtml> – "Mystery of the Maya" Web site from the Canadian Museum of Civilization

<http://school.discoveryeducation.com/lessonplans/programs/mayanewsreport/> – Lesson plan (grades 9-12), "A Classical Maya News Report" from Discovery Education

Fedick, S. L., M. de L. Flores Delgadillo, S. Sedov, E. Solleiro Rebolledo, and S. Palacios Mayor. 2008. Adaptation of Maya homegardens by "container gardening" in limestone bedrock

cavities. *Journal of Ethnobiology* 28(2): 290–304; available from: <ftp://ftp.flmnh.ufl.edu/Projects/EmeryPublications/ForestLegacy/FedicketalJEthnobia-28-2-290.pdf>

Fedick, S. L. 1997. Ancient Manipulation of Wetlands in the Northern Maya Lowlands: Report on Archaeological Investigations of 1996-97. Foundation for the Advancement of Mesoamerican Studies, Inc.; available from: www.famsi.org/reports/95087/95087Fedick01.pdf

Martin, Simon and Nikolai Grube. 1995. Maya Superstates. *Archaeology* 48(6):41-46.

Webster, David L. 2002. *The Fall of the Ancient Maya*. Thames & Hudson, London.

Correlations

Framework for K-12 Science Education

A. Scientific and Engineering Practices

1. Asking questions and defining problems
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

B. Crosscutting Concepts

2. Cause and effect: Mechanism and explanation
4. Systems and system models
7. Stability and change

C. Disciplinary Core Ideas

Life Sciences

Core Idea LS2: Ecosystems: Interactions, Energy, and Dynamics

LS2.A: Interdependent Relationships in Ecosystems

LS2.D: Social Interactions and Group Behavior

Core Idea LS4: Biological Evolution: Unity and Diversity

LS4.D: Biodiversity and Humans

Earth and Space Sciences

Core Idea ESS3: Earth and Human Activity

ESS3.A: Natural Resources

ESS3.C: Human Impacts on Earth Systems

Engineering, Technology, and the Applications of Science

Core Idea ETS1: Engineering Design

ETS1.A: Defining and Delimiting an Engineering Problem

ETS1.B: Developing Possible Solutions

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 c. Erosion—the wearing away of rock, soil and other biotic and abiotic earth materials—occurs in coastal

areas as wind, waves, and currents in rivers and the ocean move sediments.

Essential Principle 5.

The ocean supports a great diversity of life and ecosystems.

Fundamental Concept i. Estuaries provide important and productive nursery areas for many marine and aquatic species.

Essential Principle 6.

The ocean and humans are inextricably interconnected.

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

Send Us Your Feedback

In addition to consultation with expedition scientists, the development of lesson plans and other education products is guided by comments and suggestions from educators and others who use these materials. Please send questions and comments about these materials to: oceanexeducation@noaa.gov.

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Credit

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Lifeways of the Maya at Vista Alegre

Ancient Maya Lifeways Inquiry Guide

Part I: Maya Foods

1. What vegetables were commonly eaten by the ancient Maya? (Note that “vegetable” means the edible part of any plant).

2. What meats were commonly eaten by the ancient Maya?

3. What are the “three sisters”?

4. What is Xikilpak (also spelled Sikil Pac)?

5. What is “slash and burn” agriculture, and how was it used by the ancient Maya?

6. The Yucatán Peninsula rests on a foundation of what kind of bedrock?

7. What is a “karst landform”?

8. What is an aquifer? How do you think aquifers might be formed in areas where there is a lot of limestone rock?

9. Contrast the landscape of the Yucatán Peninsula with the landscape surrounding ancient Maya cities in places such as Tikal.

10. How do you think the ecological conditions of the Yucatán Peninsula might have changed the ways that ancient Maya inhabitants obtained food at Vista Alegre?

11. Are you a garbologist? Artifacts recovered from middens (trash pits) at Vista Alegre included spindle whorls and ceramic weights. What do you think Maya at Vista Alegre did with these items, and how might they be related to the surrounding environment?

Part III: Finding Food at Vista Alegre

Diego de Landa Calderón was a Spanish Bishop of the Roman Catholic Archdiocese of Yucatán. In 1566 he wrote: “Yucatán is the country with least earth that I have seen, since all of it is one living rock and has wonderfully little earth.” Without soil, it would have been difficult for Maya at Vista Alegre to grow food with the same techniques that were used in other areas where Maya lived.

The Engineering Design Process (see next page) is a way to solve many types of problems, including problems that have nothing to do with engineering. Use this process to describe at least two ways that Maya at Vista Alegre might have been able to use the natural environment of Vista Alegre to obtain food.

Engineering Design Process

The Engineering Design Process is a series of steps that engineers use to create solutions to problems. There are many versions of the Process, but the basic steps include:

- Define the problem
- Gather relevant information
- Brainstorm possible solutions
- Analyze possible solutions and select the most promising
- Test the solution by building a prototype
- Revise and improve the solution
- Repeat previous steps until results are acceptable
- Report the design process and results

These steps involve several key skills:

- Obtaining, evaluating, and communicating information;
- Analyzing and interpreting data;
- Using mathematics, information and computer technology, and computational thinking; and
- Using evidence to discuss the strengths and weaknesses of ideas and designs.

Most problems will include certain constraints that may relate to cost, size, environmental conditions, or other specific requirements. Some constraints may be identified in the statement of the problem, but most problems need additional analysis to be certain that all constraints are understood. Often, constraints will force designers to make trade-offs in their solutions. For example, the strongest material may be too expensive, or too heavy to meet cost and size constraints. Identifying the solution that meets all of the constraints with the best combination of trade-offs is called optimization. Models are frequently used to help designers visualize possible solutions, and may be two-dimensional illustrations, three-dimensional physical shapes, or mathematical calculations that predict how well a potential solution will do what is necessary to solve the problem. Each step of the Engineering Design Process involves systematically examining information that is needed to move to the next step. This kind of examination is called analysis.