

## Education

# Coral Cores: Ocean Timelines



Photo Credit: G.P. Schmah/I/FGBNMS

### Grade Level

6-12

### Timeframe

45-60 Minutes

### Materials

- Coral Core x-ray image
- Poster adhesive
- Metric rulers (1 per student)
- Yarn or string
- Tape
- Date Cards

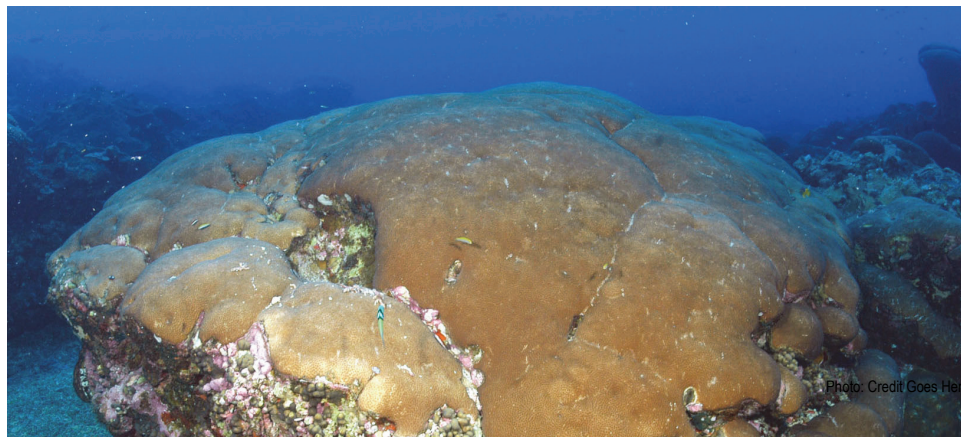


Photo Credit Goes Here

### Activity Summary

Most people are familiar with the growth rings seen in tree cross-sections, but few are aware that similar growth patterns are visible in skeletons of reef-building corals. This activity will introduce students to these growth patterns and what they can tell us about the environment in which the corals live.

### Learning Objectives

Students will be able to:

- Describe growth patterns in reef-building coral skeletons.
- Determine an annual growth average for a particular coral skeleton.
- Identify potential impacts to coral growth.
- Use existing data to estimate for missing data.
- Compare coral colony size at the time of specific historical events.

### Background Information

Coral polyps are soft-bodied animals related to anemones and jellyfish. Their tube-like bodies are closed at one end. A mouth opening at the other end is surrounded by flexible, stinging tentacles.

Coral polyps within a colony are genetically identical and situated in close proximity to one another, with each polyp joined to the ones

beside it. Beneath this thin layer of living tissue at the top of a coral colony, the polyps of reef-building corals create hard layers of calcium carbonate. This is what we consider the hard, or stony, part of the reef. This is the coral skeleton.

As coral colonies grow, new layers of skeleton are deposited. The amount of growth in coral skeletons is determined by variations in temperature and other weather conditions.

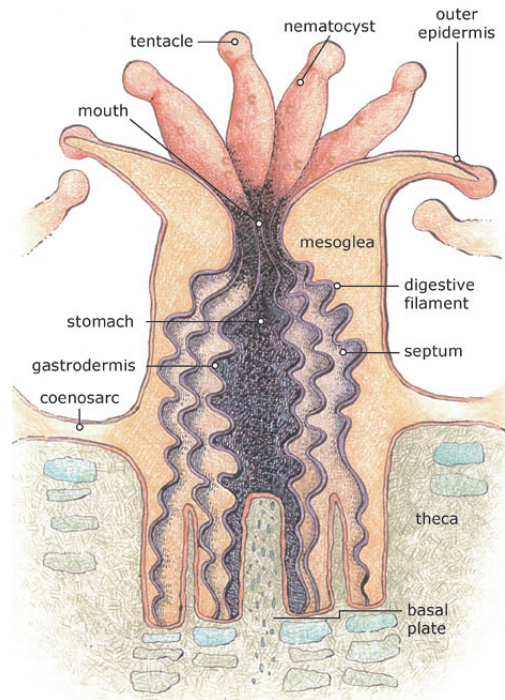


Photo Credit: National Ocean Service

At Flower Garden Banks National Marine Sanctuary, in the northwestern Gulf of Mexico, scientists have determined that coral skeletons tend to grow more rapidly in fall and winter months, when temperatures are more moderate (72-77F= 22-25C). This creates less dense growth in the skeleton, while slower growth rates in summer create higher density skeleton. The result is an identifiable series of growth bands in coral colonies, much like those observed in trees. Historical temperature data for the sanctuary can be found at

[http://coralreefwatch.noaa.gov/satellite/vs/caribbean.php#FlowerGardenBanks\\_Texas](http://coralreefwatch.noaa.gov/satellite/vs/caribbean.php#FlowerGardenBanks_Texas)

In order to see these layers, scientists drill cores out of established coral heads. This gives them a look at years-worth of layers in one compact unit. The larger the coral colony, the more years of data they can extract. In Flower Garden Banks National Marine Sanctuary there are many large coral colonies, some as big as small cars. This means that there is potential for a lot of data.

X-rays of coral cores allow scientists to examine the annual growth bands in reef-building corals. Dark bands show the slow, high-density growth that takes place during the summer. Lighter bands show the faster, low-density growth that takes place during the winter.

Scientists can take a look back in time to determine when temperatures were warmer or cooler, by simply examining the depth of each growth band. Larger low-density bands indicate warmer winter temperatures. Slightly darker bands, known as stress bands, indicate periods of environmental stress, such as temperature extremes.

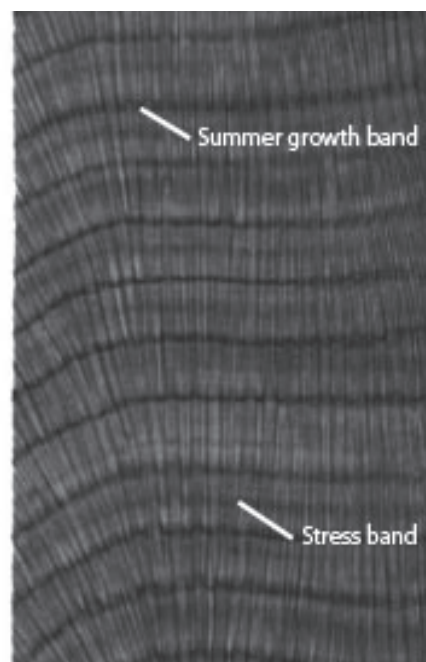


Photo Credit: Amy Bratcher, Texas A&M University

## Vocabulary

**CALCIUM CARBONATE** – A white crystalline compound that occurs naturally in coral skeletons and mollusk shells, as well as limestone and marble. Used to manufacture cement. Chemical symbol  $\text{CaCO}_3$ .

**COLONY** – A group of the same kinds of animals living together.

**DENSITY** – A measure of a compactness of a substance.

**PALEOCLIMATOLOGY** – Study of climatic conditions in the geologic past using evidence found in geologic records such as coral skeletons, sediments, etc.

**POLYP** – An animal with a cylindrical body and a mouth opening surrounded by stinging tentacles. The end opposite the mouth is attached to a hard surface.

Within each band scientists can also evaluate the chemical content to learn more about atmospheric conditions. By drilling out 12 tiny samples from each growth band, they can examine the oxygen and carbon isotopes to determine specific temperatures during each month of the year.

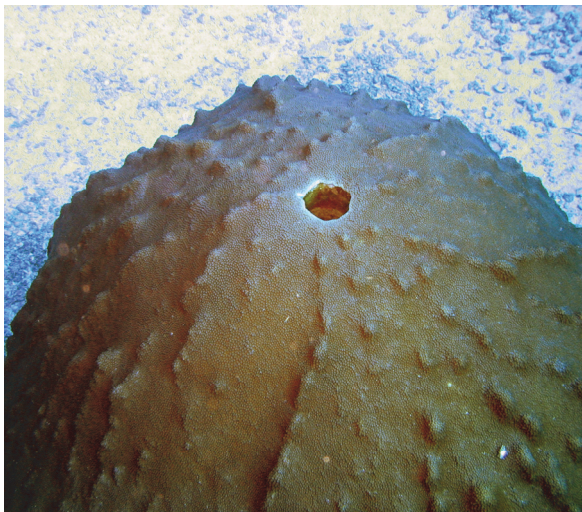


Photo Credit: G.P. Schmahl /FGBNMS

In 2005, coral core samples were taken from several colonies of *Montastrea faveolata* (image below), a species of star coral, at East and West Flower Garden Banks.

Scientists from Texas A&M University are analyzing these core samples to identify patterns in growth over periods of time. They will then compare these to what we know of air and water

temperature readings in the region. This information can then be used to help them evaluate cores that go back farther than recorded weather data, and “read” climate history.

Why do we want to do all of this? Understanding how climate change has affected the Gulf of Mexico over a period of years, decades, or even centuries may help us recognize and anticipate future climate changes, so that we can appropriately manage our marine resources.

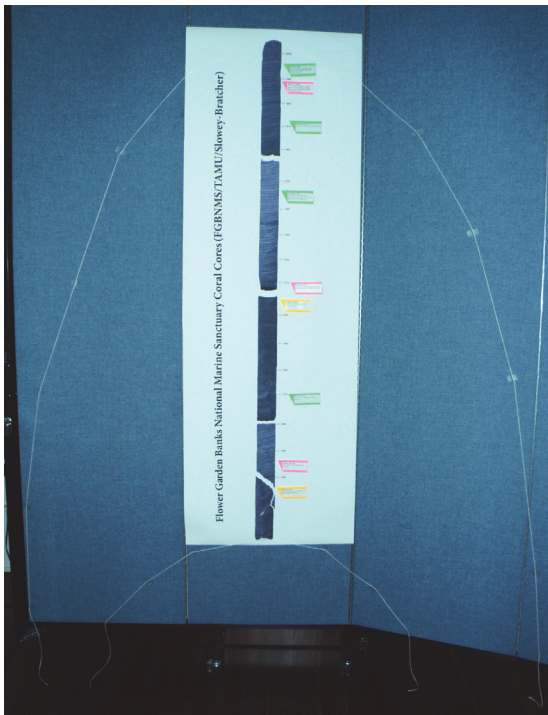
## Preparation

- 1) Cut apart the four core images, then copy and enlarge them. To create life size images you will have to double the size of each core. Display the core images on the wall, one above the other, to create one continuous core.
- 2) Copy and cut apart the Date Cards you wish to use, or create your own.

## Procedure

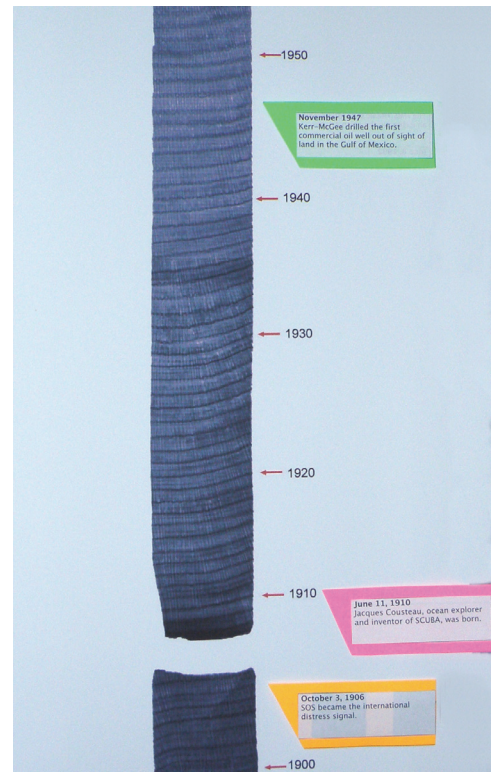
- 1) Have students examine the images and identify the summer growth bands. These are the denser, darker bands caused by slower growth.
- 2) Have students identify the winter growth bands. These are the lighter, less dense areas.
- 3) Starting at the top of the core, have students label the very first dark band as 2005.

- 4) Have students count back and label every 10 years on the core. How many years are represented by this coral core sample?
- 5) Have each student select a 10-year span and measure the depth of each growth band within that decade, to the nearest millimeter. What is the greatest depth? Least depth? Average depth? What does this tell them about temperature change in that decade?
- 6) Have students identify any stress bands within that decade then research what kinds of stressors might cause these.
- 7) Assuming that the coral core is incomplete by about 50 years, have students calculate the likely height of the missing section (the oldest part). Reposition the core image so that the bottom of the core sample is that far above the floor. Use yarn or string to create the outline of a coral head from the bottom of the core image to the floor.



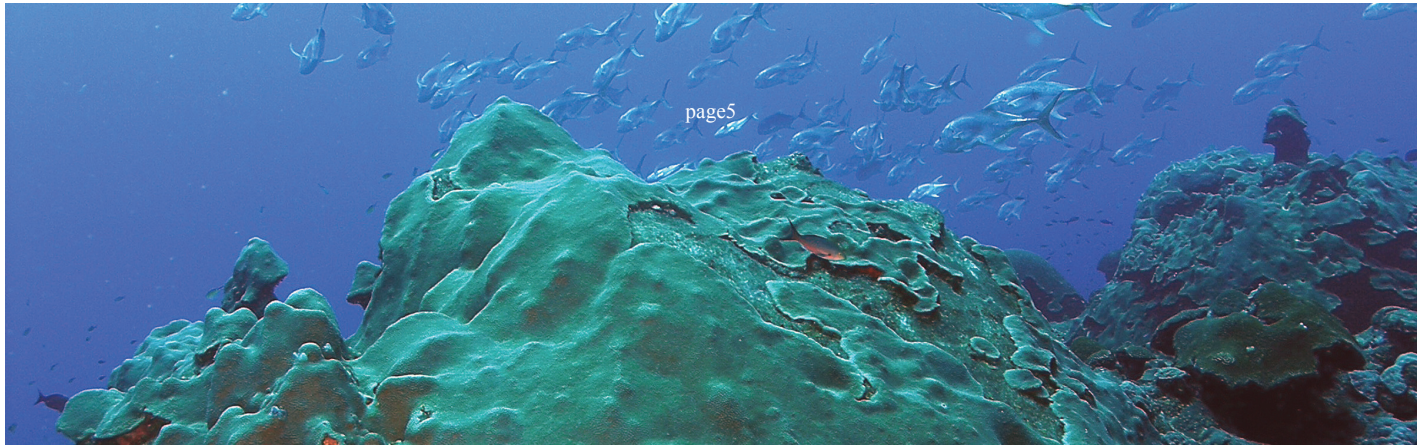
- 8) Using the same assumption as above, have students calculate the likely height of the coral colony at the time the core sample was

taken. Create an outline of a coral head from the top of the core image to the floor, remembering that corals grow out as well as up. Compare the change in size over the lifespan of the coral colony.



### Extending the Lesson

- 1) Lay Date Cards face down on a table.
- 2) Have each student select one of the Date Cards and match it to the corresponding year on the coral core image. Attach the card near the appropriate growth band.
- 3) Have each student measure the approximate height of the coral head at the time that event took place.
- 4) Discuss with students the events and world changes that have occurred during the lifespan of that coral head. Are any of these events likely to have affected the corals of Flower Garden Banks National Marine Sanctuary?



## Additional Notes

The coral core images in this activity are x-rays of a *Montastrea faveolata* core taken from Flower Garden Banks National Marine Sanctuary in 2005. These images are consecutive, from left to right, and account for the entire core sample.

You will notice there are some breaks in the sample. These occurred while attempting to extract the core from the coral head. This might lead to a discussion on the difficulties of doing this kind of work. Scientists don't always get to work with "perfect" samples.

The small arrows that you see next to the core sample on the far right indicate high-density growth bands from the years 1860, 1850 and 1840. You can use these as reference points to help check your students' work.

## Related Links

Flower Garden Banks National Marine Sanctuary (FGBNMS) <http://flowergarden.noaa.gov>

Coral Cores: Ocean Timelines  
<http://flowergarden.noaa.gov/science/coralcores.html>

FGBNMS Education Lessons & Activities  
[http://flowergarden.noaa.gov/document\\_library/documents.html](http://flowergarden.noaa.gov/document_library/documents.html)

National Marine Sanctuaries

<http://sanctuaries.noaa.gov>

## For More Information

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## Acknowledgement

This lesson was developed by NOAA's Flower Garden Banks National Marine Sanctuary. Technical information was provided by researchers Niall Slowey and Amy Bratcher at Texas A&M University.

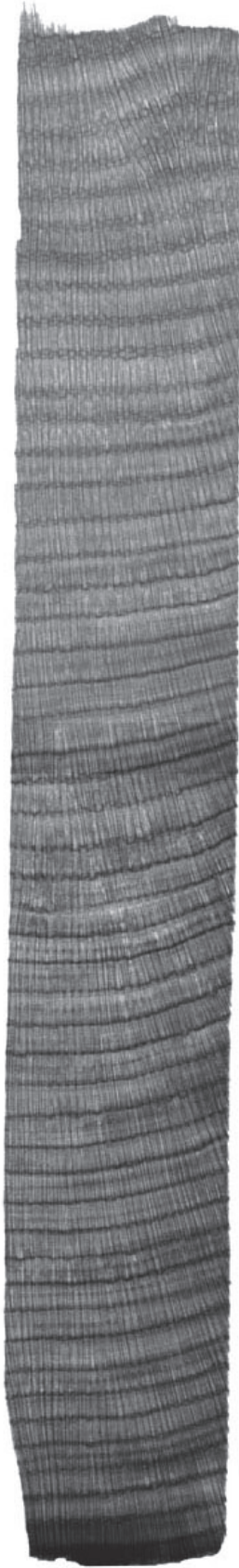
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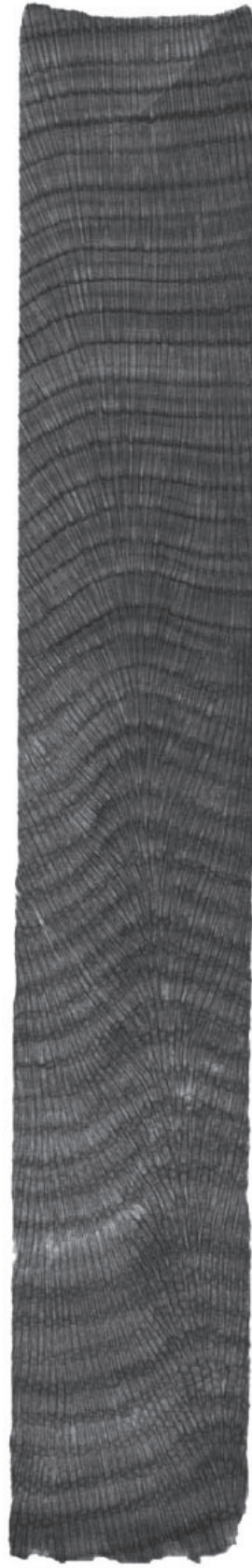
Photos: Amy Bratcher



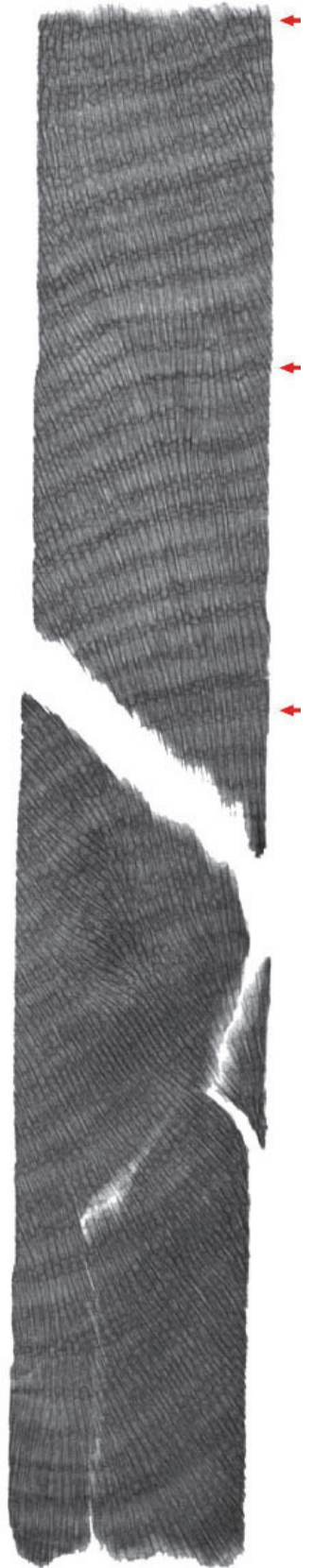
A



B



C



*Montastrea faveolata*

## OCEAN SCIENCE DATE CARDS

<p><b>January 17, 1992</b> Flower Garden Banks National Marine Sanctuary designated in northwestern Gulf of Mexico.</p>	<p><b>January 23, 1960</b> Bathyscaph <i>Trieste</i> made the world's deepest dive to 35, 802 feet in the Marianas Trench.</p>
<p><b>May 2, 1775</b> Benjamin Franklin made the first scientific study of the Gulf Stream.</p>	<p><b>March 15, 1960</b> President Eisenhower created the first underwater preserve in the U.S in Key Largo, Florida.</p>
<p><b>March 23, 2005</b> An autonomous underwater vehicle was launched to collect scientific data in the Gulf Stream.</p>	<p><b>March 24, 1989</b> Exxon-Valdez spilled 11 million gallons of oil into Prince William Sound, Alaska, affecting 2000km of Alaska coastline.</p>
<p><b>April 15, 1912</b> The <i>HMS Titanic</i> sank after striking an iceberg in the north Atlantic.</p>	<p><b>April 28, 1962</b> Thor Heyerdahl and his crew sailed from Peru on a raft called <i>Kon Tiki</i>, arriving in Polynesia 101 days later.</p>
<p><b>June 8, 1992</b> World Oceans Day was celebrated for the first time.</p>	<p><b>August 10, 1846</b> The Smithsonian Institute was founded.</p>
<p><b>June 2, 1977</b> The leatherback sea turtle was listed as endangered throughout its range.</p>	<p><b>November 21, 2001</b> Regulations were enacted to prevent all anchoring at Flower Garden Banks National Marine Sanctuary.</p>
<p><b>July 16, 1872</b> Roald Amundsen, polar explorer and first to reach the South Pole, was born.</p>	<p><b>June 11, 1910</b> Jacques Cousteau, ocean explorer and inventor of SCUBA, was born.</p>

<p><b>February 12, 1809</b> Charles Darwin, famed naturalist and explorer, was born.</p>	<p><b>August 4, 1790</b> The U.S. Coast Guard was established.</p>
<p><b>January 3, 1807</b> Sir James Clark Ross took the first modern sounding in the deep sea.</p>	<p><b>October 1996</b> Stetson Bank was added to the Flower Garden Banks National Marine Sanctuary.</p>
<p><b>August 15, 1934</b> William Beebe and Otis Barton descended 3,028 feet under the sea in a bathysphere.</p>	<p><b>December 22, 1938</b> Marjorie Courtenay-Latimer discovered the first living Coelacanth.</p>
<p><b>September 1, 1985</b> Dr. Robert Ballard discovered the wreck of the <i>HMS Titanic</i>.</p>	<p><b>October 18, 1972</b> The Clean Water Act was enacted.</p>
<p><b>October 23, 1972</b> The Marine Protection, Research and Sanctuaries Act established the National Marine Sanctuary Program.</p>	<p><b>November 1947</b> Kerr-McGee drilled the first commercial oil well out of sight of land in the Gulf of Mexico.</p>
<p><b>November 17, 1869</b> The Suez Canal opened.</p>	<p><b>December 1862</b> The ironclad ship <i>Monitor</i> sank off of Cape Hatteras, NC.</p>
<p><b>August 28, 1998</b> An artificial reef was formed off Port Isabel, TX by sinking a ship.</p>	<p><b>December 28, 1973</b> The Endangered Species Act was enacted.</p>



## WORLD EVENTS DATE CARDS

<p><b>September 16, 1810</b> Mexico won its independence from Spain.</p>	<p><b>June 18, 1812</b> The War of 1812, between the U.S. and Great Britain, began.</p>
<p><b>1817-1820</b> Jean Lafitte occupied Galveston Island and used it as a base for smuggling and privateering.</p>	<p><b>January 3, 1823</b> Stephen F. Austin received a grant from Mexico to begin colonization of Texas.</p>
<p><b>December 3, 1828</b> Andrew Jackson was elected President of the United States.</p>	<p><b>December 23, 1823</b> Clement C. Moore first published <i>A Visit from St. Nicholas</i>.</p>
<p><b>June 14, 1834</b> Isaac Fischer, Jr. received a patent for sandpaper.</p>	<p><b>August 27, 1957</b> The first oil well in the U.S. was drilled near Titusville, PA.</p>
<p><b>February 23-March 6, 1836</b> The Mexicans laid siege to the Alamo in Texas.</p>	<p><b>May 5, 1862</b> Mexico wins independence from Spain (Cinco de Mayo).</p>
<p><b>April 21, 1836</b> Sam Houston won the Battle of San Jacinto against Mexico.</p>	<p><b>December 29, 1845</b> Texas became the 28<sup>th</sup> state under President James Polk.</p>
<p><b>March 17, 1845</b> The rubber band was invented.</p>	<p><b>August 15, 1914</b> The Panama Canal was opened.</p>

<p><b>December 29, 1851</b> The first YMCA opened in Boston, MA.</p>	<p><b>May 1, 1840</b> First postage stamp issued in Great Britain.</p>
<p><b>October 27, 1997</b> Mini-crash of stock markets around the world.</p>	<p><b>April 9, 1865</b> The U.S. Civil War ended.</p>
<p><b>February 1, 1861</b> Texas joined the Confederate States of America.</p>	<p><b>January 1, 1863</b> Abraham Lincoln signed the Emancipation Proclamation.</p>
<p><b>March 30, 1870</b> Texas was re-admitted to the Union.</p>	<p><b>March 7, 1876</b> Alexander Graham Bell received a patent for the telephone.</p>
<p><b>July 4, 1876</b> The United States celebrated its Centennial.</p>	<p><b>January 27, 1888</b> The National Geographic Society was founded in Washington, DC.</p>
<p><b>March 12, 1912</b> The Girl Scouts organization was founded.</p>	<p><b>March 12, 1894</b> Coca Cola was first sold in bottles.</p>
<p><b>September 8, 1900</b> The <i>Great Storm</i> struck Galveston and destroyed the island, killing over 6000 people.</p>	<p><b>September 18, 1926</b> The Great Miami Hurricane killed over 100 people.</p>

<p><b>June 25, 1950</b> The Korean War began.</p>	<p><b>July 1965</b> U.S. troops were first committed to the Vietnam War.</p>
<p><b>September 7, 1888</b> George Eastman patented the first film camera under the trademark <i>Kodak</i>.</p>	<p><b>January 1, 1892</b> Ellis Island began accepting immigrants.</p>
<p><b>September 1, 1939</b> World War II began.</p>	<p><b>October 28, 1986</b> 100<sup>th</sup> anniversary of the dedication of the Statue of Liberty in New York Harbor.</p>
<p><b>March 20, 1917</b> The zipper was patented by Gideon Sundback.</p>	<p><b>June 28, 1914</b> Frances Ferdinand was assassinated at Sarajevo, which led to the start of World War I.</p>
<p><b>February 8, 1910</b> The Boy Scouts of America was founded.</p>	<p><b>September 15, 1883</b> The University of Texas opened in Austin, TX.</p>
<p><b>May 16, 1888</b> The state capitol was dedicated in Austin, TX.</p>	<p><b>January 10, 1901</b> “Black Gold” was discovered at Spindletop oil field near Beaumont, TX.</p>
<p><b>December 17, 1903</b> The Wright Brothers made their first flight at Kitty Hawk.</p>	<p><b>October 3, 1906</b> SOS became the international distress signal.</p>

## JACQUES COUSTEAU DATE CARDS

<p><b>1910</b> Cousteau was born in Saint-André-de-Cubzac, France on June 11.</p>	<p><b>1959</b> Cousteau addressed the first World Oceanic Congress.</p>
<p><b>1930</b> Cousteau entered Ecole Navale (French Naval Academy).</p>	<p><b>1960</b> Cousteau joined a movement to prevent the dumping of French atomic waste into the Mediterranean Sea.</p>
<p><b>1933</b> Cousteau graduated from the Naval Academy and entered the French Navy.</p>	<p><b>1960</b> Cousteau was featured on the cover of <i>Time</i> Magazine.</p>
<p><b>1936</b> Cousteau was given a pair of underwater goggles. Upon first explorations, he immediately began designing a device for underwater breathing.</p>	<p><b>1961</b> Cousteau was awarded <i>National Geographic</i> Magazine's Gold Medal.</p>
<p><b>WWII</b> Cousteau served as a gunnery officer in the French Navy and was awarded the prestigious Legion d'Honneur.</p>	<p><b>1966</b> Cousteau's first hour-long special, "The World of Jacques-Yves Cousteau," aired on TV.</p>
<p><b>1942</b> Cousteau designed the Aqua-Lung.</p>	<p><b>1968</b> "The Undersea World of Jacques Cousteau" was first aired and ran for eight seasons.</p>
<p><b>1957</b> Cousteau resigned from the French Navy and became director of the Oceanographic Museum in Monaco.</p>	<p><b>1975</b> Cousteau founded the Cousteau Society to raise public opinion against pollution.</p>

<b>1985</b> Cousteau received the U.S. Presidential Medal of Freedom.	<b>1987</b> Cousteau was inducted into the Television Academy's Hall of Fame.
<b>1988</b> National Geographic Society honored Cousteau with the Centennial Award.	<b>1989</b> France admitted Cousteau membership into its prestigious Academy.
<b>1997</b> Cousteau died in Paris, France on June 25.	<b>SOURCE:</b> <a href="http://www.notablebiographies.com/Co-Da/Cousteau-Jacques.html">http://www.notablebiographies.com/Co-Da/Cousteau-Jacques.html</a>

## Education Standards

### National Education Standards

Science: MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

ELA/Literacy: WHST.6-8.2 Write informative/explanatory texts to examine a topic.

ELA/Literacy: WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research.

ELA/Literacy: WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

ELA/Literacy: RST.11-12.9 Synthesize information from a range of sources into a coherent understanding of a concept.

Mathematics: HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when report quantities.

Mathematics: 6.SP.B.5 Summarize numerical data sets in relation to their context.

### Texas Essential Knowledge and Skills (TEKS) - Science

6.2C Collect and record data using the International System of Units (SI) and qualitative means.

6.2E Analyze data to formulate reasonable explanations, communicate conclusions, and predict trends.

6.12E Describe biotic and abiotic parts of an ecosystem in which organisms interact.

7.2C Collect and record data using the International System of Units (SI) and qualitative means.

7.2E Analyze data to formulate reasonable explanations, communicate conclusions, and predict trends.

7.13A Investigate how organisms respond to external stimuli found in the environment.

8.2C Collect and record data using the International System of Units (SI) and qualitative means.

8.2E Analyze data to formulate reasonable explanations, communicate conclusions, and predict trends.

8.11D Recognize human dependence on ocean systems and explain how human activities have modified these systems.

Aquatic Science.2F Collect data, make accurate measurements, record values, and calculate relevant quantities.

Aquatic Science.2J Communicate valid conclusions.

Aquatic Science.3B Communicate and apply scientific information extracted from various sources.

Aquatic Science.4A Identify key features and characteristics of atmospheric, geological, hydrological and biological systems as they relate to aquatic environments.

Aquatic Science.6B Examine the interrelationships between aquatic systems and climate and weather.

Aquatic Science.12A Predict effects of chemical, organic, physical, and thermal changes from humans on the living and nonliving components of an aquatic ecosystem.

Biology.2F Collect and organize data and make accurate measurements.

Biology.2J Communicate valid conclusions.

Biology.11B Investigate and analyze how organisms, populations, and communities respond to external factors.

Earth/Space Science.2G Make inferences and predict trends from data.

Earth/Space Science.2I Communicate valid conclusions.

Earth/Space Science.15B Investigate evidence such as cores for climate variability and its use in developing computer models to explain present and predict future climates.

### Ocean Literacy Principles

2. The ocean and life in the ocean shape the features of Earth. (a)

5. The ocean supports a great diversity of life and ecosystems. (a,f)

### Climate Literacy Principles

3. Life on Earth depends on, is shaped by, and affects climate. (a, c)

4. Climate varies over space and time through both natural and man-made processes. (e)